FLOWSERVE

USER INSTRUCTIONS

IDP® WPG, WPH, CPG and CPH

D-line centrifugal pumps

Installation
Operation
Maintenance

PCN= 26999969 10-12 (E). (Based on C937KH037.)
Original instructions.

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

Experience In Motion

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1 INTRODUCTION AND SAFETY

1.1 General

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

Flowserve products are designed, developed and manufactured with state-of-the-art technologies in modern facilities. The unit is produced with great care and commitment to continuous quality control, utilising sophisticated quality techniques, and safety requirements.

Flowserve is committed to continuous quality improvement and being at service for any further information about the product in its installation and operation or about its support products, repair and diagnostic services.

These instructions are intended to facilitate familiarization with the product and its permitted use. Operating the product in compliance with these instructions is important to help ensure reliability in service and avoid risks. The instructions may not take into account local regulations; ensure such regulations are observed by all, including those installing the product. Always coordinate repair activity with operations personnel, and follow all plant safety requirements and applicable safety and health laws and regulations.

These instructions must be read prior to installing, operating, using and maintaining the equipment in any region worldwide. The equipment must not be put into service until all the conditions relating to safety, noted in the instructions, have been met. Failure to follow and apply the present user instructions is considered to be misuse. Personal injury, product damage, delay or failure caused by misuse are not covered by the Flowserve warranty.

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), minimum efficiency for some water pumps (Ecodesign) and Equipment for Potentially Explosive Atmospheres (ATEX).

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

Where applicable this document incorporates information relevant to these Directives and Approvals. To confirm the Approvals applying and if the product is CE marked, check the serial number plate markings and the Certification. (See section 9, *Certification*.)

1.3 Disclaimer

Information in these User Instructions is believed to be complete and reliable. However, in spite of all of the efforts of Flowserve Corporation to provide comprehensive instructions, good engineering and safety practice should always be used.

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

1.5 Duty conditions

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

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

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

1.6 Safety

1.6.1 Summary of safety markings

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

DANGER This symbol indicates electrical safety instructions where non-compliance will involve a high risk to personal safety or the loss of life.

This symbol indicates safety instructions where non-compliance would affect personal safety and could result in loss of life.

This symbol indicates "hazardous and toxic fluid" safety instructions where non-compliance would affect personal safety and could result in loss of life.

CAUTION This symbol indicates safety instructions where non-compliance will involve some risk to safe operation and personal safety and would damage the equipment or property.

This symbol indicates explosive atmosphere zone marking according to ATEX. It is used in safety instructions where non-compliance in the hazardous area would cause the risk of an explosion.

This symbol is used in safety instructions to remind not to rub non-metallic surfaces with a dry cloth; ensure the cloth is damp. 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 possess the necessary knowledge and skill, appropriate training and instruction must be provided. If required the operator may commission the manufacturer/supplier to provide applicable training.

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

1.6.3 Safety action

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

DANGER NEVER DO MAINTENANCE WORK WHEN THE UNIT IS CONNECTED TO POWER

GUARDS MUST NOT BE REMOVED WHILE THE PUMP IS OPERATIONAL

DRAIN THE PUMP AND ISOLATE PIPEWORK BEFORE DISMANTLING THE PUMP

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

FLUORO-ELASTOMERS (When fitted.)

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

HANDLING COMPONENTS

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

THERMAL SHOCK

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

NEVER APPLY HEAT TO REMOVE IMPELLER

Trapped lubricant or vapour could cause an explosion.

HOT (and cold) PARTS

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

If the temperature is greater than 80 ºC (175 ºF) or below -5 ºC (20 ºF) in a restricted zone, or exceeds local regulations, action as above shall be taken.

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

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, startup, operation and shutdown*.)

CAUTION START THE PUMP WITH OUTLET VALVE PART 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 or 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 pump and mechanical 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

Ex Measures are required to:

- Avoid excess temperature
- Prevent build up of explosive mixtures
- Prevent the generation of sparks
- Prevent leakages
- Maintain the pump to avoid hazard

The following instructions for pumps and pump units when installed in potentially explosive atmospheres must be followed to help ensure explosion protection. For ATEX, both electrical and non-electrical equipment must meet the requirements of European Directive 94/9/EC. Always observe the regional legal Ex requirements eg Ex electrical items outside the EU may be required certified to other than ATEX eg IECEx, UL.

1.6.4.1 Scope of compliance

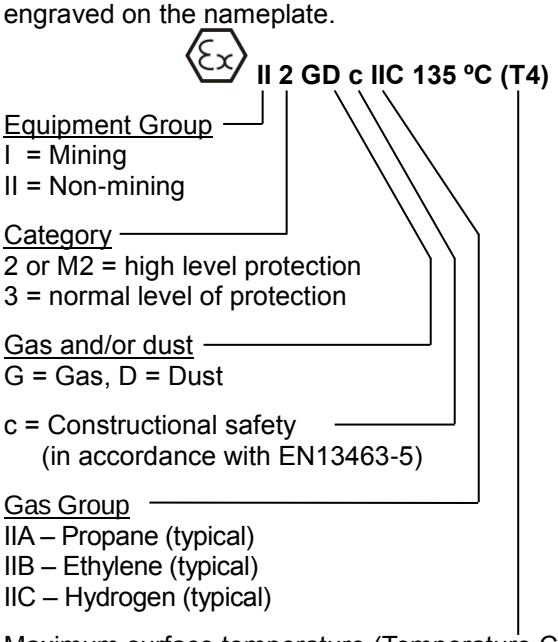
Ex Use equipment only in the zone for which it is appropriate. Always check that the driver, drive coupling assembly, seal and pump equipment are suitably rated and/or certified for the classification of the specific atmosphere in which they are to be installed.

Where Flowserve has supplied only the bare shaft pump, the Ex rating applies only to the pump. The party responsible for assembling the ATEX pump set shall select the coupling, 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 effects in the motor and so, for pump sets with a VFD, the ATEX Certification for the motor must state that it is covers the situation where electrical supply is from the VFD. This particular requirement still applies even if the VFD is in a safe area.

1.6.4.2 Marking

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



1.6.4.3 Avoiding excessive surface temperatures

ENSURE THE EQUIPMENT TEMPERATURE CLASS IS SUITABLE FOR THE HAZARD ZONE

Pumps have a temperature class as stated in the ATEX Ex rating on the nameplate. These are based on a maximum ambient of 40 ºC (104 ºF); 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 ATEX temperature class and must not exceed the values in the table that follows:

Maximum permitted liquid temperature for pumps

Temperature class to EN13463-1	Maximum surface temperature permitted	Temperature limit of liquid handled *
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 table only takes the ATEX temperature class into consideration. Pump design or material, as well as component design or material, may further limit the maximum working temperature of the liquid.

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

The operator is responsible to ensure that the specified maximum liquid temperature is not exceeded.

Temperature classification “Tx” is used when the liquid temperature varies and when the pump is required to be used in differently classified potentially explosive atmospheres. In this case the user is responsible for ensuring that the pump surface temperature does not exceed that permitted in its actual installed location.

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

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

In dirty or dusty environments, make regular checks and remove dirt from areas around close clearances, bearing housings and motors.

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

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, fit an appropriate dry run protection device (for example liquid detection or a power monitor).

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

1.6.4.5 Preventing sparks

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

To avoid the potential hazard from random induced current generating a spark, the baseplate must be properly grounded.

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

For ATEX the coupling must be selected to comply with 94/9/EC. Correct coupling alignment must be maintained.

1.6.4.6 Additional requirement for metallic pumps on non-metallic baseplates

When metallic components are fitted on a non-metallic baseplate they must be individually earthed.

1.6.4.7 Preventing leakage

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

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

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

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

If leakage of liquid to atmosphere can result in a hazard, install a liquid detection device

1.6.4.8 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.*)

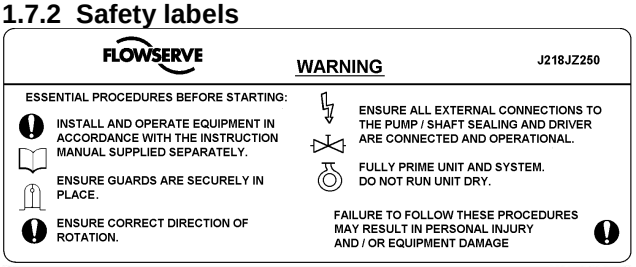
1.7 Nameplate and safety labels

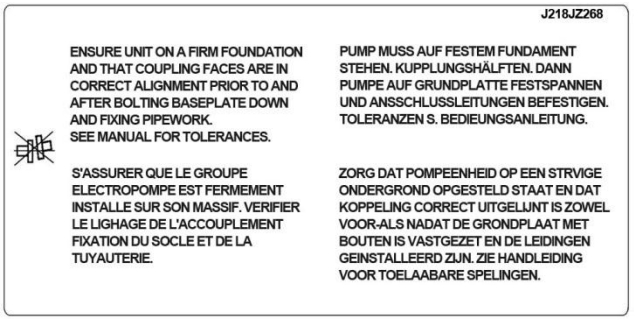
1.7.1 Nameplate

For details of nameplate, see the *Declaration of Conformity,* or separate documentation included with these User Instructions.

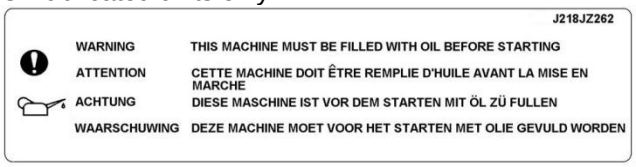
EU regulation 547/2012 requires the statement on a product nameplate: MEI ≥ 0.10 [--,-]. (See section 1.8.2, *Ecodesign*.)

1.7.2 Safety labels





Oil lubricated units only



1.8 Specific machine performance

1.8.1 General

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.

1.8.2 Ecodesign

EU regulation 547/2012 of the Directive 2009/125/EC, for the minimum efficiency of defined classes of water pumps requires that products must show their Minimum Efficiency Index (MEI) value. The EU benchmark MEI ≥ 0.70. Also product information must be available to users.

Performance curves will have been provided with the quotation or order or are available at flowserve.com.

The efficiency of a pump with trimmed impeller is usually lower than that of a pump with the full impeller diameter. Trimming of the impeller will adapt the pump to a fixed duty point, leading to reduced energy consumption. The minimum efficiency index (MEI) is based on the full impeller diameter.

The operation of this water pump with variable duty points may be more efficient and economic when controlled by, for example, by the use of a variable speed drive that matches the pump duty to the system.

Information on benchmark efficiency is available at; www.europump.org/efficiencycharts

1.9 Noise level

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

The usual approach is to control the exposure time to the noise or to enclose the machine to reduce emitted sound. You may have already specified a limiting noise level when the equipment was ordered, however if no noise requirements were defined, then attention is drawn to the following table to give an indication of equipment noise level so that you can take the appropriate action in your plant.

