

PHL Centrifugal pump

***Installation
Operation
Maintenance***

Single stage horizontal centrifugal pump

PCN= 00079593 Ed. 10-10 E



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

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1 INTRODUCTION AND SAFETY

1.1 General



These instructions shall 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 product support, repair and diagnostic services.

These instructions are intended to facilitate familiarization with the product and its use. Operating the product in compliance with these instructions is important to help ensure reliability in service and to avoid risks. The instructions may not take into account local regulations: ensure such regulations are observed by all, including the people installing the product. Always coordinate repair activities 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 shall not be put into service until all the conditions in relation with 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, these Directives and any additional Approvals cover important safety aspects in relation with 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 applicable Approvals 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 necessary information, the content of this manual may prove to be insufficient and is not guaranteed by Flowserve as to its completeness or accuracy.

Flowserve manufactures products to existing 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 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 purchase order. The acknowledgement of these conditions has been sent separately to the Purchaser. A copy should be kept with these instructions.



The product shall 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 needs 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 substances 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 marking according to ATEX. It is used in safety instructions where non-compliance in the hazardous area would cause the risk of an explosion.

Note: 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 have the necessary knowledge and skills, appropriate training and instruction shall be provided. If required the operator may commission the manufacturer/supplier to provide applicable training.

Always coordinate repair activities 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 IN OPERATION**

 **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 fluor-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 higher 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 shall 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 shall be applied.

Gland packing shall 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 shall be followed to help ensure explosion protection. Both electrical and non-electrical equipment shall 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

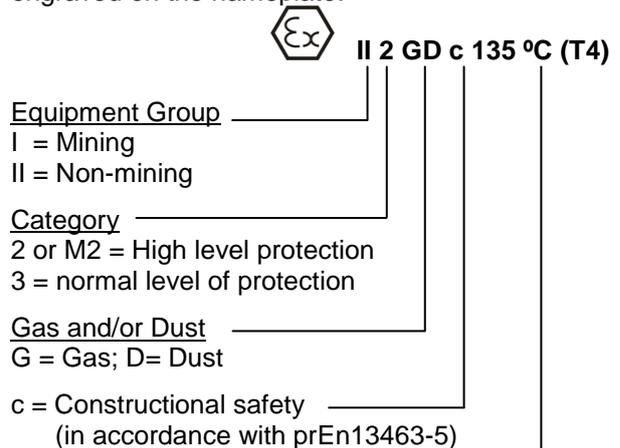
appropriate. Always check that the driver, seal and pump equipment are suitably rated and/or certified for the classification of the specific atmosphere in which they are to be installed.

Where Flowserve has supplied only the bare shaft pump, the Ex rating is only applicable 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 is applicable, 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.



Maximum surface temperature (Temperature Class)
(See section 1.6.4.3.)

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 shall 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 not completely filled. Even a short run time may give a high temperature resulting from contact between rotating and stationary components.

If there is any possibility of risk of the pump being run against a closed valve, generating high liquid and casing external surface temperatures it is recommended that an external surface temperature protection device will be mounted.

Avoid mechanical, hydraulic or electrical overload by using motor overload trips, temperature monitoring or power monitoring 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 running protection device is recommended (eg liquid detection or a power monitor).

To avoid potential hazards from fugitive emissions of vapour or gas to the 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 shall 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 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 risk of a loss of a seal barrier fluid or external flush, the fluid must be monitored.

If leakage of liquid to the 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.

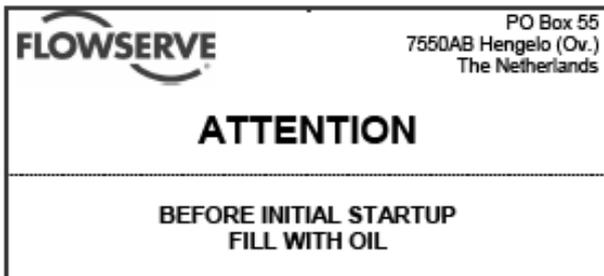
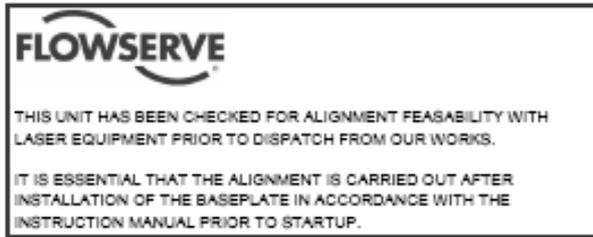
It is recommended that a maintenance plan and schedule is adopted. (See section 6, *Maintenance*.)

1.7 Nameplate and warning labels

1.7.1 Nameplate

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

1.7.2 Warning labels



ATTENTION

- When installing a horizontal pump unit, it should be completely realigned, even if it has already been tested at the Flowserve Works. Level the base plate, align the coupling and grout the base plate with a suitable (shrink-proof) concrete.
- When installing a vertical pump unit it should be aligned truly vertical on the foundation.
- After the concrete has cured, tighten the anchor bolts. The suction & discharge piping must be stress free connected and sufficiently supported to the pump. In case of temperature changes in the suction & discharge piping, these stresses may not be transferred to the pump.
- After connection of the suction & discharge piping, disconnect the coupling bolts and check the position of the coupling halves. Realign, if necessary.
- If the dowels of the electric motor feet are supplied separately, they must be installed at site after correct alignment.
- If the soft packing is supplied separately, it must be installed one by one. The joint of each ring must be placed at an angle of 180° to the adjacent one.
- Check for the correct lubricant in the bearings and motor and, if applicable, the coupling.
- If applicable, connect the auxiliary piping for cooling, sealing or flushing liquids.
- Check the rotation direction of the motor with pump and motor uncoupled before start-up. Never start an empty pump!
- Also read the separate instruction handbook of the pump unit.
- In case of doubt or complaints, contact the Flowserve service department and state the pump number.



