FLOWSERVE

USER INSTRUCTIONS

HWX centrifugal pumps

Installation
Operation
Maintenance

Vertical single stage, single suction, radially split volute type centrifugal pumps

PCN=85392694 – 03/11 (E) 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 product's operating location or directly with the product.

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

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

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

Where applicable, the Directives and any additional Approvals, cover important safety aspects relating to machinery and equipment and the satisfactory provision of technical documents and safety instructions. Where applicable this document incorporates information relevant to these Directives and Approvals. To confirm the Approvals applying and if the product is CE marked, check the serial number plate markings and the Certification, see section 9, *Certification.*

1.3 Disclaimer

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

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

1.4 Copyright

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

1.5 Duty conditions

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

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

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

1.6 Safety

1.6.1 Summary of safety markings

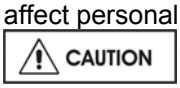
These User Instructions contain specific safety markings where non-observance of an instruction would cause hazards. The specific safety markings are:



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.

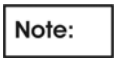

This symbol indicates "hazardous and toxic fluid" safety instructions where non-compliance would affect personal safety and could result in loss of life.



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


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


This symbol 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.



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

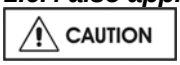
1.6.2 Personnel qualification and training

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.

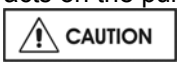
1.6.3 Safety action

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.



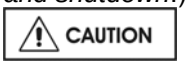
PREVENT EXCESSIVE EXTERNAL PIPE LOAD

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.



ENSURE CORRECT LUBRICATION

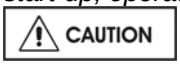
(See section 5, *Commissioning, start-up, operation and shutdown*.)



START THE PUMP WITH OUTLET VALVE PART OPENED

(Unless otherwise instructed at a specific point in the user instructions.)

This is recommended to minimise the risk of overloading and damaging the pump and 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*.)

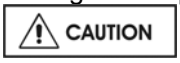


NEVER RUN THE PUMP DRY



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 itself and to the seal.



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.



NEVER DO MAINTENANCE WORK WHEN THE UNIT IS CONNECTED TO POWER

 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.

Gland packing must not be used when pumping hazardous liquids.

 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 (eg 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.

 GUARDS MUST NOT BE REMOVED WHILE THE PUMP IS OPERATIONAL
The unit must not be operated unless coupling guard is in place. Failure to observe this warning could result in injury to operating personnel.

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

1.6.4 Products used in potentially explosive atmospheres

 Measures are required to:

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

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

1.6.4.1 Scope of compliance

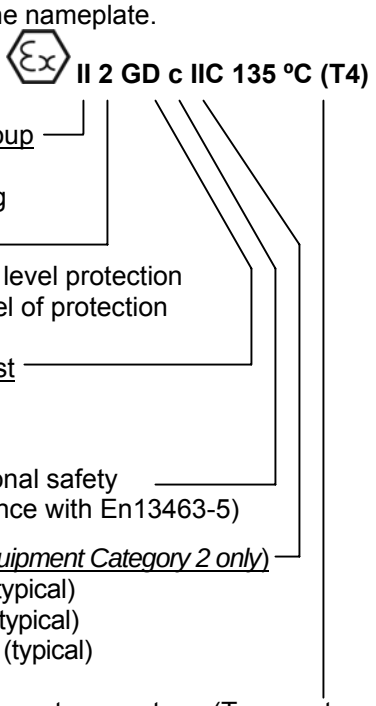
 Use equipment only in the zone for which it is appropriate. Always check that the driver, drive coupling assembly, seal and pump equipment are suitably rated and/or certified for the classification of the specific atmosphere in which they are to be installed.

Where Flowserve has supplied only the bare shaft pump, the Ex rating applies only to the pump. The party responsible for assembling the 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 affects in the motor and so, for pumps 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 °C (104 °F); refer to Flowserve for higher ambient temperatures.

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

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

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

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

Temperature classification “Tx” is used when the liquid temperature varies and 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.

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

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

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

1.6.4.4 Preventing the build up of explosive mixtures

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

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

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

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

1.6.4.5 Preventing sparks

To prevent a potential hazard from mechanical contact, the coupling guard must be non-sparking.

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

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

The coupling must be selected to comply with 94/9/EC and correct alignment must be maintained.

1.6.4.6 Preventing leakage

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

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

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

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

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

1.6.4.7 Maintenance to avoid the hazard

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

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

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

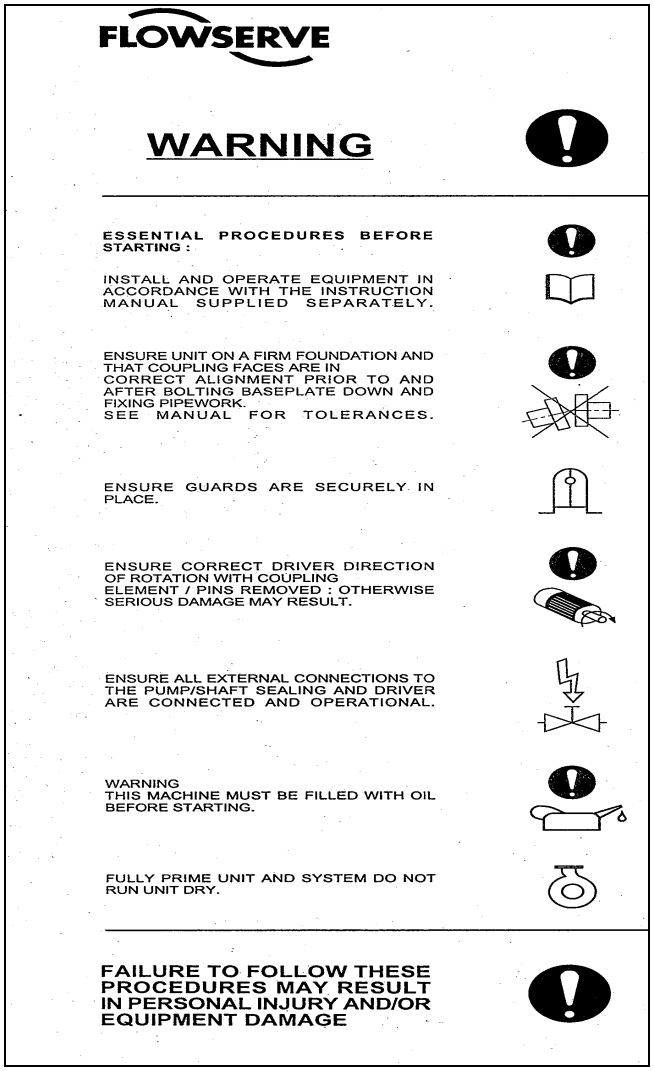
It is recommended that a maintenance plan and schedule is adopted. (See section 6, *Maintenance.)*

1.7 Nameplate and safety labels

1.7.1 Nameplate

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

1.7.2 Safety labels



1.8 Specific machine performance

For performance parameters see section 1.5, *Duty conditions*. Pump performance data are summarised on pump data sheet which is included in proper section of “Job User’s Instruction”.

1.9 Noise level

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

Pump noise level is dependent on a number of factors - the type of motor fitted, the operating conditions, pipework design and acoustic characteristics of the building. The levels specified in the table 1.1 are estimated and not guaranteed.

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

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

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

Typical sound pressure level, dBA, L_{pA} at 1 m reference 20 µPa (L_{wA} sound power 1pW where L_{pA} >85 dBA)

Motor size and speed		3500 rpm		2900 rpm		1750 rpm		1450 rpm	
kW	(hp)	Pump only dBA	Pump & motor dBA	Pump only dBA	Pump & motor dBA	Pump only dBA	Pump & motor dBA	Pump only dBA	Pump & motor dBA
<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
132	(175)	89	90	85	87	79	80	77	80
150	(200)	89	90	85	87	79	80	77	80
160	(215)	(1)	(1)	(1)	(1)	83	84	81	83
200	(270)	(1)	(1)	(1)	(1)	85	87	83	85
300	(400)					87	90	85	86
315	(422)					87	90	85	86
355	(475)					87	90	86	87
500	(670)					88	(1)	86	(1)
1000	(1300)					90	(1)	88	(1)
1500	(2000)					90	(1)	90	(1)

(1) Noise levels of machines in this range should be based on actual equipment selected
For 1180 and 960 r/min reduce the 1450 r/min values by 2dBA
For 880 and 720 r/min reduce the 1450 r/min values by 3dBA

2 TRANSPORT AND STORAGE

2.1 Consignment receipt and unpacking

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

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

Check any crates, boxes and wrappings for any accessories or spare parts which may be packed separately with the equipment or attached to side walls of the box or equipment.
Each product has a unique serial number. Checks that this number corresponds with that advised and always quote this number in correspondence as well as when ordering spare parts or further accessories.

2.2 Handling

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

2.3 Lifting

CAUTION

Make sure that any equipment used to lift the pump or any of its components is capable of supporting the weights encountered. Make sure that all parts are correctly rigged before attempting to lift.