Pump noise level is dependent on a number of operational factors, flow rate, pipework design and acoustic characteristics of the building, and so the values given are subject to a 3 dBA tolerance and cannot be guaranteed.

Motor size and speed kW (hp)	**Typical sound pressure level L_{pA} at 1 m reference 20 µPa, dBA**							
	3 550 r/min		**2 900 r/min**		**1 750 r/min**		**1 450 r/min**	
	Pump only	Pump and motor	Pump only	Pump and motor	Pump only	Pump and motor	Pump only	Pump and motor
<0.55 (<0.75)	72	72	64	65	62	64	62	64
0.75 (1)	72	72	64	66	62	64	62	64
1.1 (1.5)	74	74	66	67	64	64	62	63
1.5 (2)	74	74	66	71	64	64	62	63
2.2 (3)	75	76	68	72	65	66	63	64
3 (4)	75	76	70	73	65	66	63	64
4 (5)	75	76	71	73	65	66	63	64
5.5 (7.5)	76	77	72	75	66	67	64	65
7.5 (10)	76	77	72	75	66	67	64	65
11 (15)	80	81	76	78	70	71	68	69
15 (20)	80	81	76	78	70	71	68	69
18.5 (25)	81	81	77	78	71	71	69	71
22 (30)	81	81	77	79	71	71	69	71
30 (40)	83	83	79	81	73	73	71	73
37 (50)	83	83	79	81	73	73	71	73
45 (60)	86	86	82	84	76	76	74	76
55 (75)	86	86	82	84	76	76	74	76
75 (100)	87	87	83	85	77	77	75	77
90 (120)	87	88	83	85	77	78	75	78
110 (150)	89	90	85	87	79	80	77	80
150 (200)	89	90	85	87	79	80	77	80

Note: for 1 180 and 960 r/min reduce 1 450 r/min values by 2 dBA. For 880 and 720 r/min reduce 1 450 r/min values by 3 dBA.

Similarly the motor noise assumed in the “pump and motor” noise is that typically expected from standard and high efficiency motors when on load directly driving the pump. Note that a motor driven by an inverter may show an increased noise at some speeds.

If a pump unit only has been purchased for fitting with your own driver then the “pump only” noise levels in the table should be combined with the level for the driver obtained from the supplier. Consult Flowserve or a noise specialist if assistance is required in combining the values.

It is recommended that where exposure approaches the prescribed limit, then site noise measurements should be made.

The values are in sound pressure level L_{pA} at 1 m (3.3 ft) from the machine, for “free field conditions over a reflecting plane”.

For estimating sound power level L_{WA} (re 1 pW) then add 14 dBA to the sound pressure value.

2 TRANSPORT AND STORAGE

2.1 Consignment receipt and unpacking

Immediately after receipt of the equipment it must be checked against the delivery/shipping documents for its completeness and that there has been no damage in transportation. Any shortage and/or damage must be reported immediately to Flowserve and must be received in writing within one month of receipt of the equipment. Later claims cannot be accepted.

Check any crate, boxes or 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

A crane must be used for all pump sets or components in excess of 25 kg (55 lb.). Fully trained personnel must carry out lifting, in accordance with local regulations.

CAUTION No specific lifting points are provided for this complete machine (unless so specified). Any lifting points that can be seen are provided only for dismantling parts for servicing. Slings, ropes and other lifting gear should be positioned where they cannot slip and where a balanced lift is obtained. The angle between sling or ropes used for lifting must not exceed 60°.

Before lifting the driver alone, refer to the manufacturer’s instructions.

The driver weight is recorded on its nameplate.

2.4 Storage

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

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

2.5 Recycling and end of product life

At the end of the service life of the product or its parts, the relevant materials and parts should be recycled or disposed of using an environmentally acceptable method and local requirements. 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 or toxic fluids are disposed of safely and that the correct personal protective equipment is used. The safety specifications must be in accordance with the current regulations at all times.

3 DESCRIPTION

3.1 Configurations

This is a robust centrifugal pump design for a wide range of applications.

3.2 Name nomenclature

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

50WPG160

Nominal discharge branch size in mm

W – Cast iron design
C – Stainless steel design

PG – Standard, grease lubricated bearings
PH – Heavy duty build, oil lubricated bearings

Nominal maximum impeller diameter in mm

The typical nomenclature above is the general guide to the D-line pump 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 casing is designed with a horizontal centreline end inlet and a vertical centreline top outlet, which makes it self-venting. For ease of maintenance, the pump is constructed so that pipe connections do not have to be disturbed when internal maintenance is required.

3.3.2 Impeller

A shrouded impeller with hub rings is fitted.

3.3.3 Shaft

The large diameter stiff shaft, mounted on bearings, has a keyed drive end.

3.3.4 Bearing bearings and lubrication

The pump is fitted with ball and/or roller type bearings which may be configured differently dependent on use. The bearings may be oil or grease lubricated.

3.3.5 Seal housing

The seal housing has spigots between the pump casing and bearing housing for optimum concentricity. A fully confined gasket forms the seal between the pump casing and the seal housing. The design enables one of 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.

3.3.7 Driver

The pump is driven by a close-coupled electric motor. The position of the terminal box can be changed by rotating the complete motor. To do this, remove the fasteners from the motor flange, rotate the motor and re-fit the fasteners.

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 the purchase order. (See section 1.5.)

These pumps are generally fitted with TEFC motors with an ambient temperature limit of 40 °C. Specific pumps may be fitted with motors to suit client's requirements with other ambient temperature limits - see motor nameplate for details.

3.4.1 Pressure limits

The operating pressure has been selected to meet your specified requirements. See paragraph 1.5, *Duty conditions,* for details.

Pump units	Construction	Casing test pressure	Casing working pressure
All pump sizes except 125-225, 200-401 and 150-500	Cast iron, bronze and stainless steel	24 bar (348 psi)	16 bar (232 psi)
125-225		15 bar (217 psi)	10 bar (145 psi)
200-401	Cast iron and bronze	24 bar (348 psi)	16 bar (232 psi)
200-401	Stainless steel	16 bar (232 psi)	10.6 bar (154 psi)
150-500	Cast iron, bronze and stainless steel	12 bar (174 psi)	8 bar (116 psi)

The pressure and temperature operating limits for the flanges are in accordance with the relevant National or International standards unless advised otherwise.

Heating/cooling jackets for seal or stuffing box are designed for operation up to 5 bar (72.5 psi).

Jacketed pump casings for CPG and CPH units only are designed for operation up to 5 bar (72.5 psi).

4 INSTALLATION

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

4.1 Location

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

4.2 Part assemblies

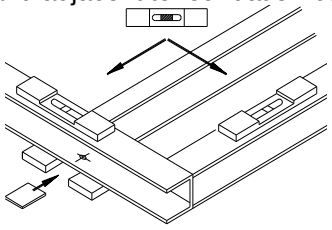
These pumps are not normally supplied in part assemblies but special accessories such as loose orifice plates are supplied loose. Ensure these are incorporated in the final installation.

4.3 Foundation

CAUTION 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 and vibration limitations. Non-compliance with the provision of correct foundation and installation may lead to failure of the pump and, as such, would be outside the terms of the warranty.

Ensure the following are met:

a) The baseplate 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.)
b) Install the baseplate onto packing pieces evenly spaced and adjacent to foundation bolts.



c) Level with shims between baseplate and packing pieces.
d) The pump and driver have been aligned before dispatch however the alignment of pump and motor half coupling must be checked. If this is incorrect, it indicates that the baseplate has become twisted and should be corrected by re-shimming
e) If not supplied, guarding shall be fitted as necessary to meet the requirements of ISO 12100 and EN953.

4.4 Grouting

Where applicable, grout in the foundation bolts.

After adding pipework connections and rechecking the coupling alignment, the baseplate should then be grouted in accordance with good engineering practice. Fabricated steel, cast iron and epoxy baseplates can be filled with grout. Folded steel baseplates should be grouted to locate their packing pieces. If in any doubt, please contact your nearest service centre for advice.

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

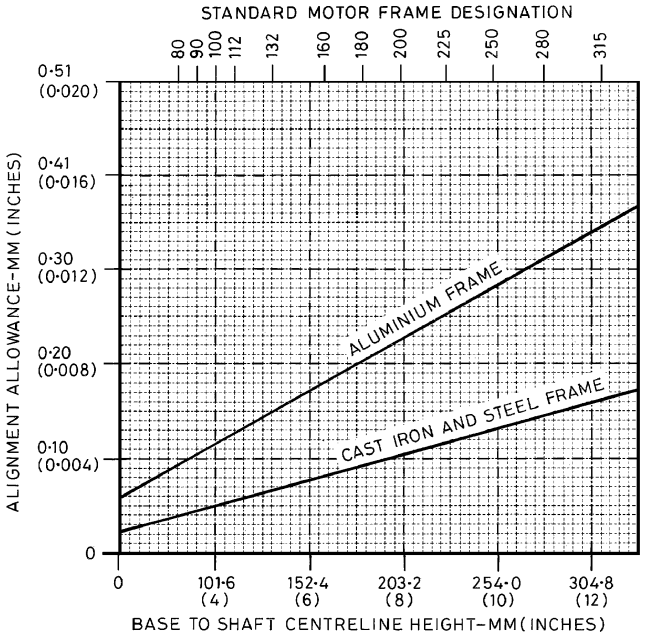
Foundation bolts should only be fully tightened when the grout has cured.

4.5 Alignment of couplings

4.5.1 Thermal expansion

The pump and motor will normally have to be aligned at ambient temperature and should be corrected to allow for thermal expansion at operating temperature. In pump installations involving high liquid temperatures, the unit should be run at the actual operating temperature, shut down and the alignment checked immediately.

Motor and pump centre line height adjustment:



Graph based on the assumptions that:
1) Operating temperature rise of the motor frame is 50 °C.
2) Packing piece/motor stool is not affected.

Operation:
a) Enter graph at base to shaft centre line height
b) Read line for frame material
c) Set motor shaft and coupling LOW by figure on left-hand side

4.5.2 Alignment methods

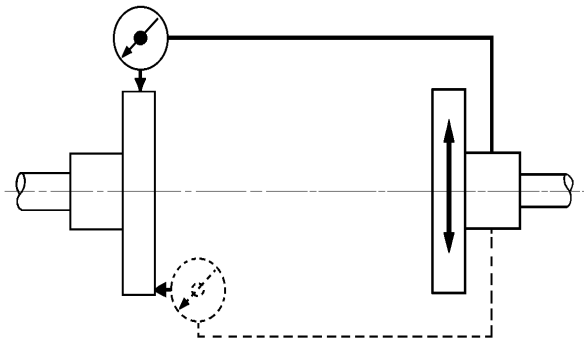
DANGER Pump and driver must be isolated electrically and the half couplings disconnected.

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. Align the motor to the pump, not the pump to the motor.

Alignment is achieved by adding or removing shims from 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 gauge as shown. The alignment values are maximums for continuous service.