V02AN99-EN

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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 with the delivery and shipping documents for its completeness and to ensure that there has been no damage during transportation.

Any shortage and or damage shall be reported immediately to Flowserve Pump Division and received in writing within one month of receipt of the equipment. Claims coming in afterwards cannot be accepted.

Check any crate, box 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

2.3.1 Lifting the pump



Attach the lifting cables behind the suction flange and through the bearing support, see Figure 1.

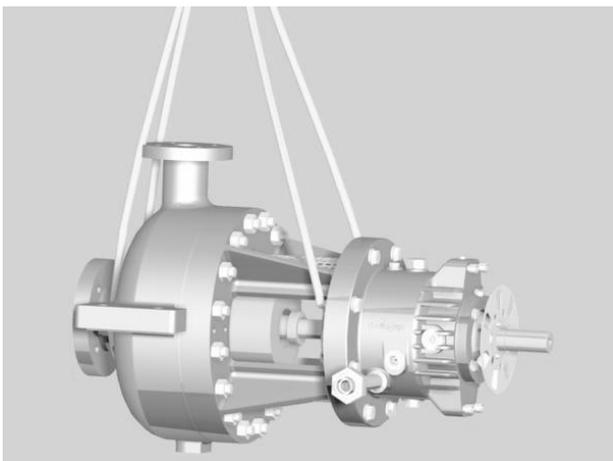


Figure 1

2.3.2 Lifting the back pull out unit

Lift the back pull out unit by the bearing support, see Figure 2.

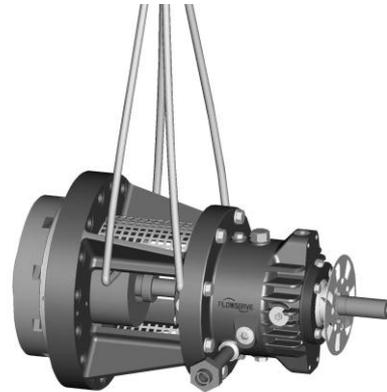


Figure 2

2.3.3 Lifting with foundation frame

The unit must be lifted at the lifting lugs or eye bolts of the base plate. For lifting of the total unit a lifting beam or lifting frame shall be used to avoid damaging of the E-motor, seal plan, interconnecting piping and/or instruments).



Unsafe lifting is never allowed!

 A crane shall 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



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, in accordance with environmentally acceptable methods 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 shall be in accordance with the current regulations at all times.

3 PUMP DESCRIPTION

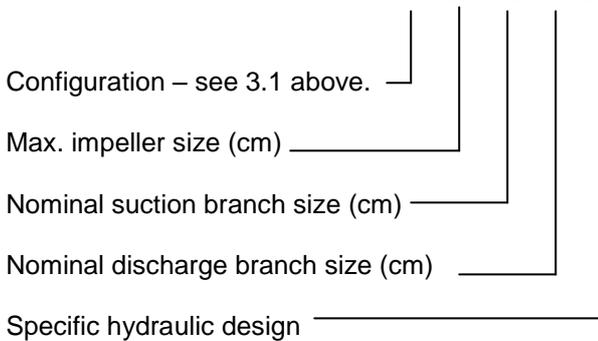
3.1 Configuration

The PHL type pump is a heavy duty, single stage, horizontal centrifugal pump, designed for the Petrochemical Industry, chemical plants, general service and circulating applications.

3.2 Name nomenclature

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

PHL 30.20.15.30F



The typical nomenclature above is the general guide to the PHL 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 Pump Shaft

The pump is of the dry shaft design and has a keyed drive end.

3.3.5 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.

3.3.6 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.

3.3.7 Driver

The driver can be an electric motor or diesel motor or turbine.

3.3.8 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 are included as additional information to help with your installation. It is typical, and factors such as temperature, materials, and seal type may influence these 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 +450 °C (842 °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	up to 3600

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.)
PHL 25.08.05	240 (9.45)	90/130 (3.54/5.12)	0.35/0.43 (0.014/0.017)
PHL 25.10.08	235 (9.25)	130/-- (5.12/--)	0.43/-- (0.017/--)
PHL 25.15.10	242 (9.53)	165/200 (6.50/7.87)	0.45/0.50 (0.018/0.020)
PHL 30.20.15	290 (11.4)	220/265 (8.66/10.43)	0.50/0.55 (0.020/0.022)
PHL 35.08.05	370 (14.57)	100/130 (3.93/5.12)	0.35/0.43 (0.014/0.017)
PHL 35.10.08	370 (14.57)	130/140 (5.12/5.51)	0.43/0.43 (0.017/0.017)
PHL 35.15.10	354 (13.93)	180/200 (7.09/7.87)	0.48/0.50 (0.019/0.020)
PHL 40.10.08	420 (16.54)	140 / 140 (5.51/5.51)	0.43/0.43 (0.017/0.017)
PHL 40.15.10	420 (16.54)	170/195 (6.66/7.68)	0.48/0.50 (0.019/0.020)
PHL 40.20.15	420 (16.54)	220/290 (8.66/11.41)	0.50/0.60 (0.020/0.025)

4 INSTALLATION



Equipment operated in hazardous locations shall 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

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 requirements are met.

The 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.