A crane must be used for all pump sets in excess of 25 kg (55 lb). Fully trained personnel must carry out lifting, in accordance with local regulations. The driver and pump weights are recorded on general arrangement drawing included into the job user's instruction.

2.3.1 To Lift unit

To lift the pump, driver, and mounting plate as a unit, rig the unit from the lifting lugs located on the support head. Also rig guide lines from the mounting plate to prevent the unit from tipping over. Rig using a spreader bar, as illustrated on figure 2.1 below, to prevent damage to the driver.

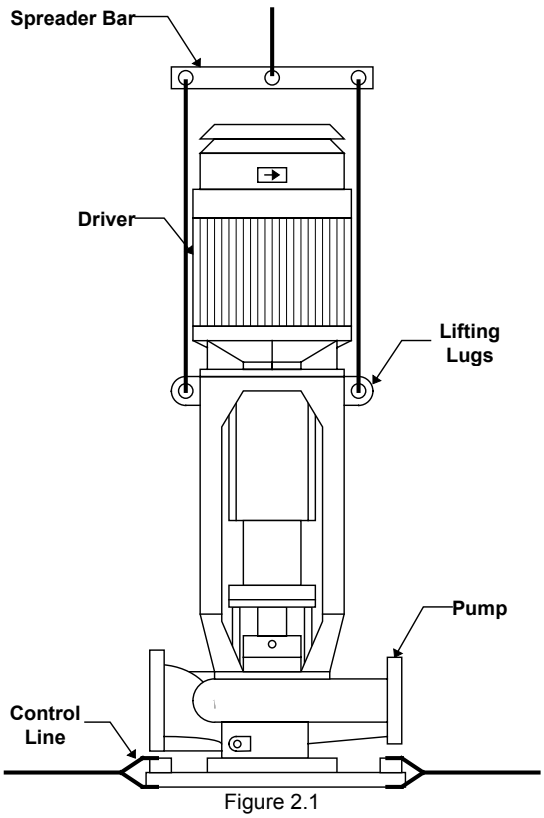


Figure 2.1

CAUTION ***Do not lift pump, motor, baseplate unit by slinging from pump casing and/or eye bolt on motor.***

2.3.2 To lift driver

Refer to Manufacturers Instructions.

2.3.3 To lift complete pump only

Lifting of the pump alone should be performed in accordance with paragraph 2.3.1, *to lift unit* above. However, the use of a spreader bar is not required.

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.
Electric Motors (Pump Driver) should not be stored in damp places without special protection (Refer to Motor manufacturers instructions).

The pump may be stored as above for up to 6 months.

2.4.1 Long term storage

During extended periods of storage prior to installation, precautions must be taken to protect the pump from deterioration. The various parts of the pump are protected prior to shipment by applying varying grades of preservative to the parts. However, during shipment and handling the preservatives are subjected to conditions that can cause their removal. Also, during extended periods of time the preservatives may deteriorate. The listed procedures (2.4.1.1 to 2.4.1.5) should be followed to prevent deterioration of the pump during the extended storage period. These procedures may also be supplemented by the experience of the person(s) performing the tasks.

2.4.1.1 Inspection upon arrival

When the pump is received it should be inspected for damage or other signs of rough handling. If any damage is found it should be reported to the carrier immediately. Inspect the preservative coating on various parts. If necessary, renew preservative in areas where it has been rubbed or scraped.

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

Inspect all covers over pump openings and piping connections. If covers or seals for the covers are damaged or loose, they are to be removed, and a visual inspection made of the accessible interior areas for accumulation of foreign materials or water. If necessary, clean and preserve the interior parts as noted above to restore the parts to the "as shipped" condition. Install or replace covers and fasten securely.

If the pump is configured for use with a pure mist lubrication system, then special precautions must be taken to prevent corrosion of the bearings. Remove the coupling guard, then place a bag of desiccant material near each end of the bearing housing, then wrap the entire bearing housing in an air-tight plastic covering. This arrangement should only be disturbed for periodic inspections.

If the pump was shipped in a sealed plastic covering, then the covering should be reinstalled prior to placing the pump in storage.

2.4.1.2 Storage

CAUTION If at all possible, the pump and its component parts should be stored indoors where they will be protected from the elements. In no case should any pump element be subjected to extended periods of submergence or wetting prior to start up. If it is not possible to store the pump and its components indoors, precautions must be taken to protect them from the elements. Regardless of whether storage is indoors or outside, the storage area should be vibration free. All boxes marked for indoor storage should be stored indoors. When stored outdoors the pump and its components should be protected from dirt, dust, rain, snow, or other unfavourable conditions by heavy plastic sheets, canvas, waterproof burlap or other suitable coverings. All equipment must be placed upon skids or blocks to prevent contact with the ground and surface contaminants. Equipment must be adequately supported to prevent distortion and bending.

The pump shaft should be rotated, in the direction of rotation, at least 1 and 1/4 turns each week during the storage period and any other periods of stand by.

When selecting a storage area the following should be taken into
consideration.

a) The deterioration of the equipment will be proportionate to the class of storage provided.
b) The expenses involved in restoring the equipment at time of installation will be proportionate to the class of storage provided.

2.4.1.3 Inspection and maintenance

The stored equipment has to be placed on a periodic inspection schedule by the purchaser.

The responsibility for setting up an inspection schedule rests with the purchaser and will be dependent upon the class of storage provided. It would be expected initially, inspection would occur weekly, then depending upon the inspection reports being favourable or unfavourable, inspection would continue weekly, monthly, or quarterly, as may be determined.

Each inspection should consist of a general surface inspection to assure that:

a) Pump supports are firmly in place.
b) Pump covers over openings are firmly in place.
c) Pump coverings, plastic or tarps are firmly in place. Any holes or tears must be repaired to prevent entrance of dirt or water.
d) Pump covers are periodically removed from openings and interior accessible areas inspected. If surface rusting has occurred, clean or coat with preservative.
e) If rusting occurs on exterior surfaces clean and repaint or coat with preservative.
f) Check individually wrapped parts for signs of deterioration. If necessary, renew preservative and wrapping.

Six months prior to the scheduled installation date, a FLOWSERVE representative is to be employed to conduct an inspection. This inspection may include,

not necessarily in its entirety and not limited to the following:

a) An inspection of all periodic inspection records as kept on file by the purchaser, and all inspection reports that have been compiled during the storage period.
b) An inspection of the storage area to determine the "as stored" condition of the equipment prior to any protection covers being removed.
c) An inspection of the equipment with protective covers and flange covers removed.
d) Depending upon the length of time the equipment was stored, the type of storage provided (i.e. Indoor: heated, unheated, ground floor, concrete floor. Outdoors: under roof, no roof, waterproof coverings, on concrete, on ground) and as a result of the inspection of (a),(b) & (c) above the FLOWSERVE representative may require a partial or complete dismantling of the equipment.
e) Dismantling may necessitate restoration of painted or preserved surfaces, and, or replacement of gaskets, "O" rings, packing and bearings.
f) All costs involved during inspection, dismantling, restoration, replacement of parts and reassembly will have to the accounted to the purchaser. All necessary labour, tools and cranes will be supplied by the purchaser.

Upon completion of the inspection the FLOWSERVE representative shall submit a report to the purchaser, and to the Manager of Customer Service, stating in detail the results of the inspection.
One month prior to installation of the equipment, a FLOWSERVE representative is to be employed to conduct a final inspection. This inspection will be made to assure that the requirements of the six months inspection report were satisfactorily completed and that the equipment is ready for installation.
Upon completion of this inspection the FLOWSERVE representative shall submit a final report to the purchaser, and to the Manager of Customer Service, advising the results of the final inspection.
All costs involved in conducting the final inspection will have to the accounted to the purchaser.
Prior to and during start up, any requirements for the services of an FLOWSERVE representative will revert back to the original contract agreement for equipment purchased, with revised costing.

2.4.1.4 Painting and preservation

Paints and preservatives used are either FLOWSERVE standard or 'special' as required by the contract specification. Refer to FLOWSERVE for the description of paints and preservatives used on this order if needed

2.4.1.5 Associated equipment

Motors, Turbines, Gears, etc., being supplied by FLOWSERVE.
Generally rotors of associated equipment should be blocked to relieve bearing loads. Storage should be indoors and dry. See the specific manufacturers storage requirements.

2.5 Recycling and end of product life

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



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.

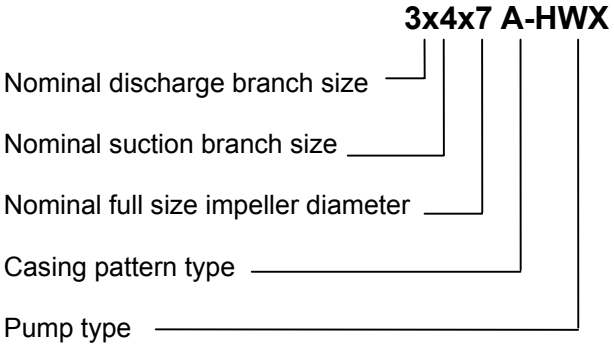
3 PUMP DESCRIPTION

3.1 Configurations

The HWX pump is a vertical, single-stage, single suction, radially split centrifugal process pump. The pump conforms to the specifications outlined in API 610/682 and is intended for continuous duty service in all process and industrial applications within specified pressure and temperature limitations. Maintenance of the pump is facilitated by the in-line configuration, use of cartridge mechanical seals, and a spacer coupling designed to allow a back pull-out disassembly of the internal pump parts.