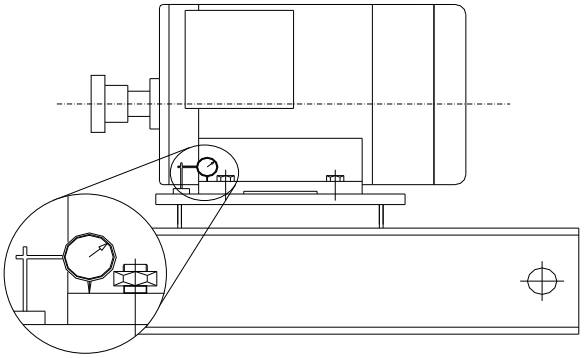


Permissible misalignment limits at working temperature:

- *Parallel alignment*
  - 0.25 mm (0.010 in.) TIR maximum
- *Angular alignment*
  - 0.3 mm (0.012 in.) TIR maximum for couplings not exceeding 100 mm (4 in.) flange diameter
  - 0.5 mm (0.020 in.) TIR maximum for couplings over 100 mm (4 in.) diameter

When checking parallel alignment, the total indicator read-out (TIR) shown is twice the value of the actual shaft displacement.

4.5.3 Check for soft foot



This is a check to ensure that there is no undue stress on the driver holding down bolts; due 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.

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

4.6 Piping

CAUTION 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

CAUTION Never use pump as a support for piping.

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.

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

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

CAUTION Ensure piping and fittings are flushed before use.

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

Take into account the available NPSH which must be higher than the required NPSH 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 as large a radius as possible.
b) On suction lift the piping should be inclined up towards the pump inlet with eccentric reducers incorporated to prevent air locks.
c) On positive suction, the inlet piping must have a constant fall towards the pump.
d) The pipe next to the pump should be the same diameter as the pump suction and have a minimum of two pipe diameters of straight section between the elbow and the pump inlet flange. Where the NPSH margin is not large, it is recommended that the pipe straight is 5 to 10 pipe diameter. (See section 10.3, Reference 1.) Inlet strainers, when used, should have a net 'free area' of at least three times the inlet pipe area.
e) Fitting isolation and non-return valves will allow easier maintenance.
f) Never throttle pump on suction side and never place a valve directly on the pump inlet nozzle.

4.6.3 Discharge piping

a) 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.
b) Fitting an isolation valve will allow easier maintenance.

4.6.4 Flange loads

The permissible flange loading is dependent on a number of factors such as dimensions, flange rating, pressure, temperature, material, pump configuration etc. The recommendations contained in the section on pipework connections should be followed to eliminate these loads.

When requested the permissible flange loading will have been supplied separately to the purchaser and should be obtained and retained with this manual. If in doubt contact Flowserve for information.

4.6.5 Auxiliary piping

CAUTION The connections that are to be piped up will have been fitted with protective metal or plastic plugs which will need to be removed.

4.6.5.1 Pumps fitted with packed glands

a) When suction pressure is below ambient pressure and differential head is less than 10 m, it may be necessary to feed gland packing with liquid to provide lubrication and prevent the ingress of air.
b) When pumping “dirty” liquids a clean liquid supply to the gland is recommended.

4.6.5.2 Pumps fitted with mechanical seals

a) Single seals requiring re-circulation will normally be provided with the auxiliary piping from pump casing already fitted.
b) Seal housings/covers having an auxiliary quench connection require connection 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.
c) Double seals require a barrier liquid between the seals, compatible with the pumped liquid.
d) With back-to-back double seals, the barrier liquid should be at a minimum pressure of 1 bar above the maximum pressure on the pump side of the inner seal. The barrier liquid pressure must not exceed limitations of the seal on the atmospheric side. For toxic service the barrier liquid supply and discharge must be in a safe area.
e) Special seals may require modification to auxiliary piping described above. Consult Flowserve if unsure of correct method or arrangement.
f) For pumping hot liquids, to avoid seal damage, it is recommended that any external flush/cooling supply be continued after stopping the pump.

4.6.5.3 Pumps fitted with heating/cooling jackets

Connect the heating/cooling pipes from the site supply. The top connection should be used as the outlet to ensure complete filling/venting of the annulus.

4.6.6 Final checks

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

4.7 Final shaft alignment check

After connecting piping to the pump, rotate the shaft several times by hand to ensure there is no binding and all parts are free. Recheck the coupling alignment, as previously described, to ensure no pipe strain. If pipe strain exists, correct piping.

4.8 Electrical connections

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

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.

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.

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.

A device to provide emergency stopping must be fitted.

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

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

CAUTION See section 5.2, *Direction of rotation,* before connecting the motor to the electrical supply.

4.9 Protection systems

The following protection systems are recommended particularly if the pump is installed in a potentially explosive area or is handling a hazardous liquid. If in any 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, install a protection device 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, fit a power monitor 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 install an appropriate leakage detection system.

To prevent excessive surface temperatures at bearings carry out temperature or vibration monitoring.

5 COMMISSIONING, START-UP, OPERATION AND SHUTDOWN

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

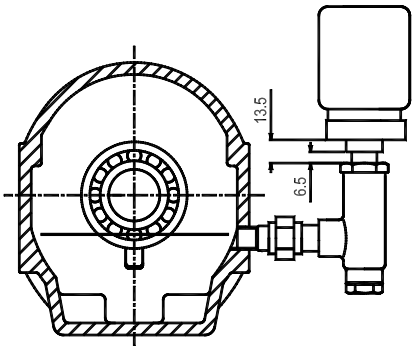
5.1 Pre-commissioning procedure

5.1.1 Lubrication

Determine the mode of lubrication of the pump set, eg grease, oil etc.

CAUTION For oil lubricated pumps, fill the bearing housing with correct grade of oil to the correct level, ie sight glass or constant level oiler bottle.

When fitted with a constant level oiler, the bearing housing should be filled by unscrewing or hinging back the transparent bottle and filling it with oil. Watchdog oilers are self-setting and internally vent balanced. Where an adjustable body Denco oiler is fitted this should be set to the height shown in the following diagram:



The oil filled bottle should then be refitted so as to return it to the upright position. Filling should be repeated until oil remains visible within the bottle.

Grease lubricated pumps and electric motors are supplied pre-greased.

Where the ambient temperature is very low special lubricants are required. Where oil lubrication is utilized and the ambient is less than -5 °C (23 °F) ensure the oil's pour point is at least 15 °C (27 °F) below the ambient temperature or use oil class SAE 5W-50 or API-SJ and ensure the upper operating range of the oil is then not exceeded. . IS0 VG 46 oil is generally selected for an initial lubrication schedule.

Other drivers and gearboxes, if appropriate, should be lubricated in accordance with their manuals.

5.2 Pump lubricants

5.2.1 Recommended oil lubricants

	Oil	Splash / force feed / purge oil mist/ pure oil mist lubrication		
Centrifugal pump lubrication	Viscosity cSt @ 40 ºC	32	**46**	68
	Oil temperature range *	-5 to 65 ºC (23 to 149 ºF)	**-5 to 78 ºC (23 to 172 ºF)**	-5 to 80 ºC (23 to 176 ºF)
	Designation to ISO 3448 and DIN51524 part 2	ISO VG 32 32 HLP	**ISO VG 46 46 HLP**	ISO VG 68 68 HLP
Oil companies and lubricants	**BP Castrol** †	Energol HLP-HM 32	**Energol HLP-HM 46**	Energol HLP-HM 68
	ESSO †	NUTO HP 32	**NUTO HP 46**	NUTO HP 68
	ELF/Total †	ELFOLNA DS 32 Azolla ZS 32	**ELFOLNA DS 46 Azolla ZS 46**	ELFOLNA DS 68 Azolla ZS 68
	LSC (for oil mist)**	LSO 32 (Synthetic oil)	**LSO 46 (Synthetic oil)**	LSO 68 (Synthetic oil)
	ExxonMobil †	Mobil DTE 24	**Mobil DTE 25**	Mobil DTE 26
	Q8 †	Q8 Haydn 32	**Q8 Haydn 46**	Q8 Haydn 68
	Shell †	Shell Tellus 32	**Shell Tellus 46**	Shell Tellus 68
	Chevron Texaco †	Rando HD 32	**Rando HD 46**	Rando HD 68
	Wintershall (BASF Group) †	Wiolan HS32	**Wiolan HS46**	Wiolan HS68
	Fuchs †	Renolin CL 32	**Renolin CL 46**	Renolin CL 68

* Note that it normally takes 2 hours for bearing temperature to stabilize and the final temperature will depend on the ambient, r/min, pumpage temperature and pump size. Also some oils have a greater viscosity index than the minimum acceptable of 95 (eg Mobil DTE13M) which may extend the minimum temperature capability of the oil. Always check the grade capability where the ambient is less than -5 ºC (23 ºF).

† Use LSC for oil mist. Oil parameters provide flash point >166 ºC (331 ºF), density >0.87 @ 15 ºC (59 ºF), pour point of -10 ºC (14 ºF) or lower. Normal compounded oils CANNOT be used with oil mist as anti-foam additives need to be avoided. Most oils recommended for wet splash lubrication contain foam inhibitors as well as antioxidants and anticorrosion additives, so they are unsuitable for oil mist. Some synthetic lubricants may attack the Nitrile seals used in a regular bearing housing. The LSC LSO oils are recommended for oil mist applications.

5.2.2 Recommended grease lubricants

Grease	NLGI 2 *	NLGI 3
Temp. range	-20 to +100 ºC (-4 to +212 ºF)	-20 to +100 ºC (-4 to +212 ºF)
Designation acc. to DIN	KP2K-25	KP3K-20
BP	Energrease LS-EP2	Energrease LS-EP3
Elf	Multis EP2	Multis EP3
Fuchs	RENOLIT EP2	RENOLIT EP3
ESSO	Beacon EP2	Beacon EP3
Mobil	Mobilux EP2	Mobilux EP3 **
Q8	Rembrandt EP2	Rembrandt EP3
Shell	Alvania EP2	Alvania EP2
Texaco	Multifak EP2	Multifak EP3
SKF	LGEP 2	

* NLGI 2 is an alternative grease and is not to be mixed with other grades.

** Standard pre-packed grease for fitted antifriction bearings.

5.2.2.1 Food grade grease, when applicable:

NSF H1 Klubersynth UH1 64-62 is the food grade grease option and it is NLGI grade 2.

5.2.3 Bearing sizes and oil capacities

Frame size	Integral and 2 piece grease lubricated frames		Heavy duty oil lubricated bearings		Approx. oil capacity
	Pump end	Drive end	Pump end	Drive end	
	Ball bearing	Ball bearing	Roller bearing	Back-to-back pair	
1	6206 Z-OO	6206 ZNR-OO	NU 206 C3	T206 BG	0.6 L
2 & 3	6309 Z-OO	6309 ZNR-OO	NU 309 C3	7309 BG	0.8 L
4	6311 Z-OO	6311 ZNR-OO	NU 311 C3	7311 BG	1.0 L
5	6314 Z-OO	6314 ZNR-OO	Not available	Not available	1.2 L

NB The bearing sizes do not constitute a purchasing specification.