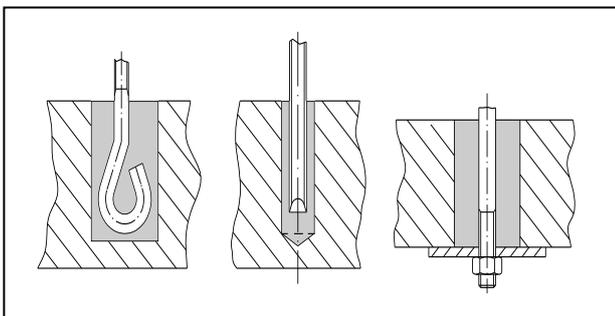


Figure: foundation bolts

- 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:

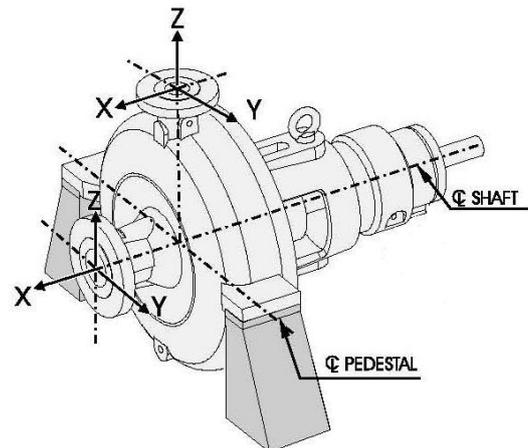
- do not place the pump unit on the base until it is **completely** set;
- fill the recesses with water at least 24 hours before grouting the foundation bolts. Wetting the recesses will strengthen the bond between the mortar of the foundation bolts and the base;
- remove the water from the recesses when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

4.3.1 Positioning the foundation bolts

- Lift the pump unit above the base in accordance with the lifting instructions described in § 3.1.
- Place the foundation bolts with nuts and washers in the foundation frame.

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

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



- The level of the center line of the suction and discharge nozzles should correspond with the center line of the pipes to be connected.
- The position of the suction and discharge nozzles in the y and z directions (see Figure 2) and
- The vertical distance between the base and the foundation frame (40 mm) before filling with mortar.
- Lay steel filler blocks 25 mm thick on the base on either side of the foundation bolts.
- Place the pump unit on the filler blocks.
- Lay thin filler plates under the adjusting bolts.
- Adjust the pump unit so that it is roughly level and at the required height by turning the adjusting bolts in the welded-on adjusting bosses of the foundation frame 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 foundation frame 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 set in accordance with the specifications.

4.4 Adjusting the foundation frame

To make sure that the unit is leveled, use a calibrated machine level with an accuracy of 0.02 mm/m¹. 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 foundation frame in the direction A-B with an accuracy of 0.05 mm/m¹ using the adjusting bolts, see Figure 3. Fill the space between the filler blocks and the foundation frame with thin filler plates.
- Tighten the foundation nuts, along the A-B axis, by applying a moment equal to ¼ the maximum permissible moment (M_{max}) of the foundation bolt.
- Level the foundation frame in the directions C-D, E-F and G-H with an accuracy of 0.05 mm/m¹ using the adjusting bolts. Fill the space between the filler blocks and the foundation frame with thin filler plates.
- Tighten the other foundation nuts by applying a moment equal to ¼ the maximum permissible moment (M_{max}) of the foundation bolt.
- Check that the nuts of the foundation bolts are still tight.

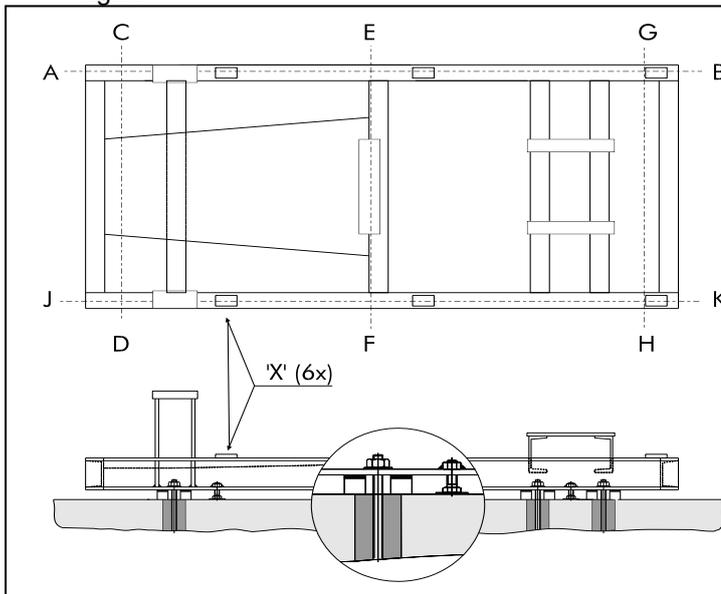


Figure 3: Adjusting foundation frame

- Place the electric motor on the pump center line, using shims between the supporting faces of the foundation frame and the motor base. The maximum allowable deviation in axial or radial direction is 0.05 mm and depends on the type of coupling.

- Retract all foundation bolts and check that the foundation frame is level in all directions with an accuracy of 0.05 mm/m¹.
- Check the position and level along the center line of the suction and discharge nozzles. Adjust, if necessary, by following the procedures given above.
- Fill in the outer edges of the foundation frame, including filler plates, **completely**, using non-shrinkable mortar (e.g. Pagel V1 or equivalent) and let this set in accordance with the specifications.
- Grout the foundation frame, via the fill opening (see Figure 3), **completely**, using non-shrinkable concrete and let this set in accordance with the specifications.
- Check that the nuts of the foundation bolts are still tight and tighten, if necessary, by applying the correct moment (¼ M_{max}).
- 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 Baseplate not Intended for Grouting but Installed on Concrete Foundations

According to the figure 4.3.1 and 4.4.1 the baseplate will not be grouted but only a sealing shall be provided. During the preparation, as indicated on the General Arrangement drawing a certain number of openings into the sealing must be guaranteed. After the sealing the blocks used to realise the openings must be removed. Blocks has to be wider than the baseplate longitudinal beam in order to guarantee the opening for the drainage.

Note: The filler grout must be of a non-shrinkable kind and fill up the space between the beams and the concrete pour. Make sure that filler grout is dry before removing the blocks.