3.2 Nomenclature

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



The typical nomenclature above is the general guide to the HWX 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 casing is of single or dual volute design that reduces forces on the rotating element thereby minimizing vibration and shaft deflection.

Dual volute is standard on many 3 inch discharge pumps and on all pumps above 3 inch discharge.

Single volute is standard on some 3 inch discharge pumps and on all smaller sizes.

The fluid passages are designed to prevent turbulence and emphasize streamline flow.

Motor support heads are mounted directly on the casing for a true back-pull-out of the pump rotor without disturbing the driver electrical connections, nor casing.

3.3.2 Impeller

The HWX impeller is a fully shrouded, radial flow, single suction design. All sizes are precision cast to assure the highest attainable efficiency. All impellers are dynamically balanced keyed to the shaft and secured by locknut and lockscrew. Renewable wear rings are press fit onto the impeller hubs (front and back) and positively secured with axial screws or tack welding.

3.3.3 Casing cover

The casing cover is either fabricated from plate or cast, depending on the material of construction. Designed to the dimensional standards within the API 682 specification, the seal chamber can accommodate a wide variety of single or dual seal arrangements as standard.

3.3.4 Shaft

The shaft is of ample strength and rigidity. It is precision machined over its entire length and has generous fillet radii at each change of section to reduce stress concentrations. Shaft deflections at the seal chamber are minimal and fall within the guidelines stated in API 610 8th - 9th Edition.

3.3.5 Bearing housing

There are three types of bearing housing, depending on the desired lubrication: grease, pure oil mist, and *Oil Cascade* sump. To maximise parts interchangeability, there are only two sizes of bearing housings and bearings used for all pump sizes. For grease and pure oil mist lubrication, a fabricated steel bearing housing is used; a cast housing is used for *Oil Cascade* sump design. Operating speeds are from 900 to 3600 r.p.m. TRICO constant level oiler is supplied as standard for *Oil Cascade* sump and no constant level oiler is supplied for pure oil mist.
Fan cooling is supplied always as a standard for grease and *Oil Cascade* sump. No cooling is required for pure oil mist application.

3.3.6 Pump bearings and lubrication

The standard bearing arrangement for all HWX pumps is angular contact deep groove ball thrust bearings arranged back to back and a deep groove ball radial bearing able to ensure long life under the most severe operating conditions.

Thrust Bearings are brass cage design and line bearing is metal cage design in accordance with normal oil industry preferences and API 9th ed. requirement. Bearing manufacturers must be FPD approved suppliers.
Lubrication of the bearings is provided by oil cascade, pure oil mist or grease.

3.3.7 Shaft seal
The mechanical seal is a cartridge type design for single, tandem, and double seals to control the leakage of liquid to the environment. The cartridge design provides for proper axial alignment of the seal faces and minimises the contamination of sensitive seal faces during installation.
Lubrication of the mechanical seal is provided by the pumped liquid or by an auxiliary seal-flush system. A vent connection is provided to eliminate the possibility of the seal becoming vapour bound.

3.3.8 Driver
The driver is normally an electric motor mounted on a support head and coupled to the pump by a flexible spacer coupling.

3.3.9 Coupling/Coupling guards
Flexible spacer couplings are provided in various makes and models to suit customer preference.
(Aluminium non- hinged guards are provided)

3.3.10 Mounting Plate and Motor Support Head
HWX pumps are supplied with a mounting plate as a standard, already suitable for levelling screws installation.

Extended dimension mounting plates are available on request for applications where coolers or seal pots are required and need to be contained within the mounting plate.

The motor support head is a heavy duty, register-fit motor mount with generous openings allowing easy accessibility for field maintenance. The open compartments allow easy access to all bolting and removal of the entire rotor with the bearing housing from either side.

3.3.11 Accessories
Accessories may be fitted when specified by the customer.

3.4 Performance and operating limits
This product has been selected to meet the specifications of your purchase order see section 1.5.

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

3.4.1 Effect of specific gravity
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-pressurise the pump.

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

CAUTION ***When pump is handling heavy viscous liquid, the temperature of the liquid must allow it to be pumped easily. Liquid may have to be heated prior to pump start-up.***

3.4.3 Changing the 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. Power varies as speed ratio cubed. If increasing 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.

3.4.4 Net Positive Suction Head (NPSH)
Any liquid, hot or cold, must be pushed into the impeller of the pump by absolute pressure, such as the atmospheric or vessel pressure from which the pump takes its suction.
The head in feet of liquid necessary to push the required flow into the pump is called Net Positive Suction Head. This value, more commonly called NPSH, is measured above the vapour pressure of the liquid at the pumping temperature.
There are two kinds of NPSH: the $NPSH_R$ is the head required by the pump to cover the losses in the pump suction - that is shown on the pump characteristic curve. The second, $NPSH_A$, is the head available in the system, taking into account friction loss in suction piping, valves, fittings etc. In all cases the $NPSH_A$,

measured above vapour pressure, must exceed the $NPSH_R$ in order to push the liquid into the pump. Failure to have this will result in both bad performance and mechanical damage to the pump, and in certain cases actual pump failure.
If any change in $NPSH_A$ is proposed, ensure its margin over $NPSH_R$ is 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.

3.4.5 Minimum Continuous Stable Flow
The Minimum Continuous Stable Flow for the pump is stated on the Data sheet.

3.4.6 Minimum flow control
In all cases, it is the customer's responsibility to supply a system and/or control which assures that any pump within a system is not operated below its minimum flow condition.
In many cases, this is not a problem because the system is operating within its own flow range to assure product delivery. A simple high pressure alarm, shut down and/or bypass control can be used. However, in systems where product demand has high swings or where more than 100% capacity units are desired to support a product system, additional care must be taken.

3.4.7 Thermal control
A thermal control of the unit can be provided by thermal sensors which read direct or "related to" fluid temperatures and respond accordingly by opening additional flow paths until the given unit re-establishes the acceptable temperature rise, and sets off alarms if not achieved within reasonable/normal time periods. (High limit could actually shut down unit).

3.4.8 Pressure and/or Flow Control
Pressure and/or flow sensors can be used to hold the unit at higher flows by opening additional flow paths once a "high pressure limit" or " low flow limit" was indicated. Upon system reaching increased flow a "low pressure limit" or "high flow limit" setting would close the bypass flow path. Care must be taken to allow for signal spread to avoid cyclic conditions.

3.4.9 Operating at Reduced Capacity
CAUTION Damage to pump may result from prolonged operations at capacities less than MCSF as stated in Data Sheet.

4 INSTALLATION

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

4.1 Location
The HWX pump is designed to be installed directly in the pipeline. The driver must be located above the pump and the piping must be supported. The pump must be supported by a support pad which will allow the pump to move freely with the piping to accommodate thermal growth.
Make certain that the space above the pump is sufficient to provide clearance for lifting the pump assembly from the casing, and that the space around the unit provides room for general accessibility and ventilation. Be sure to allow adequate space for maintenance operations involving dismantling and inspection of parts. The certified general arrangement drawing gives the overall dimensions, mounting details, clearance required, etc.
Location of the unit should be in an area where ambient temperatures are not detrimental to the operation of the driver (see driver instructions).
When selecting a location, be sure to make provisions for draining and venting of the pump seal and seal-flush system. Refer to the General Arrangement and Seal Piping drawings for location and size of pipe taps for the seal-flush system.
CAUTION When pump is fitted with manifold vent and drain lines, each line must be equipped with an individual valve to prevent any liquid from a high pressure line flowing into a low pressure line. These valves must be closed during pump operation.

4.2 Part assemblies
If motor is supplied loose. It is the responsibility of the installer to ensure that the motor is assembled to the pump and lined up as detailed in section 4.5.2.

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 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.
The foundation should be sufficiently rigid and substantial to prevent any pump vibration and to permanently support the mounting plate at all points.

The most satisfactory foundations are made of reinforced concrete. These should be poured well in advance of the installation to allow sufficient time for drying and curing.
The General Arrangement Drawing (In Job's User Instruction) will furnish overall outline of pump mounting plate, anchor bolt locations, size of bolts, etc in order to provide proper shape to the primary concrete. Anchor bolts can be positioned or by a special template (not supplied by FLOWSERVE see figure 4.2) or by the mounting plate itself if proper pockets have been provided in primary concrete.