5.3 Direction of rotation

CAUTION Serious damage can result if the pump is started or run in the wrong direction of rotation. Ensure the pump is given the same rotation as the pump direction arrow.

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.

5.4 Guarding

⚠ Guarding is supplied fitted to the pump set.

In member countries of the EU and EFTA, it is a legal requirement that fasteners for guards must remain captive in the guard to comply with the Machinery Directive 2006/42/EC. When releasing such guards, the fasteners must be unscrewed in an appropriate way to ensure that the fasteners remain captive.

Whenever guarding is removed or disturbed ensure that all the protective guards are securely refitted prior to start-up.

5.5 Priming and auxiliary supplies

5.5.1 Filling and priming

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

Priming may be carried out with an ejector, vacuum pump interceptor or other equipment, or by flooding from the inlet source.

When in service, pumps using inlet pipes with foot valves may be primed by passing liquid back from the outlet pipe through the pump.

5.6 Starting the pump

a) CAUTION Ensure flushing and/or cooling/ heating liquid supplies are turned ON, before starting pump.
b) CLOSE the outlet valve.
c) OPEN all inlet valves.
d) Prime the pump.
e) Start motor and check the outlet pressure.
f) If the pressure is satisfactory, SLOWLY open the outlet valve.
g) CAUTION Do not run the pump against a closed valve for more than 10 seconds.
h) If NO pressure, or LOW pressure, STOP the pump. Refer to section 7, *Faults; causes and remedies,* for fault diagnosis.

5.7 Running the pump

5.7.1 Pumps fitted with packed glands

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.

If no leakage takes place stop the unit, take out the packing and repack to avoid the packing overheating. If overheating takes place the pump should be stopped and allowed to cool. before being re-packing. When the pump is re-started it should be checked 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 ten minutes with steady leakage and the gland nuts tightened by 10 degrees at a time until leakage is reduced to an acceptable level, normally 30 to 120 drops per minute. Bedding in of the packing may take another 15 minutes.

5.7.2 Pumps fitted with mechanical seal

Mechanical seals require no adjustment. Any slight initial leakage will stop when the seal is run in. Seals will always have leakage emission from the boundary film edge in operation.

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

CAUTION For external flush or quench, this should be started before the pump is run and allowed to flow for a period after the pump has stopped.

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

5.7.3 Bearings

Ex If the pumps are working in a potentially explosive atmosphere monitor temperature and/or vibration at the bearings.

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

- Record the bearing temperature (t) and the ambient temperature (ta)
- Estimate the likely maximum ambient temperature (tb)
- Set the alarm at (t+tb-ta+5) ºC (t+tb-ta+10) ºF and the trip at 100 ºC (212 ºF) for oil lubrication and 105 ºC (220 ºF) for grease lubrication

It is important, 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 should then remain constant or marginally reduce with time.

5.7.4 Normal vibration levels, alarm and trip

For guidance, pumps generally fall under a classification for rigid support machines within the International rotating machinery standards and the recommended maximum levels below are based on those standards.

CAUTION 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		Horizontal pumps ≤ 15 kW mm/sec (in./sec) r.m.s.	> 15 kW mm/sec (in./sec) r.m.s.
Normal	**N**	≤ 3.0 (0.12)	≤ 4.5 (0.18)
Alarm	**N** x 1.25	≤ 3.8 (0.15)	≤ 5.6 (0.22)
Shutdown trip	**N** x 2.0	≤ 6.0 (0.24)	≤ 9.0 (0.35)

5.7.5 Stop/start frequency

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

Motor rating kW (hp)	Maximum stop/starts per hour
Up to 15 (20)	15
Between 15 (20) and 45 (60)	10

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

5.8 Stopping and shutdown (all series)

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

5.9 Hydraulic, mechanical and electrical duty

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

5.9.1 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.

5.9.2 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.

5.9.3 Pump speed

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

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

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

If any change in $NPSH_A$ is proposed, ensure these margins are not significantly eroded. Refer to the pump performance curve to determine exact requirements particularly if flow has changed.

If in doubt please consult your nearest Flowserve office for advice and details of the minimum allowable margin for your application.

5.9.5 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

6.1 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.)

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 5.7.

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

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

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

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

Do not spray air or compressed inert gas on skin.

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

Never use air or compressed inert gas to clean clothes.

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

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

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

6.2 Maintenance schedule

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

a) Any auxiliary systems installed must be monitored, if necessary, to ensure they function correctly.
b) Check for any leaks from gaskets and seals. The correct functioning of the shaft seal must be checked regularly.
c) Check that the duty condition is in the safe operating range for the pump.
d) Check vibration, noise level and surface temperature at the bearings to confirm satisfactory operation.
e) Check dirt and dust is removed from areas around close clearances, bearing housings and motors.

Our specialist service personnel can help with preventative maintenance records and provide condition monitoring for temperature and vibration to identify the onset of potential problems.

If any problems are found the following sequence of actions should take place:

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

6.2.1 Routine inspection (daily/weekly)

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

a) Check operating behaviour. Ensure noise, vibration and bearing temperatures are normal.
b) Check that there are no abnormal fluid l leaks (static and dynamic seals).
c) Check shaft seal leaks are within acceptable limits.
d) Check running hours since last recharge of grease or complete grease change.
e) Check any auxiliary supplies eg heating/cooling (if fitted) are functioning correctly.

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

6.2.2 Periodic inspection (six monthly)

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

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

6.2.3 Re-lubrication

For general guidelines refer to section 5.1, *Lubrication.*

Lubricant and bearing temperature analysis can be useful in optimizing bearing change intervals.

6.2.4 Mechanical seals

When leakage becomes unacceptable the seal will need replacement.

6.3 Spare parts

6.3.1 Ordering of spares

Flowserve keeps 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.
4) Part number – taken from section 8.
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.

6.3.2 Storage of spares

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

6.4 Recommended spares

Recommended spares are defined on the following basis and contained in the table in section 8.

- Class 1 (S1) – start-up and commissioning spares.
- Class 2 (S2) – two year spares requirement covering maintenance for this period.
- Class 3 (S3) –capital spares requirement.

A multiplier is provided in the last column of the table for multiple pump purchases, which can be used where more than one pump is purchased to give the estimated volume of spares required.

See section 8 for recommended spares.

6.5 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 20 screws/nuts
- Socket spanners (wrenches), up to M 20 screws
- Allen keys, up to 10 mm (A/F)
- Range of screwdrivers
- Soft mallet
- Thickness feeler gages

6.6 Fastener torques

Fastener size	Torque Nm (lbf•ft)
M8	16 (12)
M10	25 (18)
M12	35 (26)
M16	80 (59)
M20	130 (96)

Note: Screws for the drive end bearing cover should be tightened uniformly to 7 Nm (5 lbf•ft).

CAUTION Non-metallic gaskets incur creep relaxation - before commissioning the pump check and retighten fasteners to tightening torques stated.

6.7 Disassembly

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

CAUTION Before dismantling the pump for overhaul, ensure genuine Flowserve replacement parts are available. Refer to sectional drawings for part numbers and identification. (See section 8, *Parts lists and drawings.*)

6.7.1 Dismantling bearing housing assembly

To remove proceed as follows:

a) Disconnect all auxiliary pipes and tubes where applicable.
b) Remove coupling guard and disconnect coupling.
c) If oil lubricated frame, drain oil by removing drain plug.
d) Pull off the pump half of coupling and remove coupling key.
e) Remove support foot. Fit a screw into the tapped hole in the frame to act as support. (NB: On larger units leave the support foot in place.)
f) Remove the nuts which secure the integral frame or bearing housing/adaptor to the pump casing.
g) Remove the rotating element complete with bearing frame or bearing housing as one complete unit for further dismantling.
h) Prise open the impeller locknut washer and remove impeller nut (right hand thread). If an inlet inducer is fitted then this should be removed first (right hand thread).
i) Pull off the impeller.
j) On units fitted with gland packing, remove the gland nuts and remove the gland from the studs. Unscrew the stuffing box cover/bearing bracket bolts (where fitted) and remove the stuffing box cover.
k) Remove gland packing, lantern ring and packing seating ring.
l) Remove shaft sleeve (if fitted).
m) On units fitted with mechanical seals, the manufacturer's instructions should be followed when dismantling and assembling. For standard mechanical seals the following procedures give general guidance.
n) Remove the nuts securing the seal plate to the casing backplate seal housing and slide the seal plate away.
o) Unscrew the stuffing box cover/bearing adaptor bolts (where fitted) and remove the stuffing box cover. The inboard seat on a double seal will come away with the stuffing box cover.
p) Mark the position of the seal drive collar on the shaft (or sleeve if fitted). Loosen the drive screws in the seal drive collar and remove the rotating element of the seals from the shaft or sleeve. For double seals, smooth any marks on the shaft or sleeve made by the inboard seal before removing the outboard seal.
q) Remove stationary seat(s) from the seal plate and seal housing. This should only be necessary if the stationary face or its seating ring are being replaced.
r) Remove shaft sleeve (if fitted).

6.7.2 Dismantling bearing frame

This operation should only be necessary if the bearings are to be replaced.

a) Pull off the pump half coupling and remove coupling key. Remove liquid thrower and both bearing covers noting that metal labyrinth throwers are secured by M 4 socket head setscrews.
b) Press shaft, complete with bearings, out of bearing housing towards coupling end. On oil lubricated units the outer race and roller of the pump end bearing will stay in the housing. These should now be removed.
c) Remove bearing locknut (and lockwasher where fitted) and drive off bearings.

6.7.3 Renewable rings

a) When fitted, these should only be removed from the casing and stuffing box cover when they need to be replaced.
b) They should be prised out from behind using levers, or alternatively, carefully drilled followed by chiselling to split the ring to facilitate removal.
c) Replacement rings should be pressed into position ensuring they are square within the recess.

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 housing and impeller

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

6.8.2 Shaft and sleeve (if fitted)

Replace if grooved, pitted or worn.

6.8.3 Gaskets and O-rings

After dismantling, discard and replace.

6.8.4 Bearings

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

6.8.5 Bearing isolators, labyrinths or lip seals (if fitted)

The lubricant, bearings and bearing housing seals are to be inspected for contamination and damage. If oil bath lubrication is utilised, these provide useful information on operating conditions within the bearing housing. If bearing damage is not due to normal wear and the lubricant contains adverse contaminants, the cause should be corrected before the pump is returned to service.

If the pump is fitted with lip seals they should be replaced at overhaul.

Labyrinth seals and bearing isolators should be inspected for damage but are normally non-wearing parts and can be re-used.

Bearing seals are not totally leak free devices. Oil from these may cause staining adjacent to the bearings.