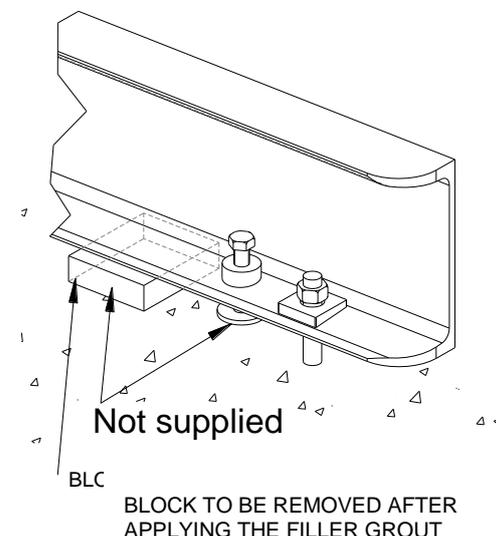


Figure 4.3.1

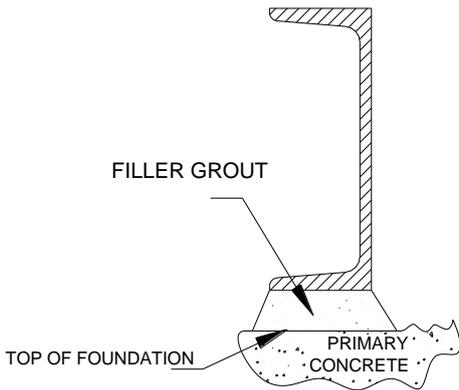


Figure 4.4.1

4.5 Initial alignment

4.5.1 Thermal expansion

The PHL 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



DANGER

Ensure pump and driver are isolated electrically and the half couplings are disconnected.



CAUTION

The alignment **MUST** be checked.

Although the pump will have been aligned at the factory it is most likely that this alignment will have been disturbed during transportation or handling. If necessary, align the motor to the pump, not the pump to the motor.

4.5.2.1 Shaft/Coupling alignment



CAUTION

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

Note:

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

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

4.5.2.1.1 Types of misalignment

There are two types of shaft misalignment: angular and offset. Therefore, two sets of measurements and corrections are required. Both types of misalignment can occur in horizontal and vertical planes and are present in most applications.

A) Angular misalignment

In angular misalignment, the centre line of the shafts intersect, but are not on the same axis.

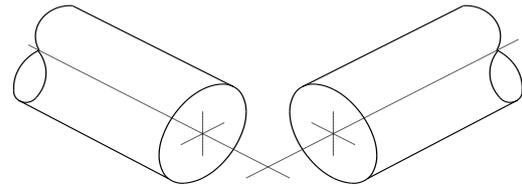


Figure 4.5

B) Offset misalignment

In offset misalignment, the shaft centre lines are parallel but do not intersect.

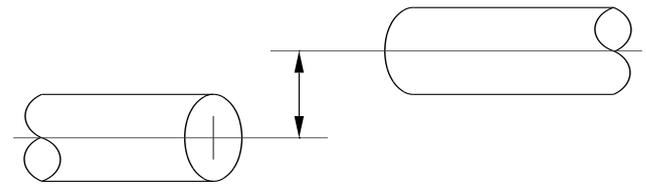


Figure 4.6.1 – offset misalignment

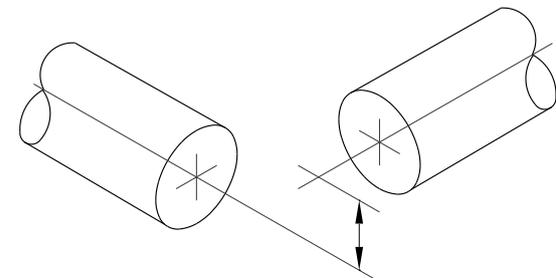


Figure 4.6.2 – combination of offset and angular misalignment

4.5.2.2 Alignment using the Reverse Alignment Method

The following practices are recommended when using the reverse method of alignment. These should be carried out prior to main alignment.

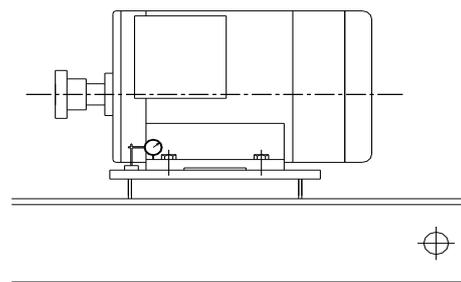


Figure 4.7

CHECK FOR SOFT FOOT

This is a check to ensure that there is no undue stress on the driver holding down bolts; owing to non-level baseplate or twisting. To check, remove all shims and clean surfaces and tighten down driver to the baseplate. Set a dial indicator as shown in sketch and loosen off the holding down bolt while noting any deflection reading on the Dial Test Indicator - a maximum of 0.05 mm (0.002 in.) is considered acceptable but any more will have to be corrected by adding shims, for example, if the Dial Test Indicator shows the foot lifting 0.15 mm (0.006 in.) then this is the thickness of shim to be placed under that foot. Tighten down and repeat the same procedure on all other feet until all are within tolerance

Note: If the driver is an electric motor with sleeve bearings then the magnetic centre at which the rotor will run must be set. This is usually done by lining up a groove in the shaft to a pointer fixed to the motor body (refer to Motor Manufacture’s instructions).

4.5.2.3 Alignment using a graph (Reverse Alignment)

DANGER Ensure pump and driver are isolated electrically and the half couplings are disconnected.

CAUTION The alignment **MUST** be checked. Although the pump will have been aligned at the factory it is most likely that this alignment will have been disturbed during transportation or handling. If necessary, align the motor to the pump, not the pump to the motor.

The alignment is achieved by adding or removing shims under the motor feet and also moving the motor horizontally as required. In some cases where the alignment cannot be achieved it will be necessary to move the pump before recommencing the above procedure.