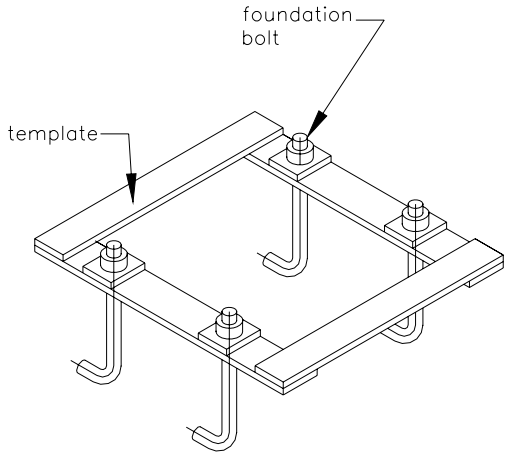


Figure 4.1
Template for Hanging Foundation Bolts

Figure 4.3 below illustrates an alternative foundation bolt arrangement which can be used in lieu of standard foundation bolts. Notice the large washer with lugs at the bottom. It should be welded to the bolt and pipe sleeve to prevent turning.
Allow a little more than the specified threaded bolt length above the rail of the mounting plate. The excess can always be cut off if it is not needed.
A rough finish top surface is best when applying grout.

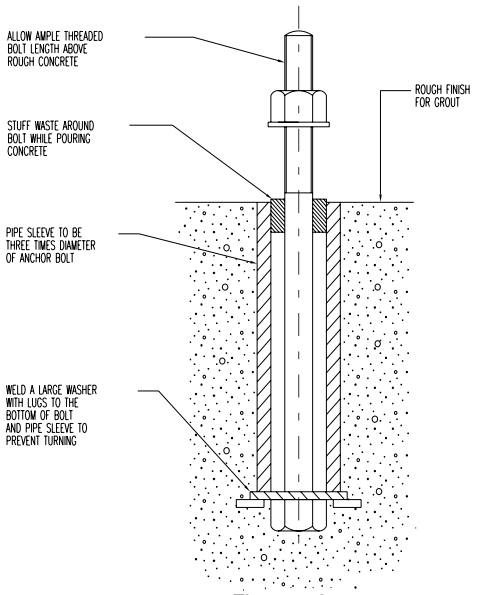


Figure 4.2

4.3.1 Baseplate levelling

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

Note: Coupling bolting and spacer piece must be removed from between the pump and driver half couplings before lifting the pump assembly.

Note: When lifting pump assembly use all lifting lugs provided. Refer to Section 2.3.1

Prepare sufficient steel plates to be placed below each mounting plate jacking screw furnished with the mounting plate. The purpose of the plate is to spread the load of the screw without crushing the concrete below.

4.3.2 Method of levelling mounting plate using wedges or shims

a) Level the mounting plate by using a machinist's level on the machined surfaces of the pump and driver pads. Levelling is best achieved by adjusting the shim pack thickness under each holding bolt. Carefully raise the mounting plate by using either the mounting plate jacking screws provided or by levering with a suitable pinch bar or by installing a low level hydraulic jack.
b) Adjust the shim pack thickness and lower the mounting plate.

c) Repeat this procedure in a logical manner at each bolt position until the mounting plate is both straight and levelled. A degree of 0.25 mm per metre (0.0035 inch per foot) length is achievable on most units with a maximum of 0.40 mm per metre length (0.005 inch per foot).
d) When the mounting plate is level, pull down the foundation bolts so they are snug. This may have disturbed the mounting plate, so re-check the levels.
e) Ensure that shaft alignment per Section 4.5 can be achieved prior to grouting the mounting plate.

4.4 Grouting

It is a matter of personal preference whether the levelling wedges under the mounting plate should be removed after grouting. If you do not want to remove the wedges, carefully mark their locations before pouring grout.

CAUTION ***Before grouting perform a rough shaft/coupling alignment. Alignment after grout has set will not be possible if above is not satisfactorily completed.***

Use a good, high strength, non shrink grout mix and install as per manufacturer's instructions.

4.5 Initial alignment

4.5.1 Thermal expansion

CAUTION 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.

4.5.2 Alignment methods

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

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

4.5.2.1 Shaft/Coupling alignment

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

Note: Adjustment to correct the alignment in one direction may alter the alignment in another direction. Always check in all directions after making any adjustment.
Coupled equipment must be aligned to minimise unnecessary stresses in shafts, bearings and coupling. Flexible couplings will not compensate for appreciable misalignment. Foundation settling, thermal expansion or nozzle loads resulting in baseplate/foundation deflection and vibration during operation may require the full coupling misalignment capability.

4.5.2.1.1 Types of misalignment

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

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

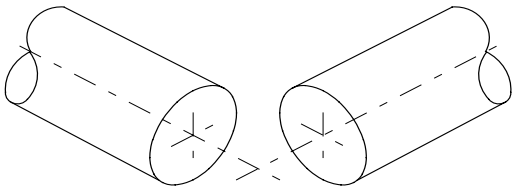


Figure 4.3

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

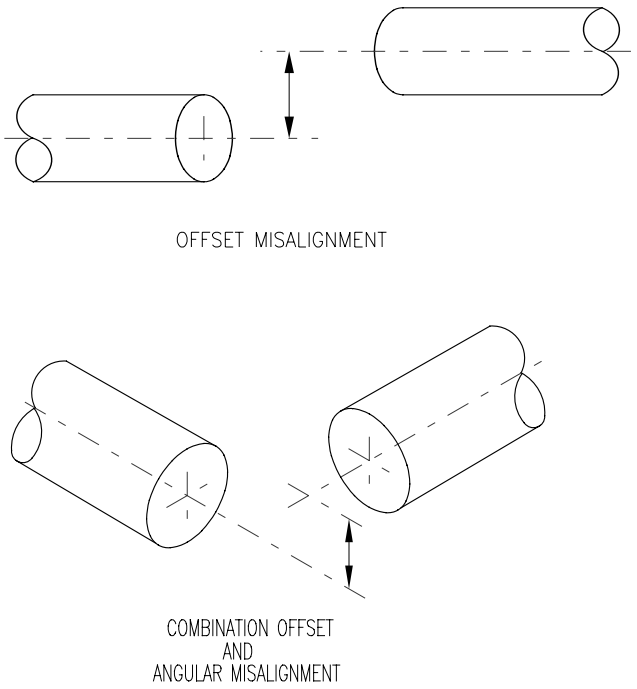


Figure 4.4

4.5.2.2 Alignment using the Reverse Alignment Method

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

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

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

Note: To prevent deflection of dial indicator, the bracket must be rigid in construction and securely fixed in position.

a) Attach lifting equipment to driver and set it on support head.
b) Check hubs for run out or possible bent shaft conditions and correct, if necessary, before proceeding with alignment.
c) Attach a bracket to the pump coupling hub or shaft. Set dial indicator to read the periphery or rim of the driver coupling hub. (See figure 4.5)

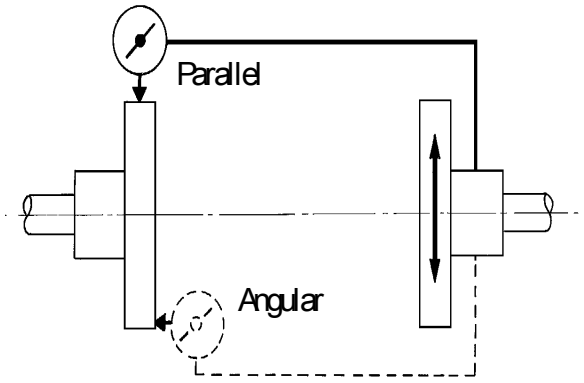


Figure 4.5

d) Set the dial indicator to zero.
e) Rotate pump shaft 360° and record indicator reading. If reading is less than 0.05mm TIR (0.002 in.), proceed to step (f).
The Maximum permissible misalignment at working temperature is:

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

f) Tighten motor hold down bolts. Re-check offset misalignment by rotating the pump shaft 360° and verifying indicator reading is less than 0.05 mm (0.002 in) TIR.
g) If misalignment exceeds maximum allowed:
   - Release driver hold down bolts.
   - Using jackscrews, make necessary horizontal corrections while monitoring indicator.
   - repeat steps (d) and (e) above to verify alignment setting.
h) Repeat step (f).
i) Remove dial indicator and bracket.
j) Briefly operate driver in accordance with manufacturer's instructions and observe rotation of shaft; its rotation must correspond to the direction in which the pump is designed to turn.
k) Secure coupling spacer between half-couplings, if not previously done.
l) Secure coupling spacer between half-couplings, if not previously done.
m) Install coupling guard.

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

4.5.4 Hot alignment

The factory alignment of driver and pump would be performed at an average temperature of 75°F (24°C). Since operation of a pump at less than, or greater, than this temperature would cause alignment changes due to thermal effects on the pump's pedestal position, final alignment must be made with the pump and driver at their actual operating temperature; else there can be no assurance that pump and driver are in alignment while operating. Driver temperature change from ambient to operation temperature will also affect alignment.

A hot check can only be made after the unit has been in operation a sufficient length of time to assume its NORMAL operating temperature and conditions. If the unit has been correctly cold set, parallel misalignment will be within 0.05 mm (0.002 in.) TIR and the angular misalignment will be within 0.025 mm (0.001 in.) when in operation. If not make adjustments.