Inspect the bearing carrier circlip groove. Ensure it is free from damage and that housing lubrication passages are clear.

Replace grease nipples or the filter breather (where fitted) if damaged or clogged.

On oil lubricated versions, the oil level sight glass should be replaced if oil stained.

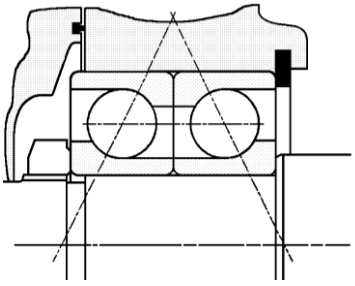
6.9 Assembly

To assemble the pump, consult the sectional drawings. (See section 8, *Parts lists and drawings*.)

Ensure threads, gasket and O-ring mating faces are clean. Apply thread sealant to non-face sealing pipe thread fittings.

6.9.1 Bearing housing and rotating element assembly

a) Clean the inside of the bearing housing, bearing carrier and bores for bearings.
b) Attach bearing housing support foot.
c) Press drive side bearing(s) on to shaft. If duplex bearings are to be fitted, these must be mounted back-to-back, as shown below:



The following methods are recommended for fitting the bearings onto the shaft:

Method 1. Use a hotplate, hot bath, oven or induction heater to heat the bearing race so it can easily be placed in position then allowed to shrink and grip the shaft. It is important that the temperature is not raised above 100°C (212°F).

Method 2. Press the bearing onto the shaft using equipment that can provide a steady, even load to the inner race. Take care to avoid damage to the bearing and shaft.

a) Fit bearing locknut (and lockwasher where applicable).
b) On grease lubricated pumps, pack the bearings with grease and pack the bearing cover cavity approximately one third full with grease.
c) Insert the shaft, complete with bearings, into the bearing housing/frame towards the pump end.
d) When fitting a labyrinth flinger, the groove in the pump end bearing cover should be filled with grease and the labyrinth flinger positioned to give a clearance of 0.5 to 0.65 mm in front of the bearing cover. Screws for the drive end bearing cover should be tightened uniformly to 6.8 Nm (5 lbf•ft).
e) Refit the liquid thrower.
f) Fit the shaft sleeve (if applicable) ensuring the O-seal ring is correctly fitted.

6.9.2 Packed gland units

a) The stuffing box should be packed with good quality packing suitable for the liquid being handled.
b) Assemble the gland packing into the stuffing box housing before fitting on to the shaft.
c) Stagger the joints in the gland packing by 90 degrees to each other.
d) The lantern ring halves (if required) should be positioned mid-way along the packing.
e) Position the gland squarely against the last ring and tighten the gland nuts finger-tight only.
f) Install into bearing housing assembly and fit the two screws to hold the seal housing in place.
g) Check that the shaft rotates freely.

6.9.3 Seal housing and seal assembly

a) Extreme cleanliness is required. The sealing faces and shaft or sleeve surface must be free from scratches or other damage.
b) Carefully press the stationary seat into the mechanical seal housing or cover, ensuring that the seating ring is not deformed.
c) Where an anti-rotation pin is fitted ensure that correct engagement with the slot is achieved.
d) Place any separate seal covers over the shaft.

e) Set the seal to the same position as marked when dis-assembling the unit or refer to manufacturer's instructions to position the mechanical seal rotating elements on the shaft or sleeve.
f) Tighten any drive screws in the seal drive collar.
g) For precise compression most cartridge seals should be set after complete pump assembly.
h) Refit the seal plate and check that the seal is not over-compressed or locked up solid.
i) Fit new casing gasket and refit the complete stuffing box cover/bearing housing unit to the pump casing. Coat the screws with anti-galling compound and tighten into casing.

6.9.4 Rotary oil seals

a) Oil lip seals are not totally leak free devices and oil leaking from a bearing housing can be visually unpleasant in a clean pump room. Very careful fitting practice for lip seals is therefore essential. Particular attention must be paid to protecting the seal from keyways by using shimming or tape and careful handling of the shaft to avoid even fine longitudinal scratches.
b) Perfectly assembled oil seals can have a leakage rate from almost zero to 40 mg/hr. This is equivalent to approximately 2 drops per hour and at this rate the constant level oiler would need filling only once every 6 months.
c) Fit oil seal carefully into position and refit the drive side bearing cover and screws and tighten up.
d) Refit coupling key and pump half coupling using heat, if necessary, to facilitate fitting. Do not hammer the pump half coupling onto the shaft as this will cause loading and damage to the bearings.
e) Rotate pump shaft by hand to check for freedom of rotation.

6.9.5 Refit to baseplate

a) Refit pump to baseplate and check coupling alignment as described in section 4.7, *Final shaft alignment check*.
b) Refit all safety guards and ensure all other items have been re-attached and all fasteners tightened. as section 6.6, *Fastener torques,*

6.9.6 Wear ring clearances

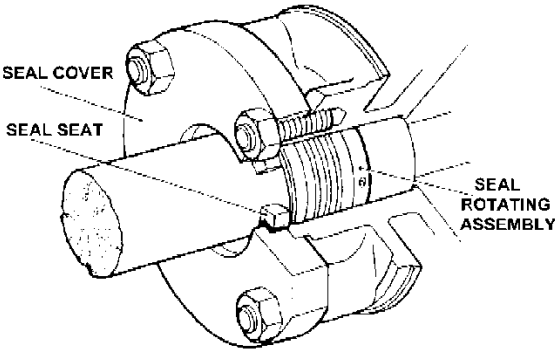
Pump size	Impeller hub diameter (mm)		Diametral ring or casing clearance (mm)	
	Front	Back	Front	Back
65-100	82.54/82.45	82.54/82.45	0.64/0.4	0.64/0.46
50-125				
50-160				
40-200				
40-250				
32-125	70.54/70.47	70.75/70.47	0.60/0.46	0.60/0.4
32-160				
32-200				
65-125	93.54/93.45	93.54/93.4	0.64/0.46	0.64/0.46
65-160				
50-200				
50-250				
50-315				
80-125	111.47/111.38	93.54/93.45	0.71/0.53	0.64/0.46
25-161	55.54/55.47	55.54/55.47	0.60/0.46	0.60/0.46
80-160	111.47/111.38	111.47/111.38	0.71/0.53	0.71/0.53
65-200				
65-250				
65-315				
100-160	152.47/152.37	152.47/152.37	0.67/0.53	0.67/0.53
100-200				
100-250				
125-250				
100-315				
125-315				
100-400				
125-225	168.10/168.00	168.10/168.00	0.80/0.60	0.80/0.63
125-400	184.00/183.90	184.00/183.90	0.71/0.53	0.71/0.53
150-250	209.40/209.30	209.40/209.30	0.80/0.60	0.80/0.63
150-315				
150-400				
200-401	269.24/269.14	269.24/269.14	0.85/0.65	0.85/0.65
150-500	219.47/219.37	219.47/219.37	0.73/0.53	0.73/0.53

6.10 Sealing arrangements

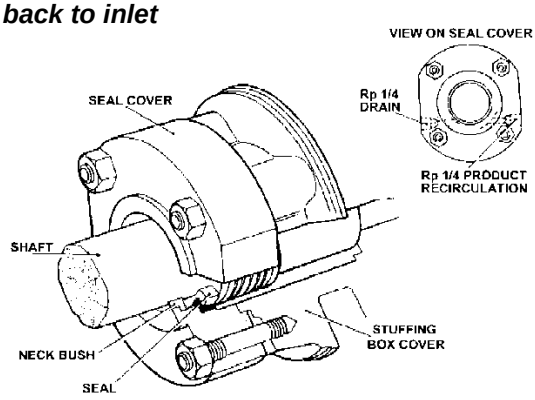
This section shows details of the seal arrangements. Contact your nearest Flowserve sales office or service centre if you require further information or are unsure of the specific arrangement supplied.

6.10.1 Single seal types

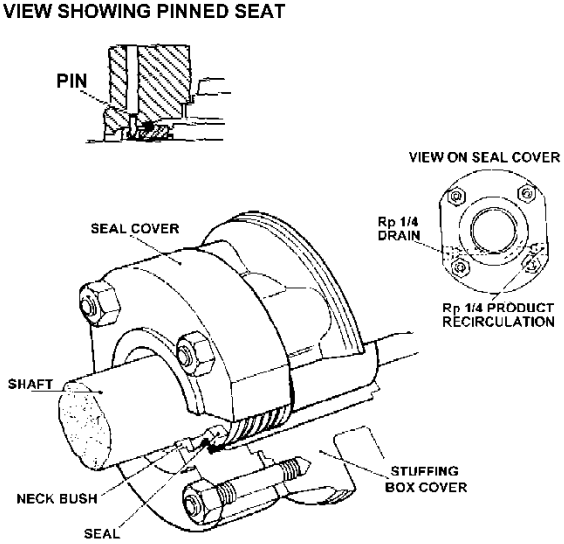
6.10.1.1 Single seal with simple seal cover



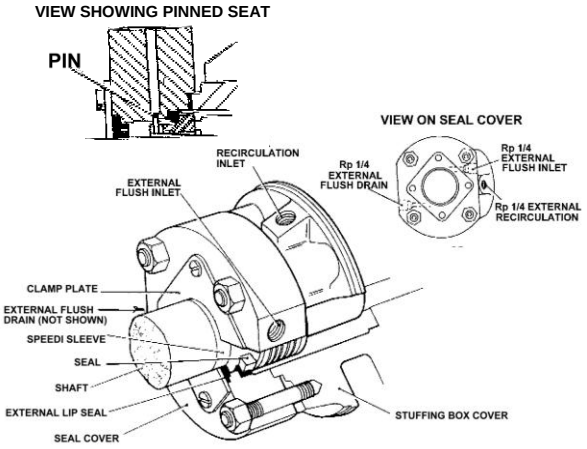
6.10.1.2 Single seal arranged for recirculation back to inlet



6.10.1.3 Single seal with external PTFE neck bush

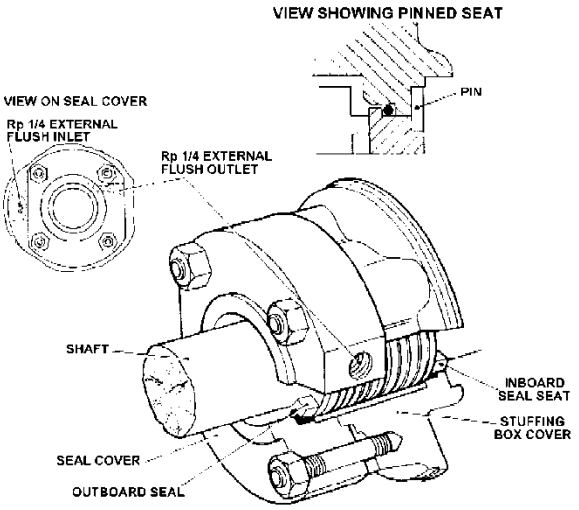


6.10.1.4 Single seal with external lip seal



6.10.2 Double seal types

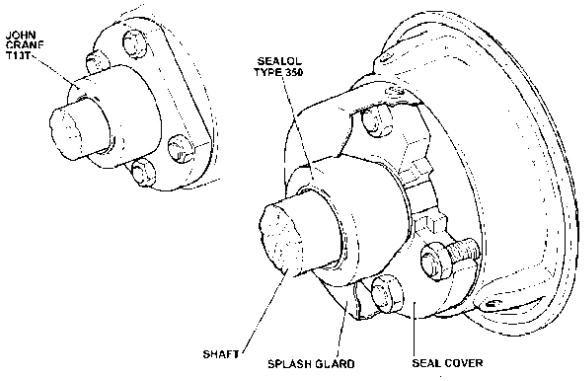
6.10.2.1 Double back-to-back seal



Note:

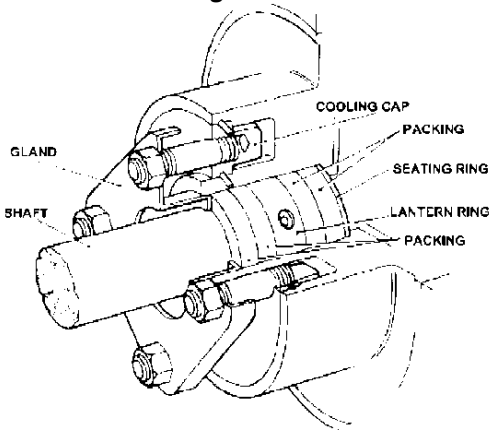
1. Seal seat seating ring not fitted to Ø70 units.
2. When pinned seat used, pin is located axially.

6.10.3 External seals



6.10.4 Packed gland seal types

6.10.4.1 Packed gland with modern fibre packing



Packed gland seal with lantern ring

Note:

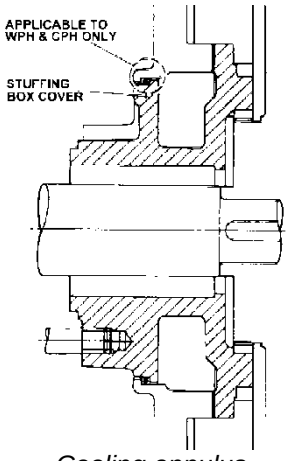
1. Pressed stainless steel gland illustrated.
2. Cast split gland optional.

6.10.5 Stuffing box cover/seal housing data

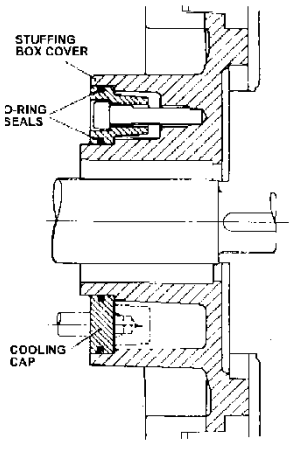
Pump size	Seal size (mm)				
	30	35	45	55	70
100/125	Cooling annulus				Not applicable
160	Cooling annulus				Cooling cap
200	Cooling annulus		Cooling cap	Cooling annulus	
225/250	Not applicable		Cooling cap See note 2		Cooling cap
315					
400			Cooling cap		See note 1
500			Not applicable		

Notes:

1. Sizes 200-401 and 150-500 have no cooling feature on the stuffing box cover when fitted with 70 mm diameter seal.
2. Cooling cap not fitted for 0 to 110 °C packed gland units and 0 to 80 °C standard seal units.



Cooling annulus



Cooling cap

7 FAULTS; CAUSES AND REMEDIES

FAULT SYMPTOM

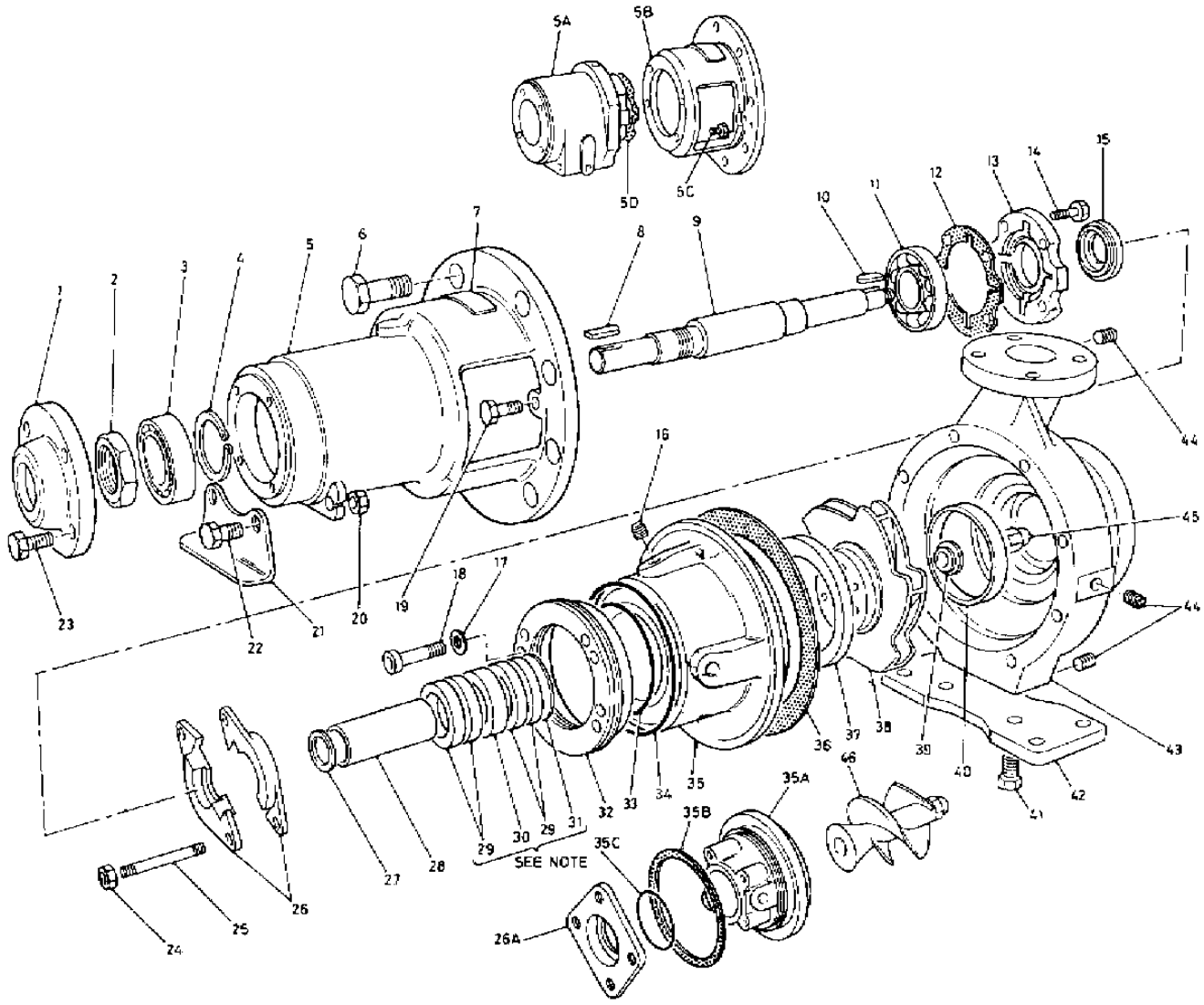
Pump overheats and seizes	Bearings have short life	Pump vibrates or is noisy	Mechanical seal has short life	Mechanical seal leaks excessively	Pump requires excessive power	Pump loses prime after starting	Insufficient pressure developed	Insufficient capacity delivered	Pump does not deliver liquid	POSSIBLE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

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

8 SECTIONAL ARRANGEMENT DRAWINGS AND PARTS LISTS

8.1 WPG sectional drawing



8.1.1 WPG parts list and recommended spare parts

Ref on drawing	Part no.	Description	Start-up spares (S1)	2 year spares (S2)	5 year spares (S3)	Multiplier for multiple pumps
1	3260.1	Bearing cover				
2	3712	Bearing locknut			YES	25 %
3	3013	Thrust ball bearing		YES		50 %
4	6544 ***	Circlip			YES	25 %
5	-	Integral frame				
5A	3200	Bearing housing				
5B	1340	Adaptor				
5C	6570.1	Screw				
5D	4590.1	Gasket	YES	YES		50 %
6	6570.2	Screw				
7	9322	Plate				
8	6700.1	Coupling key			YES	25 %
9	2100	Shaft			YES	25 %
10	6700.2	Key			YES	25 %
11	3011	Radial ball bearing		YES		50 %
12	4590.2	Gasket		YES		50 %
13	3260.2	Bearing cover				
14	6570.3	Screw				
15	3711	Bearing labyrinth ring		YES		50 %
16	6569	Plug				
17	4590.3	Gasket		YES		50 %
18	6570.4	Screw				
19	6570.5	Screw				
20	6580.1	Nut				
21	3134.1	Support foot				
22	6570.6	Screw				
23	6570.7	Screw				
24	4122	Gland nut				
25	6572.1	Stud				
26	4121	Gland, split				
26A	4120	Gland				
27	4590.4	Gasket		YES		50 %
28	2400	Sleeve		YES		25 %
29	4130	Gland packing	YES	YES		50 %
30	4134	Lantern ring	YES	YES		50 %
31	4133	Packing seating ring	YES	YES		50 %
32	6550	Cooling device				
33	4610.1	O-ring		YES		50 %
34	4610.2	O-ring		YES		50 %
35	-	Stuffing box cover (cooling cap)				
35A	4113	Stuffing box cooling chamber cover				
35B	4590.5	Gasket		YES		50 %
35C	4610.3	O-ring		YES		50 %
36	4590.6	Gasket		YES		50 %
37	1521	Casing cover wear ring			YES	25 %
38	2200	Impeller			YES	25 %
39	6543	Lockwasher for impeller nut			YES	25 %
40	1500	Casing wear ring			YES	25 %
41	6570.8	Screw				
42	3134.2	Support foot				
43	1100	Casing				
44	6515	Drain plug				
45	2912	Impeller nut			YES	25 %
46	2215**	Inducer				