For couplings with narrow flanges use a dial indicator as shown below to check both parallel and angular alignment.

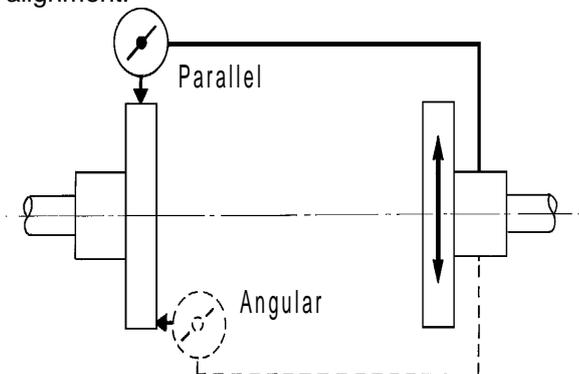


Figure 4.8

Maximum permissible misalignment at working temperature:

- Parallel 0.05 mm (0.002 in.) TIR
- Angular 0.025 mm (0.001 in.) TIR

Pumps with thick flanged non-spacer couplings can be aligned by using a straight-edge across the outside diameters of the coupling hubs and measuring the gap between the machined faces using feeler gauges, measuring wedge or calipers.

When the electric motor has sleeve bearings it is necessary to ensure that the motor is aligned to run on its magnetic centreline.



Refer to the motor manual for details.

A button (screwed into one of the shaft ends) is normally fitted between the motor and pump shaft ends to fix the axial position.



CAUTION If the motor does not run in its magnetic centre the resultant additional axial force may overload the pump thrust bearing.



Complete piping as below and see sections 4.7, “Final shaft alignment check” up to and including section 5, “Commissioning, start-up, operation and shutdown” before connecting driver and checking actual rotation.

4.5.3 Shims

The shims between the equipment feet and mounting surface should be clean and dry. This is especially critical for pumps in service for sometime and need to be realigned. Water, dirt and rust may change the height of the shim pack over a period of time. Shims should be made large enough to support the weight of the equipment on its mounting foot. Do not use many thin shims as this may result in a spongy mounting.

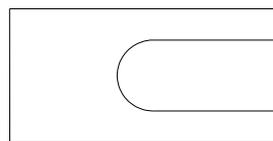


Figure 4.9 Recommended shim design

Move the equipment vertically by adding or removing the calculated thickness of shims. Torque holding down bolts to required values.

4.5.4 Assemble coupling

- a) Assemble coupling as per the manufacturer's instructions included in Appendix of this manual.
- b) Install coupling guard

4.5.5 Installation check list

- a) Level Baseplate?
- b) Grout Baseplate - Check Foundation Bolts?
- c) Alignment Shaft/Coupling?

- d) Piping Installed - Correct Vent, Gauge, Valve, Suction Strainer Locations?
- e) All Flange Bolting Correctly Torqued with appropriate gaskets in place?
- f) Check Shaft/Coupling Alignment again.
- g) Coupling guard correctly installed?



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 shall be higher than the required NPSH of the pump.



Never use the pump as a support for piping.

Maximum allowable forces and moments on the pump flanges vary with the pump size and type. To minimize these forces and moments, which, 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 bring piping into place by applying forces to the 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 allowable forces and moments on the pump casing. 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

- a) The inlet pipe should be one or two sizes larger than the pump inlet bore and pipe bends should be of a radius as large as possible.
- b) Pipework reducers should have a maximum total angle of divergence of 15 degrees.
- c) Keep the total length of the suction pipe as short as possible.
- d) 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 allowable forces and moments on PHL 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 casing drains and gland leakage to a convenient disposal point.

4.6.5.2 Pumps fitted with gland packing

When suction pressure is below atmospheric 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 auxiliary piping different 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 base plate 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 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.

5 COMMISSIONING, START-UP, OPERATION AND SHUTDOWN

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

5.1 Pre-commissioning procedure

CAUTION 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

CAUTION See lubrication schedule under Appendix 1.

5.3 Impeller clearance

No functional adjustments are to be considered.

5.4 Direction of rotation

CAUTION 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.

CAUTION 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

CAUTION Ensure all electrical, hydraulic, pneumatic, sealant and lubrication systems (as applicable) are connected and operational.

CAUTION Ensure the inlet pipe and pump casing are completely full of liquid before starting continuous duty operation.

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 Warming-up instructions for hot pumps

5.7.1 Prefix

For pumps with a duty temperature above 200 °C, bearing cooling is required as to be specified on the pump data sheet. Stuffingbox cooling is required depending on the sealselection and conditions required to the seal. In general, this means that stuffingbox cooling is not required, when a cooling system on the sealharness is sufficient to maintain a constant duty temperature of the seal, which is lower than the design temperature of the seal. However, because not all factors which have their impact on the temperature and duty of the seal are constant factors, such as heat flux pump, heatload seal, ambient temperature, the wear of the seal and friction of the sealfaces etc. or in case that process fluid cooling is required, jackets on the stuffingboxes might be applied.

5.7.2 Warming-up procedure

When a cooling jacket is applied on the stuffingbox, the pump with a duty temperature above 100 °C has to be warmed-up, to avoid difficulties caused by thermal expansion of the relevant pump parts through thermal shock (pumphousing, cover, shaft, jacket, seal and connection parts etc.).

Follow below mentioned instructions punctual:

- First- Check if cooling medium to the jacket is connected and with the required flow.
- Second- Bring the pump to the working temperature from 100 °C at a time schedule of 5 °C per minute. Up to 100 °C no special time schedule is required. (see also chapter commissioning).
- Third- Check at duty of the pump that no major thermal fluctuations appear with a time schedule larger than described under "second".

Note: for stopping the pump, the time schedule as described for warming-up should be held in opposite time-temp. schedule (cooling-down 5 °C per minute).

5.8 Starting the pump

- a) **CAUTION** 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) Start motor and check outlet pressure.
- f) If the pressure is satisfactory, slowly OPEN outlet control valve.