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

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

4.5.5 Assemble coupling

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

4.5.6 Installation check list

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

4.6 Piping

CAUTION Never use the pump as a support for piping

4.6.1 General

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

Suction and discharge piping should be of ample size, be installed in direct runs, and have a minimum of bends. Double bends must be avoided in suction line and a straight run of pipe, equal 5 times the pipe diameter is desired directly upstream of the suction nozzle.

In order to minimise 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. Typical suction and discharge piping arrangement is according to Figure.4.6.

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

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

Maximum forces and moments allowed on the pump flanges vary with the pump size and type. To minimise 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.

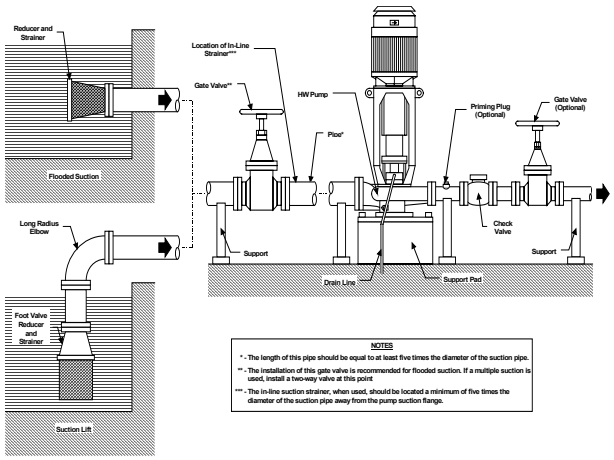


Figure 4.6

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 radius as possible.
b) Keep the suction pipe free of all air pockets. (Vent is required).
c) Pipework reducers should have a maximum total angle of divergence of 15 degrees.
d) The piping should be inclined up towards the pump inlet with eccentric reducers incorporated to prevent air locks.
e) Flow should enter the pump suction with uniform flow, to minimise noise and wear.
f) Except if considerable foreign matter is expected strainers are not recommended in inlet piping. Inlet strainers, when used, should have a net "free area" (see section 4.6.2.1)

4.6.2.1 Suction strainer

In a new installation, great care should be taken to prevent dirt, scale, welding beads and other items from entering the pump, as it is particularly important to protect the numerous close running fits from abrasive matter present in new piping

The suction system should be thoroughly flushed before installing the suction strainer and making up suction piping to the pump.
The suction strainer should be installed between 5 to 20 pipe diameters upstream from the pump suction flange.

Note: ***The open area of the strainer should have a minimum of a 3 to 1 ratio to the area of the pump suction.***

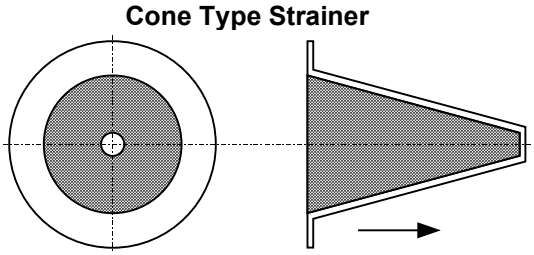


Figure 4.7
Cone Type Strainer

The FLOWSERVE recommendation for suction strainers consists of a conical shaped steel plate. The plate has 1.6 mm (1/16 in.) perforations and is of sufficient size and thickness for the required flow. The strainer should be fitted with a screen to filter the incoming flow: 100-mesh screen is typical for start-up operation at limited flow rates; 20-mesh screen is typical for final operation. See Figure.4.11.

Other type of strainers may be used as long as they conform to the requirements stated above.

Pressure gauges should be installed on both sides of the screen so that the pressure drop across the screen can be measured.
When the unit is being started, the gauges on each side of the screen should be carefully watched. An increase in the differential pressure between the two gauges indicates that the screen is becoming clogged with dirt and scale. At this point, the pump should be shut down, and the screen cleaned and/or replaced. Differential pressure should be monitored on a regular basis.

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

CAUTION ***The pressure drop across the strainer is a direct reduction in the NPSH available to the pump. NPSH available must always exceed the NPSH required by the pump. This requirement may limit pump flow rate, particularly during startup.***

4.6.2.2 Bypass Line

CAUTION ***Operation at low flows results in pump horsepower heating the liquid. A bypass may be required to prevent vaporisation and subsequent pump damage. Refer to local FLOWSERVE branch to determine if a bypass is required. Mechanical damage may result from continuous operation at flows less than specified.***

4.6.3 Discharge piping

a) Install a check valve and a gate valve in the discharge pipe of the pump. When the pump is stopped, the check valve will protect the pump against excessive pressure and will prevent the pump from running backward. The check valve should be installed between the gate valve and the pump nozzle in order to permit its inspection. Never throttle pump on suction side and never place a valve directly on the pump inlet nozzle.
b) Pipework reducers should have a maximum total angle of divergence of 15 degrees.

4.6.4 Drains

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

4.6.5 Pumps fitted with mechanical seals

Cartridge mechanical seals are provided, to seal the shaft against leakage. The seals used on the "HWX" pump have internal design differences for sealing against specific liquids and conditions.

Long seal life with minimal leakage can only be obtained if the seals are provided with clean, cool liquid. Even tiny solids that may be suspended in the liquid being pumped can damage the seal faces and cause the seal to leak, making an external flush or a different seal arrangement necessary. The seal balancing and flushing arrangement provided for each pump is designed and fitted for the specific order requirements.
The "HWX" pump can be arranged with either a single, dual mechanical pump seal. Refer to the General Arrangement for piping connections to be used with your pump.
Mechanical seal replacement or servicing requires that the pull out element be removed from the casing.
For removal of cartridge element refer to Manufacturer's instructions.

4.6.6 Final checks

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

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 strain on coupling is due to pipe. 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.

Ex 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 5.3, *Direction of rotation* before connecting the motor to the electrical supply.

4.9 Protection systems

Ex The following protection systems are recommended particularly if the pump is installed in a

potentially explosive area or is handling a hazardous liquid. If in doubt consult Flowserve.

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

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

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

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

5 COMMISSIONING, START-UP, OPERATION AND SHUTDOWN

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

5.1 Pre-commissioning procedure

The following steps should be followed at initial start up and after the equipment has been overhauled:

a) Prior to installing the pump, flush the suction side of the system to remove all deposit (slag, bolts etc).
b) Ensure the pump and piping is clean. Before putting the pump into operation, the piping should be thoroughly back flushed to remove any foreign matter which may have accumulated during installation. Take all possible care not to contaminate your system.
c) Install suction strainer if required. (See Section 4.6.2.1).
d) Fill the bearing housing with the appropriate oil to the correct level (if applicable). Bearing must receive a small amount of oil prior to starting to ensure adequate lubrication at start up. (Refer to Section 5.1.1).
e) Grease the thrust bearings with the proper greaser fitted on the bearing (if applicable). Bearing must receive a small amount of grease prior to starting to ensure adequate lubrication at start up. (Refer to Section 5.1.1).
f) Turn pump rotor by hand or with a strap wrench to make sure it turns smoothly.
g) Assure that correct seal piping has been installed and has not been damaged.
h) Prior to coupling installation, bump start motor to check for correct rotation. If rotation is not correct refer to motor manual for appropriate connections to change rotation (Shut down all power prior to change).
i) Ensure coupling is correctly aligned and lubricated. (Refer to Section 4.5).
j) Ensure coupling guard is correctly installed.

⚠ **The unit must not be operated unless coupling guard is securely and completely bolted in place. Failure to observe the warning could result in injury to operating personnel.**

a) Check torque of all bolting and the plugs for tightness.

5.1.1 Lubrication

Lubrication of bearing is by grease, by oil mist or by oil cascade into the bearing housing.

5.1.1.1 Grease Lubricated Ball-Bearings

Before a pump with greased ball bearings is placed into operation, it must have grease supplied to the thrust bearings, the line bearing is life greased. Unplug the grease outlet plug located opposite the zirc fitting in the bearing housing outer cover. Pump grease into the zirc fitting in the bearing housing outer cover until grease just begins to extrude from the grease outlet. Replug the grease outlet and turn the shaft several times by hand to distribute the grease in the bearings. Thereafter, re-grease thrust bearings at 3000 hour intervals of operation. Refer to Section 5.2.1 for proper grease type.

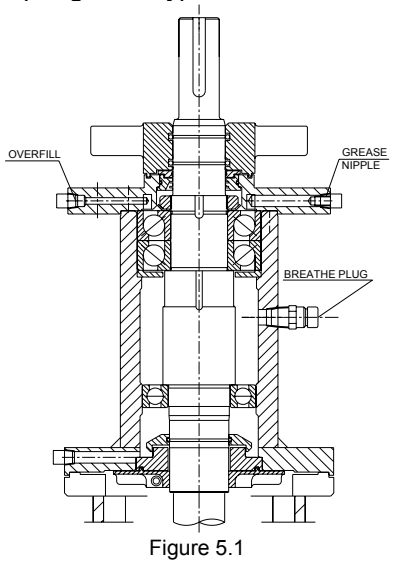


Figure 5.1

5.1.1.2 Pure Oil Mist Lubricated Ball-Bearings

For bearings lubricated by pure oil mist system, ensure that the pure oil mist system is installed on the pump bearing housing, and is operating in accordance with the manufacturer's instructions. No further preparation is necessary.