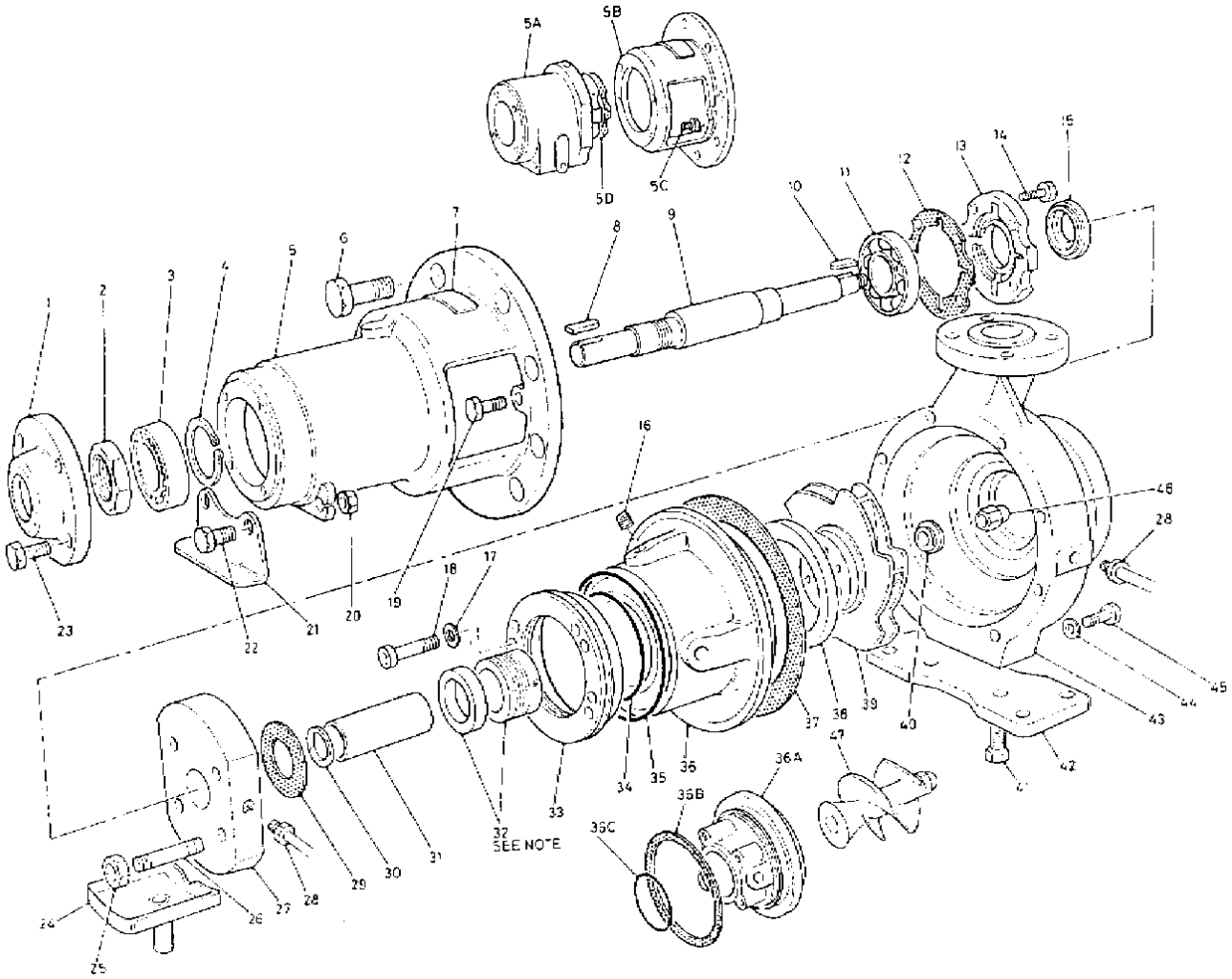
Note: Reference 29 – for details of various arrangements, refer to section 6.10*, Sealing arrangements.*

* Not fitted on 100 and 125 size pumps.

****** Optional features.

*** Frame 3/4 sleeved units only.

8.2 CPG sectional drawing



8.2.1 CPG parts list and recommended spare parts

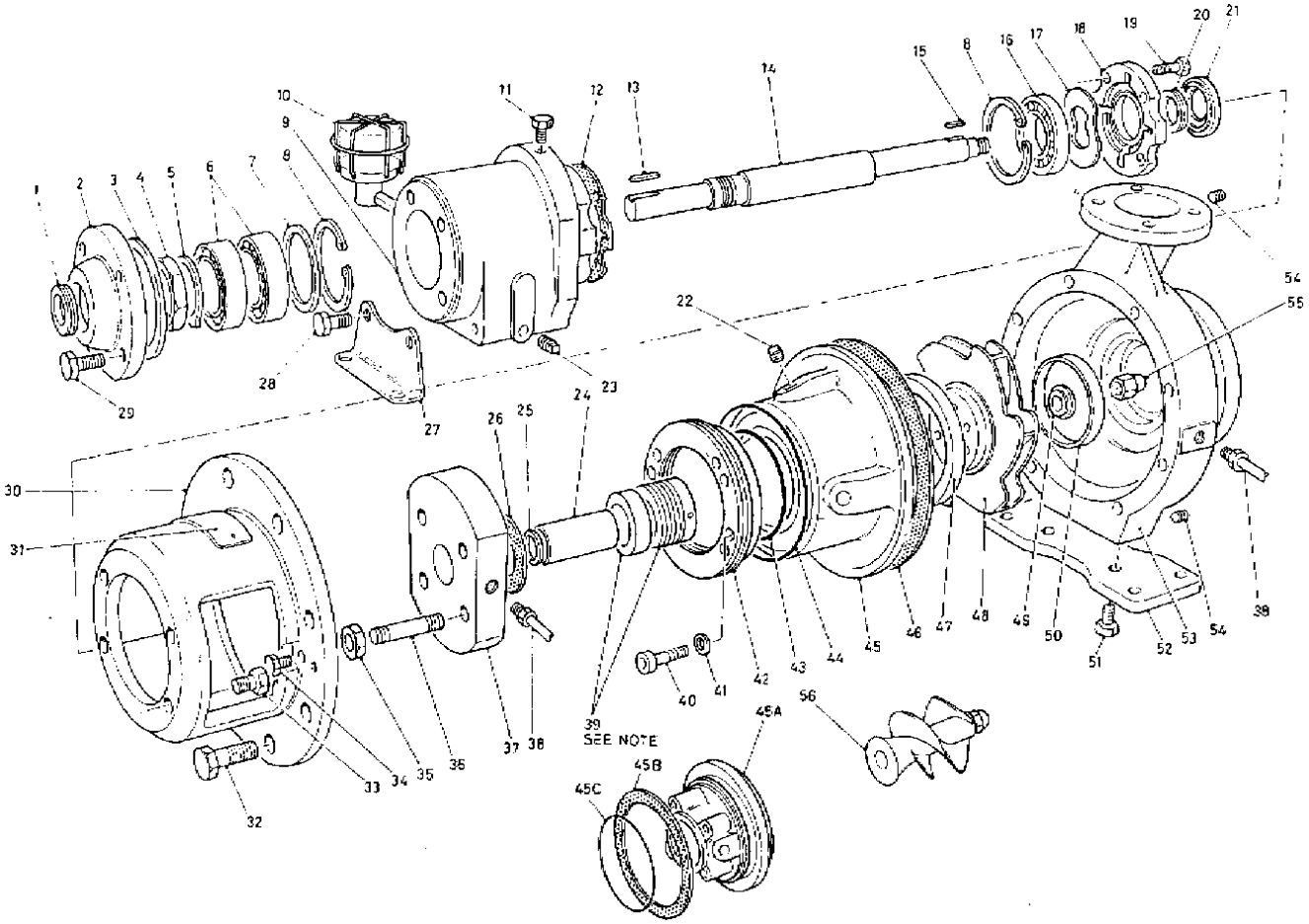
Ref on drawing	Part no.	Description	Start-up spares (S1)	2 year spares (S2)	5 year spares (S3)	Multiplier for multiple pumps
1	3260.1	Bearing cover				
2	3712	Bearing locknut			YES	25%
3	3013	Thrust ball bearing		YES		
4	6544 **	Circlip			YES	25%
5	-	Integral frame				
5A	3200	Bearing housing				
5B	1340	Adaptor				
5C	6570.1	Screw				
5D	-	Gasket	YES	YES		50%
6	6570.2	Screw				
7	9322	Plate				
8	6700.1	Coupling key			YES	25%
9	2100	Shaft			YES	25%
10	6700.2	Key			YES	25%
11	3011	Radial ball bearing		YES		50%
12	4590.2	Gasket		YES		50%
13	3260.2	Bearing cover				
14	6570.3	Screw				
15	3711	Bearing labyrinth ring		YES		50%
16	6569	Plug				
17	4590.3	Gasket		YES		50%
18	6570.4	Screw				
19	6570.5	Screw				
20	6580.1	Nut				
21	3134.1	Support foot				
22	6570.6	Screw				
23	6570.7	Screw				
24	4135	Drip pan				
25	6580.2	Nut				
26	6572.2	Stud				
27	4212	Seal cover				
28	4420	Seal pipe				
29	4590.7	Gasket		YES		50%
30	4590.8 **	Gasket		YES		50%
31	2400 **	Sleeve		YES		25%
32	4200	Mechanical seal	YES	YES		50%
33	6550	Cooling device				
34	4610.1	O-ring		YES		50%
35	4610.2	O-ring		YES		50%
36	-	Stuffing box cover (cooling cap)				
36A	4113	Stuffing box cooling chamber cover				
36B	4590.5	Gasket		YES		50%
36C	4610.3	O-ring		YES		50%
37	4590.6	Gasket		YES		50%
38	1521 *	Casing cover wear ring			YES	25%
39	2200	Impeller			YES	25%
40	6543	Lockwasher for impeller nut			YES	25%
41	1500	Casing wear ring			YES	25%
42	6570.8	Screw				
43	3134.2	Support foot				
44	1100	Casing				
45	6569.2	Drain plug				
46	2912	Impeller nut			YES	25%
47	2215**	Inducer				

NB: Reference 32 - for details of various arrangements, refer to section 6.10, *Sealing arrangements*.

* These items are integral with the stuffing box cover on the following pump sizes: 125CPG225, 150CPG250, 50CPG315, 65CPG315, 100CPG315, 125CPG315, 150CPG315, 100CPG315, 125CPG400, 150CPG400.