- g) Do not run the pump with the outlet valve closed for a period longer than 30 seconds.
- h) If NO pressure, or LOW pressure, STOP the pump. Refer to section 7, *Faults; causes and remedies*, for fault diagnosis.

5.9 Running the pump

5.9.1 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 start overheating. If overheating takes place the pump should be stopped and allowed to cool down 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, not even for a short time.

5.9.2 Pumps fitted with mechanical seal

Mechanical seals are not adjustable. 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 faces.



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



Never run a mechanical seal dry, not even for a short time.

5.9.3 Bearings



If the pumps are working in a potentially explosive atmosphere, temperature or vibration monitoring 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 been 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 reduced with time. (Refer to section 6.1.1 for further information.)

5.9.4 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	≤ 6.0 (0.18)

5.9.5 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)	6
Between 15 (20) and 90 (120)	6
Above 90 (120)	4

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

5.10 Stopping and shutdown

- a)  Close the outlet valve, but ensure that the pump runs in this condition not longer 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 longer 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.

5.11 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 to decide how to evaluate the implications of any change. If in doubt, contact your nearest Flowserve office.

5.11.1 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.

5.11.2 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.

5.11.3 Pump speed

Changing pump speed effects flow, total head, power absorbed, $NPSH_R$, noise and vibration. The flow is directly proportion of the 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.

5.11.4 Net positive suction head ($NPSH_A$)

$NPSH$ available ($NPSH_A$) is a measure of the head available in the pumped liquid, above 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.

5.11.5 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 leakage can make the floor slippery. Machine maintenance must always begin and finish by cleaning the floor 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 wear 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 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:

- Any auxiliary systems installed must be monitored, if necessary, to ensure they function correctly.
- 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.
- Check for any leakage from gaskets and seals. The correct functioning of the shaft seal must be checked regularly.
- Check pump bearing lubricant and relevant provisions (such as constant level oiler).
- Check motorbearing lubricant at intervals as described in the motor instructions.
- Check that the duty condition is in the safe operating range for the pump.
- Check vibration, noise level and surface temperature at the bearings to confirm satisfactory operation.
- Check dirt and dust is removed from areas around close clearances and motors.

Our specialised 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:

- Refer to section 7, *Faults; causes and remedies*, for fault diagnosis.
- Ensure equipment complies with the recommendations in this manual.
- 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:

- Check operating behaviour. Ensure noise, vibration and bearing temperatures are normal.
- 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.
- Check that shaft seal leakage is within acceptable limits.
- Check pumpbearing lubricant level.
- For motors with regreasable bearings, check number of running hours since last recharge of grease or since complete grease change.
- 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 (every 6 months)



- 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 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 every 6 months.

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 pump and motor bearings (line and thrust)
- 1 - mechanical seal or set of seal faces
- 2 - sets of pump- and sealsgaskets
- 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 pump and motor bearings (line and thrust)
- 1 - mechanical seal
- 2 - sets of pump- and sealgaskets
- 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 (typical)

Application	Torque Nm (lb•ft)	
	Lubricated	Non-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
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.

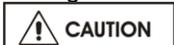
6.7.1 Removing the spacer

If applicable, remove the spacer of the coupling between the pump unit and the electric motor according to the suppliers documentation.

6.7.2 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.

6.7.3 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.

6.7.4 Removing the impeller

This procedure describes removal of the impeller from the pump shaft.

- fix the mechanical seal to the shaft sleeve by using the setting plates on top of the mechanical cover
- 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 [4590.1] 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 pump shaft and remove the released key [6700.1].
- remove packing ring [4590.3] between the impeller and the stub sleeve of the mechanical seal.



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

6.7.5 Removing the bearing bracket

The mechanical seal is mounted on the back of the casing cover which means that the bearing bracket 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 set screws from the shaft sleeve to make the mechanical seal cartridge loose.
- Remove the bolts [6577.5].
- Lift the pump bracket up vertically. Work carefully as long as the pump shaft is still inserted in the shaft sleeve.

6.7.6 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.

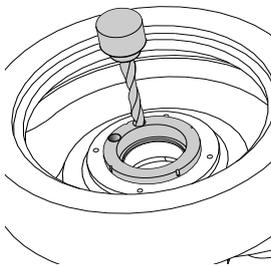
For further information on the mechanical seal, please refer to the instructions for use provided by the mechanical seal supplier.

6.7.7 Removing the case wearing rings

This is the procedure to be followed when removing the case wearing ring (2300.1) from the diffuser and, if applicable, the wearing ring in the casing cover (2300.2).

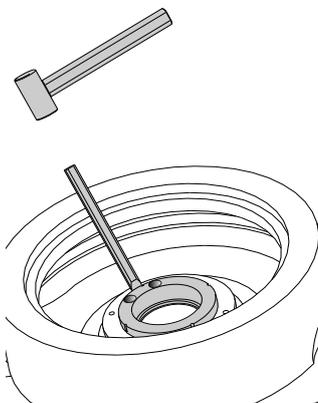
The case wearing ring (2300.2) has been pressed or shrunk into the centring rim during assembly which means that it will be necessary to drill or cut into the case wearing ring in order to weaken the upright edge.

- Remove the set screws [6570.1/3]. These set screws lock the case wearing ring on 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



- 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 diffuser or casing cover.

Figure : Removing the case wearing ring

6.7.8 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 on 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.

6.7.9 Removing the throat bush

This procedure describes removal of the throat bush from the casing cover.

- Remove set screws [6570.3] from the bottom of the casing cover. These set screws lock the throat bush [4132] in the casing cover.
- Remove the throat 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.

6.7.10 Removing the throwers

This procedure describes removing the throwers from the pump shaft.

- Untighten the set screws from the throwers (2540.1/2)
- Remove the throwers from the pump shaft.