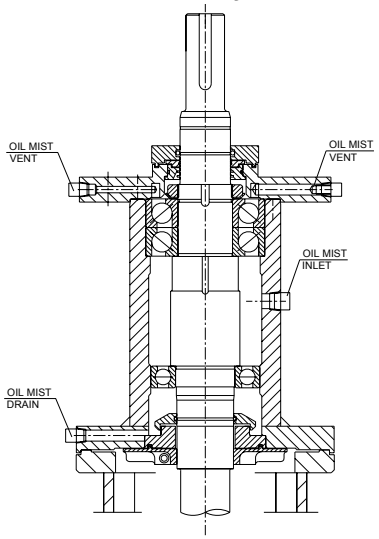


Figure 5.2

5.1.1.3 Oil Cascade Lubricated Ball-Bearings

Preparing bearing housing

Before filling the bearing housing reservoir, flush out the housing thoroughly with safety solvent and a leading grade of flushing oil, compatible with the lubricating oil that will be used. The reservoir is to be filled to appropriate level as illustrated in figures 5.3, 5.4 and 5.5

The oil level must be maintained at the correct level: oil lack may cause overheating and failure of the bearings, while exceeding the correct level can result in leakage. The constant level oiler can be adjusted by changing the height of the cross arms which support the glass reservoir, as illustrated for TRICO oiler in figure 5.5

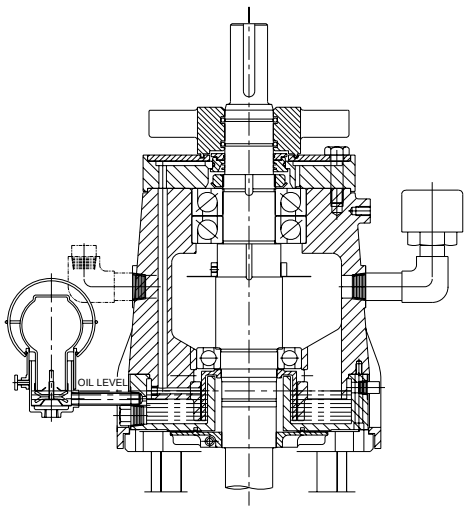


Figure 5.3

The oil circulation is ensured by a pumping ring and an oil thrower (see figure 5.4) according to the description as follow:

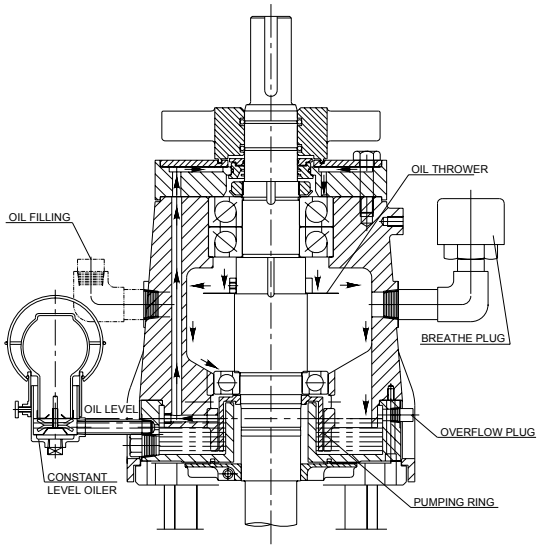


Figure 5.4

thrust bearings lubrication

- By a pumping ring fitted on the shaft the oil reach the top of the bearing housing towards the oil channel.
- Once at the top the oil flows into the thrust bearings and falls directly over the oil thrower.
- The oil thrower, fitted on the pump shaft, splash the oil to the bearing housing walls.

line bearing lubrication

- Once the oil flow on bearing housing wall it reaches the line bearing by three radial oil

collectors and then once it flows into the line bearing it returns into the oil sump.

- The oil that misses the three radial oil collectors flows directly on the oil sump.

Trico oiler setting (standard)

a) Initial fill via top of housing, using overflow plug to establish correct level (see Figure 5.4).
b) Release thumb screw and remove bottle. Establish a measurement from the centre line of the oiler connection in bearing housing to the upper cross arm of 6 mm (0.24 in.); this can be obtained by completely screwing down the lower arm as illustrated on figure 5.5.
c) Fill bottle with recommended oil and install on holder. Remove and fill bottle as many times as is required to fill the bearing housing up to the cross arm level and no air bubbles appear in the bottle.
d) Remove bottle and ascertain that the oil level is 6 mm (0.24 in.) from the centre line of oiler connection. Adjust upper cross arm as required and lock in place with lower arm.

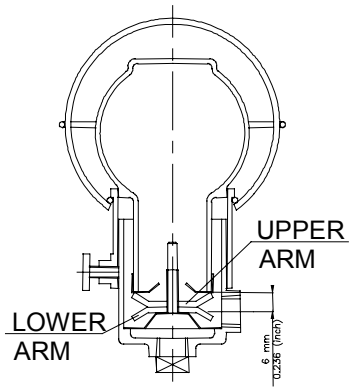


Figure 5.5

Inspection

Inspect the oil level in the bearing housing and the condition of the oil at least weekly. Oil is always subject to gradual deterioration from use and contamination from dirt and moisture which is the cause of premature bearing wear.

CAUTION For oil lubricated pumps, fill the bearing housing with correct grade of oil to the correct level, i.e. constant level oiler bottle (standard configuration) and sight glass (when fitted on request).



Figure 5.6
Sight glass

Replenishment

Replenish the oil in the oiler as required. More frequent replenishment at high temperatures may be required.

Oil change

Frequency of oil change is dependent on pump service and environmental conditions. As a general guide, oil in the bearing housing should be changed every 4000 operating hours, after the initial change.

Lubrication Specification

The ideal bearing lubricant is a straight well refined, neutral mineral, preferably of the turbine type. It should not contain free acid, chlorine sulphur or more than a trace of free alkali. It is suggested that the oil conform to the following physical characteristics.

5.2 Pump Lubricants

5.2.1 Recommended oil lubricants

	Oil	Oil Ring or Slinger Lubrication			Pure Oil Mist Lubrication
Centrifugal Pump Lubrication	Lubrication service	Ball Bearing			
	Type	Mineral Oil (Petroleum Based)			Mineral Oil (Petroleum Based)
	Viscosity mm ²/s 40 ºC [cSt]	32	46	68	100
	Oil temperature range * ºC (ºF)	-5 to 65 (-23 to 149)	up to 75 (up to 167)	up to 85 (up to 185)	-30 and above (59 and above)
	Approx. Consumption continuous operation	0.12 litres / month ¼ pint per month	0.12 litres / month ¼ pint per month	0.12 litres / month ¼ pint per month	0.12 litres ¼ pint per month
	Running in Period	500 hours	500 hours	500 hours	500 hours
	First Oil Charge	500 hours	500 hours	500 hours	500 hours
	Further Oil Changes	4000 hours	4000 hours	4000 hours	4000 hours
	One Year Consumption	1.44 litres approx. max	1.44 litres approx. max	1.44 litres approx. max	1.44 litres approx. max
	Designation according to DIN51502 ISO VG	32	46	68	100
Oil Companies and Lubricants	**BP**	BP Energol HL32 BP Energol HLP32	BP Energol HL46 BP Energol HLP46	BP Energol HL68 BP Energol HLP68	-
	CASTROL	Perfecto T32	Perfecto T46	Perfecto T68	-
	DEA	Anstron HL32 Anstron HLP32	Anstron HL46 Anstron HLP46	Anstron HL68 Anstron HLP68	-
	Elf	OLNA 32 HYDRELEF 32 TURBELF 32 ELFOLNA DS32	TURBELF SA46 ELFOLNA DS46	TURBELF SA68 ELFOLNA DS68	-
	Esso	TERESSO 32 NUTO H32	TERESSO 46 NUTO H46	TERESSO 68 NUTO H68	-
	LSC (for oil mist)	LSO 32 Synthetic oil	LSO 46 Synthetic oil	LSO 68 Synthetic oil	LSO 100 Synthetic oil
	Mobil	Mobil DTE oil light Mobil DTE13M MobilDTE24	Mobil DTE oil medium Mobil DTE15M Mobil DTE25	Mobil DTE oil heavy medium Mobil DTE26	-
	Q8	Q8 Verdi 32 Q8 Haydn 32	Q8 Verdi 46 Q8 Haydn 46	Q8 Verdi 68 Q8 Haydn 68	-
	Shell	Shell Tellus 32 Shell Tellus 37 Shell Turbo T32	Shell Tellus 01 C 46 Shell Tellus 01 46 Shell Turbo T46	Shell Tellus 01 C68 Shell Tellus 01 68 Shell Turbo T68	-
	Texaco	Rando Oil HD 32 Rando Oil HD-AZ-32	Rando Oil 46 Rando Oil HD B-46	Rando Oil 68 Rando Oil HD C-68	-
	Total	Azolla ZS32	Azolla ZS46	Azolla ZS68	-
	Wintershall (BASF Group)	Wiolan HN32 Wiolan HS32	Wiolan HN46 Wiolan HS46	Wiolan HN68 Wiolan HS68	-

(*) Note that it normally takes 2 hours for bearing temperature 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 (e.g. 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).