** Optional features.

8.3 WPH sectional drawing

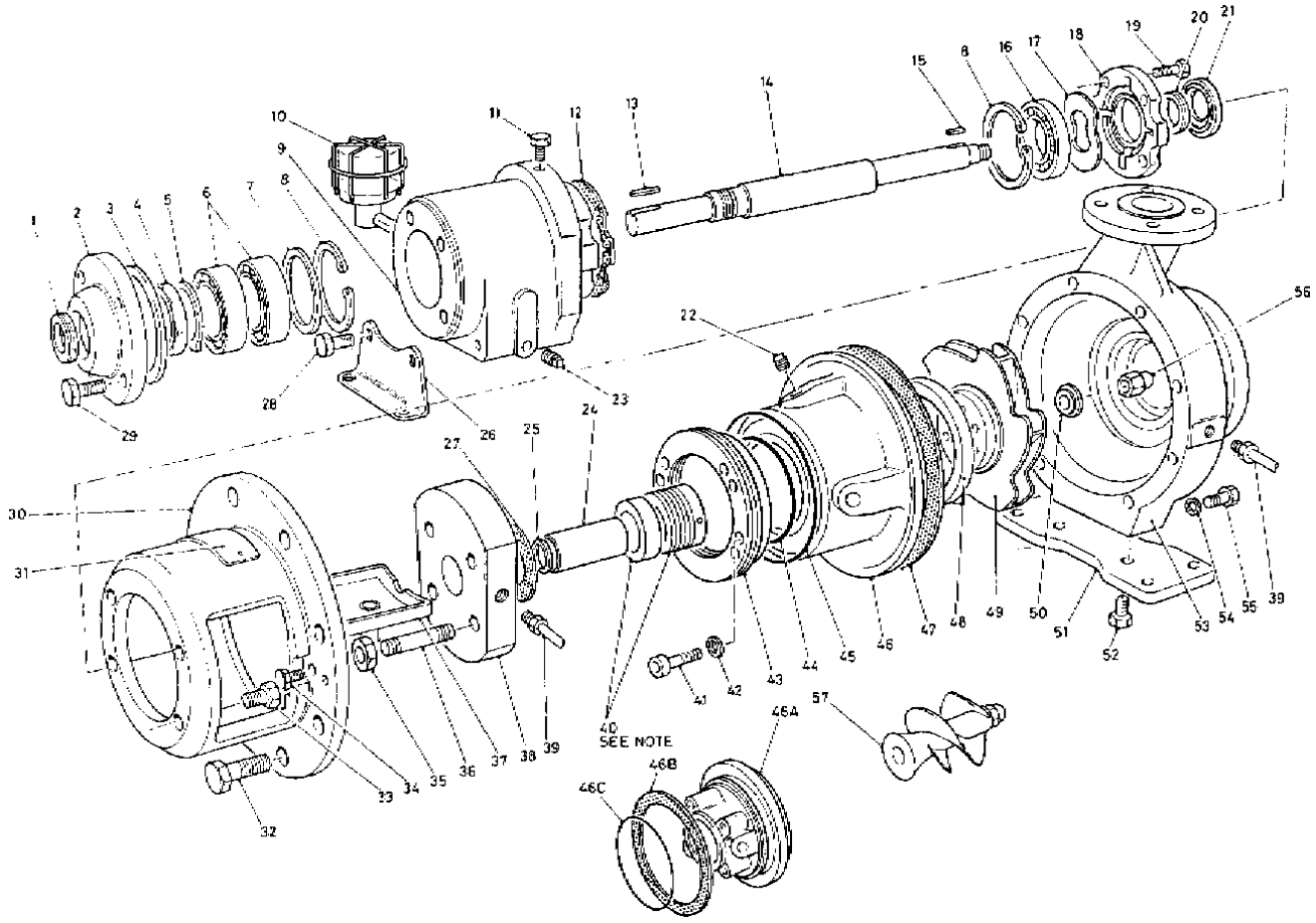


8.3.1 WPH parts list and recommended spare parts

Ref on drawing	Part no.	Description	Start-up spares (S1)	2 year spares (S2)	5 year spares (S3)	Multiplier for multiple pumps
1	4300.1	Radial lip seal		YES		50%
2	3260.1	Bearing cover				
3	4542	Seal ring		YES		50%
4	3712	Bearing locknut			YES	25%
5	3713	Bearing locknut washer			YES	25%
6	3013	Thrust ball bearing		YES		50%
7	3645	Disc spacer (thrust ring)		YES		50%
8	6544	Circlip			YES	25%
9	3200	Bearing housing				
10	3855	Constant level oiler			YES	25%
11	6529	Breather				
12	4590.1	Gasket	YES	YES		50%
13	6700.1	Key			YES	25%
14	2100	Shaft			YES	25%
15	6700.2	Key			YES	25%
16	3012	Radial roller bearing		YES		50%
17	2905	Washer				
18	3260.2	Bearing cover				
19	6570.1	Screw				
20	4300.2	Radial lip seal		YES		50%
21	3711	Bearing labyrinth ring		YES		50%
22	6569.1	Plug				
23	6569.2	Plug				
24	2400 **	Sleeve		YES		25%
25	4590.2 **	Gasket		YES		50%
26	3134.1	Support foot				
27	6570.2	Screw				
28	3134.2	Support foot				
29	6570.3	Screw				
30	1340	Adaptor				
31	9322	Nameplate				
32	6570.4	Screw				
33	6570.5	Screw				
34	6570.6	Screw				
35	6580.1	Nut				
36	6572.1	Stud				
37	4212	Seal cover				
38	4420	Seal pipe				
39	4200	Mechanical seal	YES	YES		50%
40	6570.7	Screw				
41	4590.3	Gasket				
42	-	Cooling cap				
43	4610.1	O-ring		YES		50%
44	4610.2	O-ring		YES		50%
45	-	Stuffing box cover (cooling cap)				
45A	-	Stuffing box cover (cooling annulus)				
45B	4590.4	Gasket		YES		50%
45C	4610.3	O-ring		YES		50%
46	4590.5	Gasket	YES	YES		50%
47	1500	Stuffing box cover renewable ring			YES	25%
48	2200	Impeller			YES	25%
49	6541	Impeller lockwasher			YES	25%
50	1500.1	Casing renewable ring			YES	25%
51	6570.8	Screw				
52	-	Casing support foot				
53	1100	Casing				
54	6569.3	Plug				
55	2912	Impeller nut			YES	25%
56	2215**	Inducer				

NB: Reference 39 - for details of various arrangements, refer to section 6.10, *Sealing arrangements*.
***** Not fitted on 100 and 125 size pumps.
** Optional features.

8.4 CPH sectional drawing



8.4.1 CPH parts list and recommended spare parts

Ref on drawing	Part no.	Description	Start-up spares (S1)	2 year spares (S2)	5 year spares (S3)	Multiplier for multiple pumps
1	4300.1	Radial lip seal		YES		50%
2	3260.1	Bearing cover		YES		50%
3	4542	Seal ring		YES		50%
4	3712	Bearing locknut			YES	25%
5	3713	Bearing locknut washer			YES	25%
6	3013	Thrust ball bearing		YES		50%
7	3645	Disc spacer (thrust ring)		YES		50%
8	6544	Circlip			YES	25%
9	3200	Bearing housing				
10	3855	Constant level oiler			YES	25%
11	6529	Breather				
12	4590.1	Gasket		YES		50%
13	6700.1	Key			YES	25%
14	2100	Shaft			YES	25%
15	6700.2	Key			YES	25%
16	3012	Radial roller bearing		YES		50%
17	2905	Washer				
18	3260.2	Bearing cover				
19	6570.1	Screw				
20	4300.2	Radial lip seal		YES		50%
21	3711	Bearing labyrinth ring		YES		50%
22	6569.1	Plug				
23	6569.2	Plug				
24	2400	Sleeve		YES		25%
25	4590.2	Gasket		YES		50%
26	3134.1	Support foot				
27	4590.3	Gasket		YES		50%
28	6570.2	Screw				
29	6570.3	Screw				
30	1340	Adaptor				
31	9322	Nameplate				
32	6570.4	Screw				
33	6570.5	Screw				
34	6570.6 *	Screw				
35	6580.1	Nut				
36	6572.1	Stud				
37	-	Drip tray				
38	4212	Seal cover				
39	4420	Seal pipe				
40	4200	Mechanical seal	YES	YES		50%
41	6570.7	Screw				
42	4590.4	Gasket				
43	-	Cooling cap				
44	4610.1	O-ring		YES		50%
45	4610.2	O-ring		YES		50%
46	-	Stuffing box cover				
46A	-	Stuffing box cover				
46B	4590.4	Gasket		YES		50%
46C	4610.3	O-ring		YES		50%
47	4590.5	Gasket	YES	YES		50%
48	1500**	Stuffing box cover renewable ring			YES	25%
49	2200	Impeller			YES	25%
50	6541	Impeller lockwasher			YES	25%
51	-	Casing support foot				
52	6570.8	Screw				
53	1100	Casing				
54	-	Washer				
55	6569.3	Plug				
56	2912	Impeller nut			YES	25%
57	2215**	Inducer				

NB: Reference 40 - for details of various arrangements, refer to section 6.10, *Sealing arrangements*.

***** These items are integral with the stuffing box cover on the following pump sizes: 125CPH225, 150CPH250, 50CPH315, 65CPH315, 100CPH315, 125CPH315, 150CPH315, 100CPH315, 125CPH400, 150CPH400.

****** Optional features.

8.5 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 Instruction manuals

Supplementary instruction determined from the contract requirements for inclusion into User Instructions such as for a driver, instrumentation, controller, sub-driver, seals, sealant system, mounting component etc are included under this section. If further copies of these are required they should be obtained from the purchaser for retention with these User Instructions.

Where any pre-printed set of User Instructions are used, and satisfactory quality can be maintained only by avoiding copying these, they are included at the end of these User Instructions such as within a standard clear polymer software protection envelope.

10.2 Change notes

If any changes, agreed with Flowserve Solution Group, 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:
NPSH for Rotordynamic Pumps: a reference guide, Europump Guide No. 1, Europump & World Pumps, Elsevier Science, United Kingdom, 1999.

Reference 2:
Pumping Manual, 9th edition, T.C. Dickenson, Elsevier Advanced Technology, United Kingdom, 1995.

Reference 3:
Pump Handbook, 2nd edition, Igor J. Karassik et al, McGraw-Hill Inc., New York, 1993.

Reference 4:
ANSI/HI 1.1-1.5. Centrifugal Pumps - Nomenclature, Definitions, Application and Operation.

Reference 5:
ANSI B31.3 - Process Piping.

Notes:

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Your Flowserve factory contact:

Flowserve Pumps
Flowserve GB Limited
Lowfield Works, Balderton
Newark, Notts NG24 3BU
United Kingdom

Telephone (24 hours) +44 1636 494 600
Sales & Admin Fax +44 1636 705 991
Repair & Service Fax +44 1636 494 833
Email newarksales@flowserve.com

Your local Flowserve representative:

To find your local Flowserve representative please use the Sales Support Locator System found at www.flowserve.com

FLOWSERVE REGIONAL SALES OFFICES:

USA and Canada
Flowserve Corporation
5215 North O'Connor Blvd.,
Suite 2300
Irving, Texas 75039-5421, USA
Telephone +1 972 443 6500
Fax +1 972 443 6800

Europe, Middle East, Africa
Flowserve Worthington S.r.l.
Via Rossini 90/92
20033 Desio (Milan), Italy
Telephone +39 0362 6121
Fax +39 0362 303 396

Latin America and Caribbean
Flowserve Corporation
6840 Wynnwood Lane
Houston, Texas 77008, USA
Telephone +1 713 803 4434
Fax +1 713 803 4497

Asia Pacific
Flowserve Pte. Ltd
10 Tuas Loop
Singapore 637345
Telephone +65 6771 0600
Fax +65 6862 2329