6.7.11 Removing the bearing covers

This procedure describes removing the bearing cover from the bearing housing.

- Remove the bolts (6577.2 and 6577.3) from the bearing housing (3200).
- Remove the bearing covers (3260.1 and 3260.2).

6.7.12 Removing the bearings from the bearing housing

This procedure describes removing the radial roller bearing and the axial ball bearing from the bearing housing.

- Remove the pump shaft from the bearing housing by hitting carefully, with a plastic or lead hammer, the impeller side of the pump shaft. The inner ring of the radial roller bearing (3012) and the complete axial ball bearing (3013) will shove out of the bearing housing.
- Remove the outer ring of the radial roller bearing (3012) from the bearing housing.

6.7.13 Removing the bearings from the shaft

This procedure describes removing the radial roller bearing and the axial ball bearing from the pump shaft.

- Bend open the lips of the lock washer (2911) and remove the bearing nut (2910) from the pump shaft.
- Remove the lock washer.
- Remove the axial ball bearing from the pump shaft by using the right tools.
- Remove the lock washer (6545) from the pump shaft, which is placed for locking the inner raceway of the radial roller bearing (3012).
- Remove the inner ring of the radial roller bearing from the pump shaft.

6.8 Examination of parts



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

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

6.8.2 Pump shaft and stub sleeve (if fitted)

Although the pump is 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 Pump bearings

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 bearings on the shaft

This procedure describes the assembly of the radial roller bearing and the axial ball bearing on the pump shaft.

- Clean the mounting faces of the pump shaft (2110), the radial roller bearing (3012) and the axial ball bearing (3013).
- Push the inner ring of the radial roller bearing on the pump shaft.

- Put the spring washer (6545) on the pump shaft for the radial roller bearing.
- Push the axial ball bearing on the pump shaft.
- Push the lock washer (2911) for the axial ball bearing and install the bearing nut (2910) on the pump shaft.
- Lock the bearing nut by bending the lips of the lock washer into the openings of the bearing nut.

6.9.2 Fitting the bearings in the bearing housing

This procedure describes the assembly of the axial ball bearing and the radial roller bearing into the bearing housing.

- Clean the mounting faces of the bearing housing (3200), the radial roller bearing (3012) and the axial ball bearing (3013).
- Install the outer ring of the radial roller bearing into the bearing housing.
- Push the pump shaft (2110), completely mounted with the inner ring of the radial roller bearing and the axial ball bearing into the bearing housing.

6.9.3 Fitting the bearing covers

This procedure describes the assembly of the bearing covers.

- Clean the mounting faces of the bearing housing (3200) and the bearing covers (3260.1 and 3260.2)
- Put some locktite 5926 or 510 or equal on the faces between cover and housing
- Install the bearing covers on the bearing housing.
- Install the bolts (6577.2 and 6577.3).

6.9.4 Fitting the throwers

This procedure describes the fitting of the throwers on the pump shaft.

- Clean the bore of the throwers (2540.1/2) and the pump shaft (2110).
- Push the throwers on the pump shaft.
- Fit the set screws.

6.9.5 Fitting the throat bush

This procedure describes the fitting of the throat bush into the casing cover.

- Clean the mounting surfaces of the throat bush [4132] and the casing cover (1221).
- Fit the throat bush in the casing cover on the top side.

The throat 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 throat 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 throat 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.

6.9.6 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.

6.9.7 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.

6.9.8 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, dependent from the seal type.
- Place the mechanical seal in the casing cover in accordance with the instructions for use provided by the supplier.
- Tighten the nuts [6581.2] for fixing the mechanical seal to the casing cover by applying the prescribed torque, see section 6.5.

6.9.9 Fitting the bearing bracket

This procedure describes assembly of the bearing bracket to the casing cover.

- Clean the mounting surfaces of the bearing bracket and the casing cover.
- Carefully place the pump shaft in the shaft sleeve so that the pump bracket is resting.
- Tighten the bolts [6577.5].

6.9.10 Fitting the impeller

This procedure describes assembly of the impeller to the pump shaft.

- Attach the lifting devices to the appropriate lifting points and observe the lifting instructions described in section 2.3.
- Lift up the pump back pull-out unit as a single assembly so that the end of the pump shaft is easily accessible.
- Place the key [6700.1] in the pump shaft. See Figure.
- Place a new packing ring [4590.3] against the stub sleeve of the mechanical seal.
- Slide the impeller over the pump shaft.
- Fit a new packing ring [4590.1] according to Figure.

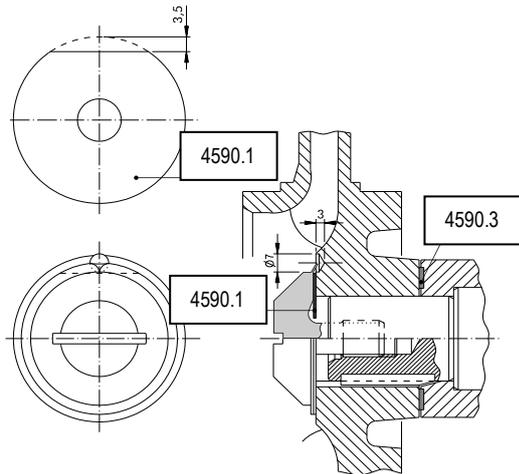


Figure: Locking impeller screw

- Place the packing ring [4590.1] 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 [4590.1] remains in place.
- 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.

Fix the shaft sleeve to the shaft and disengage the setting plates on top of the mechanical seal cover.

6.9.11 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].

6.9.12 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.
- Lift the casing cover towards 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.

6.9.13 Fitting other parts

- 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.
- Install the coupling between the pump unit and the electric motor according the suppliers documentation.
- If applicable, renew the gaskets between the flanges of the piping.
- Connect all auxiliary piping according the general arrangement drawing, the 'Process and Instrumentation Diagram' (P&ID) or the 'Auxiliary Piping Arrangement Drawing'.
- Install the coupling guard on the coupling.
- Follow the instructions for putting into operation as specified in Chapter 5.