If a synthetic lubricant (fire resistant fluid) is to be used instead of the normal type oil for the lubrication of bearings, gears etc., the material of all gaskets and "O" rings in contact with the lubricant must be compatible with the lubricant. Normal gasket materials will usually swell and deteriorate when immersed in synthetic lubricants: also normal paints will peel from internal walls of reservoirs and bearing chambers.

Grease	**Grease nipples on Thrust Bearing Side**	
	NLGI 2	**NLGI 3**
Temp. range °C (°F)	-30 to +120 (-22 to +266)	-30 to +120 (-22 to +266)
Designation according to DIN	K2K-30	K2K-30
SKF	LGMT2	LGMT3
NILS	NILENA SSO	-
Grease	**Line Bearing**	
	NLGI 3	
Temp. range °C (°F)	-30 to +120 (-22 to +266)	
SKF	MT33	

Different greases can't be mixed !

5.2.2 Recommended fill quantities

Bearing Housing Size (*)	Bearing Designation	Capacities	
		Oil Cascade litres (US pint)	Grease cm^3 ($inch^3$)
#1	7311	0.86 (1.82)	115 (7.02)
#2	7313	1.52 (3.22)	165 (10.07)

* The bearing housing size can be identified from the thrust bearing size indicated by nameplate.

5.2.3 Bearing housing oil and grease limitations

Recommended Oil Temperature At Start Up	60 °F 15.6 °C
Desirable Operating Temperature	140-160 °F 60-71 °C
Oil Level Above Oil Connection Centre line	6 mm

When the starting temperature is below -10 °C (14 °F) for long time it's suggested to use synthetic oil. Other drivers and gearboxes, if appropriate, should be lubricated in accordance with their manuals.

Recommended Grease Temperature At Start Up	15.6 °C 60 °F
Desirable Operating Temperature	60-71 °C 140-160 °F

CAUTION In the case of product lubricated bearings the source of product supply should be checked against the order. There may be requirements for an external clean supply, particular supply pressure or the commencement of lubrication supply before pump start-up.

5.2.4 CAUTION Lubrication schedule

5.2.4.1 Oil lubricated bearings

Normal oil change intervals are 4000 operating hours or at least every 6 months. For pumps on hot service or in severely damp or corrosive atmosphere, the oil will require changing more frequently. Lubricant and bearing temperature analysis can be useful in optimising lubricant change intervals.
The lubricating oil should be a high quality mineral oil having foam inhibitors. Synthetic oils may also be used if checks show that the rubber oil seals will not be adversely affected.

5.2.4.2 Grease lubricated bearings

When grease nipples are fitted, one charge between grease changes is advisable for most operating conditions, i.e. 2 000 hours interval.

Normal intervals between grease changes are 4 000 hours or at least every 6 months.

The characteristics of the installation and severity of service will determine the frequency of lubrication. Lubricant and bearing temperature analysis can be useful in optimising lubricant change intervals.

CAUTION Never mix greases containing different bases, thickeners or additives.

For both lubrication type a continuously rising temperature, or an abrupt rise, indicate a fault.
Based on the specified operating conditions and an ambient temperature of 43°C (110°F) oil sump temperature below 82°C (180°F) is expected.

5.3 Direction of rotation

CAUTION Ensure the pump is given the same rotation as the pump direction arrow fit on bearing housing. In any case the direction of rotation must be checked with the pump disconnected.

To avoid dry running the pump must either be filled with liquid or have the flexible coupling disconnected before driver is switched on.

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. If this has been removed or disturbed ensure that all the protective guards around the pump coupling and exposed parts of the shaft are securely fixed.

5.5 Priming and auxiliary supplies

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

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

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

CAUTION Before starting or while operating the pump, ensure that mechanical seal is properly assembled and tightened. Most mechanical seals are equipped with locating spacers between the gland plate and shaft sleeve. Spacers must be removed before starting unit. (Do not discard spacers. They are required to maintain proper seal setting during maintenance.)

5.6 Starting the pump

a) Close discharge valve if valve is not already closed, and then crack open to assure minimal flow. (Do not start unit with fully closed valve). On first starts care must be taken not to cause a system water hammer.
b) If a double or tandem seal buffer fluid system is used, the loop must be pressurised prior to admitting the process fluid into the pump.
c) Prepare the driver for start up in accordance with the driver manufacturer's instructions.
d) Warm up pump (if applicable).
Avoid severe thermal shocks to the pump as the result of sudden liquid temperature changes. The pump must be preheated prior to start up. Unless otherwise specified the thermal temperature of the casing must be within 55 °C (100 °F) of the temperature of the liquid to be pumped at time of start up. Due to the heavy metal sections, the casing will lag the liquid temperature during such changes, and severe temperature stresses and subsequent misalignment of machined fits may result. Preheating is accomplished by circulating a small amount of hot fluid through the casing by utilising vents, drains or bypass from discharge.

- Close valves in the discharge and bypass lines to isolate the pump during warm-up and hot standby. Pre-heating is accomplished by circulating 37.85 liters/min. (10 gpm) to the pump discharge through an inlet line between the pump discharge and first isolation valve.
- Run the outlet flow through the casing and suction nozzle back to the suction source. The warming rate of the casing should not exceed 55 °C per hour (100 °F per hour. Thermal insulation of the casing is recommended to enhance warm-up and hot standby procedures.
- Once the pump has been sufficiently pre-heated, and immediately prior to operation, the warming liquid inlet line must be closed and the bypass line must be opened.
- Note: The same procedure applies for extremely cold pumpage, where the pump would have to be cooled prior to operation by circulating cooling liquid through the discharge nozzle and casing

e) Prime pump and ensure suction valve is open.

CAUTION ***Ensure flushing and/or cooling/ heating liquid supplies (if required) are turned ON before starting the pump.***

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

a) Ensure pump recirculating line (if required) is open, clear and free of obstructions.
b) Check that pump is vented by observing leakage from casing vent (when fitted) and seal piping vent. Close vent (if fitted) when liquid is emitted.

c) Turn on cooling liquid and assure correct flow exists (to cooler, insert gland etc.) as specified.
d) Double check pump rotation by starting unit momentarily. ***The direction of input shaft rotation is counter clockwise when facing pump shaft from coupling end. Ensure that the pump coasts down to a gradual stop.***

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

e) Start the driver and bring it up to speed quickly.
f) As soon as the pump is up to rated speed slowly open discharge valve. This will avoid abrupt changes in velocity and prevent surging in the suction line.

CAUTION ***Do not operate the pump with a closed discharge valve for longer than 30 seconds, as this can cause excessive overheating of the pumped fluid and result in a pump damage.***

g) Perform the operating checks

5.7 Operating checks

In the interest of operator safety the unit must not be operated above the nameplate conditions. Such operations could result in unit failure causing injury to operating personnel. Consult user instruction book for correct operation and maintenance of the pump and its supporting components.

CAUTION ***Operation at low flows results in pump heating the liquid. A bypass may be required to prevent vaporisation and subsequent pump damage. Refer to local FLOWSERVE branch to determine if a bypass is required. Mechanical damage may result from continuous operation at flows less than the specified minimum continuous stable flow.***

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

a) Check suction and discharge pressure gauges.
b) Check pressure gauges on each side of suction strainer.
c) Check for excessive leakage in the casing cover and at seal areas.
d) Check for unusual noises and/or any excessive vibration.
e) Check for adequate flow of seal flush.
f) Check bearing housing for overheating or vibration.
g) Check oil level in bearing housing (if applicable). (Refer to Section 5).

Operation of the unit without correct lubrication can result in overheating of the bearings, bearing failures, pump seizures and actual break-up of the equipment exposing operating personnel to physical injury.

h) Check for adequate flow of cooling liquids.
i) Check for hot alignment: for services 55 °C (100 °F) and more above ambient, after unit has been operated a sufficient period of time to reach normal operating temperature and condition, the unit is to be shut down and a "HOT" coupling alignment check must be made (Refer to Section 4.5.4).

5.7.1 Venting the pump

Vent the pump to enable all trapped air to escape taking due care with hot or hazardous liquids.

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

5.7.2 Pumps fitted with mechanical seal

Mechanical seals require no adjustment. Any slight initial leakage will stop when the seal is run in.

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

CAUTION External flush or quench 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 temperature or vibration monitoring at the bearings is recommended

If bearing temperatures are to be monitored it is essential that a benchmark temperature is recorded at the commissioning stage and after the bearing temperature has stabilised (see 5.2.4.1 for temperature limits).
When a oil temperature sensor is provided:

- set the alarm at 82 °C (180 °F) and the trip at 90 °C (194 °F) for high ambient temperature and/or hot service

When the bearing temperature sensor is provided:

- set the alarm at 93 °C (180 °F) and the trip at 105 °C (200 °F)

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 rise 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 **mm/s (in./s) r.m.s.**		**HWX mm/s (in./s) r.m.s.**
Normal	**N**	≤ 5 (0.2)
Alarm	**N** x 1.25	≤ 6.2 (0.25)
Shutdown trip	**N** x 2.0	≤ 10 (0.4)

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 actual capability of the driver and control/starting system before commissioning.