7 FAULTS; CAUSES AND REMEDIES

FAULT SYMPTOM

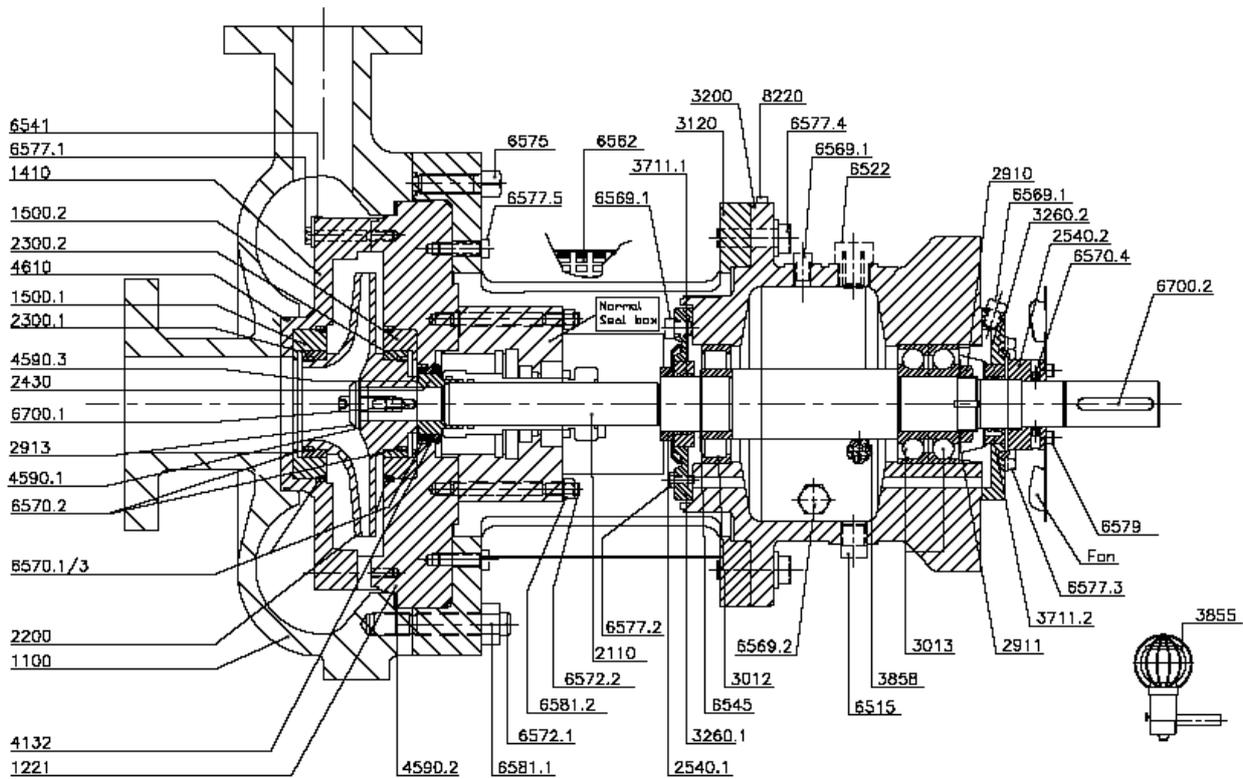
Pump overheats and seizes												
↓	Bearings have short life											
↓	Pump vibrates or is noisy											
↓	Mechanical seal has short life											
↓	Mechanical seal leaks excessively											
↓	Pump requires excessive power											
↓	Pump loses prime after starting											
↓	Insufficient pressure developed											
↓	Insufficient capacity delivered											
↓	Pump does not deliver liquid											
↓	PROBABLE CAUSES						POSSIBLE REMEDIES					
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.
				●	●	●	Wearing ring surfaces worn.					Replace worn wear ring/surfaces.

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	
			●							● ●	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. Check and CONSULT FLOWSERVE.	
			● ●								Internal misalignment of parts preventing seal ring and seat from mating properly. Check and CONSULT FLOWSERVE.	
			● ●								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



Ref.no.	Description	Ref.no.	Description
1100	Casing	4590.2	Gasket
1221	Casing cover	4590.3	Gasket
1410	Diffuser	4610	O-ring
1500.1	Casing wear ring	6515	Drain plug
1500.2	Casing wear ring	6522	Vent filter
2110	Pump shaft	6541	Lock washer
2200	Impeller	6545	Shaft circlip
2300.1	Impeller wear ring	6562	Guard
2300.2	Impeller wear ring	6569.1	Plug
2430	Throttling sleeve	6569.2	Plug
2540.1	Deflector	6570.1/3	Screw
2540.2	Deflector	6570.2	Screw
2910	Shaft nut	6570.4	Screw
2911	Shaft nut washer	6572.1	Stud
2913	Impeller screw	6572.2	Stud
3012	Radial roller bearing	6575	Jack screw
3013	Thrust ball bearing	6577.1	Hexagon head bolt
3120	Bearing support stool	6577.2	Hexagon head bolt
3200	Bearing housing	6577.3	Hexagon head bolt
3260.1	Bearing cover	6577.4	Hexagon head bolt
3260.2	Bearing cover	6577.5	Hexagon head bolt
3711.1	Bearing labyrinth ring	6579	Socket head cap screw
3711.2	Bearing labyrinth ring	6581.1	Hexagon nut
3855	Constant level oiler	6581.2	Hexagon nut
3858	Oil level sight glass	6700.1	Key
4132	Stuffing box bushing	6700.2	Key
4590.1	Gasket	8220	Direction of rotation indicator

8.2 Typical Parts list

For P.O. related parts list see table on page 29.

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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