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

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

5.8 Normal Start Up

The starting procedure to be followed for normal start up is the same as that for initial starting with the exception that section 5.6 "CHECK ROTATION" does not have to be repeated as long as driver systems have not been changed since last pump operation.

5.9 Stopping and shutdown

a) Shut down driver.

CAUTION ***The pump should be shut down rapidly to protect the internal wearing parts which are lubricated by the liquid being pumped.***

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

b) Close the pump suction and discharge valve.
c) Close valve in bypass line
d) Turn off cooling liquid. If a seal gland cooling jacket has been provided, maintain the cooling water flow until the external casing surface temperature is ambient.
e) CAUTION ***If pump is subjected to freezing temperatures the pump must be drained of liquid to prevent damage to the pump.***
f) CAUTION ***The cooling rate of the casing should not exceed 5.5°C (10°F) per minute, whether the pump is shout-down in operation.***

5.10 Hydraulic, mechanical and electrical duty

This product has been supplied to meet the performance specifications of your purchase order, however it is understood that during the life of the product these may change. The notes on section 3.4 may help the user decide how to evaluate the implications of any change. If in doubt contact your nearest Flowserve office.

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 authorised and qualified personnel who have adequately familiarised 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 5.9.

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

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

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

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

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

Do not spray air or compressed inert gas on skin.

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

Never use air or compressed inert gas to clean clothes.
Before working on the pump, take measures to prevent an uncontrolled start. Put a warning board on the starting device with the words: ***"Machine under repair: do not start"***.

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

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

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

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 bearing lubricant level, and if the hours run show a lubricant change is required.
d) Check that the duty condition is in the safe operating range for the pump.
e) Check vibration, noise level and surface temperature at the bearings to confirm satisfactory operation.
f) Check dirt and dust is removed from areas around close clearances, bearing housings and motors.
g) Check coupling alignment and re-align if necessary.

FLOWSERVE 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 suction and discharge gauges.
b) Check for abnormal operating conditions (High/Low Temperature, Flows, Vibration, Pressures Etc.)
c) Check motor current/driver power.
d) Check that there are no abnormal fluid or lubricant leaks (static and dynamic seals) and that any sealant systems (if fitted) are full and operating normally.
e) Check that shaft seal leaks are within acceptable limits.
f) Check all lubricant levels i.e. bearing housing oilers, seal Plan 52/53, seal supply systems as applicable.
g) On grease lubricated pumps, check running hours since last recharge of grease or complete grease change.
h) Check any auxiliary supplies eg heating/cooling (if fitted) are functioning correctly.
i) Check stand by pump is at applicable temperature and available to start as required.

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

6.2.2 Periodic inspection (monthly)

a) Check for lubricant contamination whether bearing oil, or seal oil (if applicable) by sample analysis.
b) Check all paint or protective coatings.
c) Check all power/instrument cable glands for tightness.

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

6.2.3 Periodic inspection (six monthly)

a) CAUTION Check foundation bolts for security of attachment, corrosion. Check grouting for looseness, cracking or general distress.
b) Change lubricants.
c) Check calibration of instruments.
d) The coupling should be checked for correct alignment and worn driving elements.

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

6.2.4 Inspection (after 3 years)

a) Check internal condition of pump and all ancillary pipework for corrosion/erosion.
b) Check internal pump components for wear.
c) Change bearings

6.2.5 Re-lubrication

Lubricant and bearing temperature analysis can be useful in optimising lubricant change intervals. In general however, the following is recommended.

6.2.5.1 Oil lubrication

CAUTION Maintaining the correct oil level is very important.

If the pump is supplied with a constant level oiler the oil level will be automatically maintained and as long as oil is visible in the glass bottle there is no need to refill. If however a sight glass has been fitted then regular checks should be made to ensure the level is maintained at the centre of the glass window.

Refer to section 5.1.1 for methods of oil fill, section 5.2.1 for oil grade recommendations and 5.2.4 for the schedule and temperature limits.

6.2.5.2 Grease lubrication

CAUTION Maintaining the correct grease grade is very important.

Line Bearing

Line bearing is greased for life so no maintenance is required.

Thrust Bearing

When grease nipples are fitted provide a one grease charge every 2000 hours.

Refer to section 5.1.1 for methods of grease fill, section 5.2.1 for grease grade recommendations and 5.2.4 for the schedule and temperature limits.

6.2.6 Mechanical seals

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

6.3 Spare parts

6.3.1 Ordering of spares

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

1) Pump serial number
2) Pump size

3) Part name – (a)
4) Part number – (a)
5) Number of parts required

(a) taken from the cross section drawing stored into the job user instruction book and only in case not available see at section 8.
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-genuine 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 (according to API)

For start up purposes:

1 - set of bearings (line and thrust)
2 - sets of gaskets and o-ring
2 - wear rings set (2 rotating + 2 stationary)
1 - mechanical seals
1 - labyrinth set (drive and impeller end)

For normal maintenance:

1 - set of bearings (line and thrust)
2 - sets of gaskets and o-ring
2 - wear rings set (2 rotating + 2 stationary)
1 - mechanical seals
1 - labyrinth and deflector set (drive and impeller end)
1 - shaft
1 - impeller

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 2" (M 50) screws/nuts
- Socket spanners (wrenches), up to 2" (M 50) screws
- Allen keys, up to 10 mm (A/F)
- Range of screwdrivers
- Soft mallet

More specialised equipment:

- Bearing pullers
- Bearing induction heater
- Dial test indicator
- Back pullout dismantling tool

6.6 Fastener torques

Main Flange Studs/Nuts (Casing to Casing Cover)		
Stud Size	**Torque Value**	
	N•m	**(lb•ft)**
⅝ in.	160-170	(118-125)
¾ in.	290-300	(214-221)
⅞ in.	460-465	(339-343)
1 in.	700-710	(516-524)
1⅛ in.	1017-1024	(750-755)
1¼ in.	1420-1430	(1047-1054)

Bearing Housing to Casing Cover		
Hex Head Screw Size	**Torque Value**	
	N•m	**(lb•ft)**
½ in.	18-22	(13-16)
⅝ in.	37-45	(27-33)

Bearing Housing End Cover to Bearing Housing		
Hex Head Screw Size	**Torque Value**	
	N•m	**(lb•ft)**
⅜ in.	8-11	(6-8)

Mechanical Seal to Casing Cover		
Stud/Nut Size	**Torque Value**	
	N•m	**(lb•ft)**
½ in.	35-41	(26-30)
⅝ in.	58-68	(45-50)
¾ in.	130-150	(95-110)

Thrust Bearing Locknut		
Bearing Size	**Torque Value**	
	N•m	**(lb•ft)**
7311	99 – 104	(73 – 77)
7313	138 – 145	(102 – 107)

Oil Thrower		
Socket Head Capscrew Size	**Torque Value**	
	N•m	**(lb•ft)**
¼ in.	4-5	(3-4)

Torque Values listed above are selected to achieve the correct amount of pre-stress in the threaded fastener. Maintenance personnel must ensure that threads are in good condition (free of burrs, galling, dirt, etc.) and that commercial thread lubricant is used. Torque should be periodically checked to ensure that it is at the recommended value.

6.7 Disassembly

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

CAUTION Before dismantling the pump for overhaul, ensure genuine Flowserve replacement parts are available.

Note: ***Refer to sectional drawings for part numbers and identification.***

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

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

CAUTION ***Remove the pipe plug(s) from the top of the bearing housing(s) and check to see that oil rings are riding free on the pump shaft and are not hung up. Failure to observe this caution could result in damage to or destruction of equipment.***

6.7.1 Pull Out Element Removal

This pump has a pull-out element, which consists of the pump shaft (2100), mechanical seal assembly (4200), casing cover (1221), impeller (2200), and bearing housing assembly, as well as their attached parts. This pull-out element makes it unnecessary to remove the driver, support head (3160), or casing (1100) to service the bearing housing assembly, mechanical seal (4200), impeller (2200), wear rings (2300.1/2300.2–1500.1/1500.2), stuffing box bushing (2430), and gaskets.
For an illustrative part reference, see the Pump Assembly drawing in the back of this manual.

a) Remove all seal piping, related instrumentation and electrical equipment that will interfere with disassembly. Drain pump casing.

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

When pump is handling "caustic" liquid extreme care must be taken to ensure safety of personnel when removing auxiliary piping or when draining pump. Protective devices of suitable protective materials must be worn when draining the pump.

b) Remove coupling guard (1342) from bearing housing (3130) by removing bolts and washers. Remove bolts and nuts holding the guard together, then remove the guard.
c) Disassemble and remove coupling spacer in accordance with the manufacturer's instructions in the back of this manual.
d) In case of Oil Lubrication drain the bearing housing of oil. This can be done by removing the drain plug situated at the bottom of the bearing housing.

Use caution when draining hot oil from bearing housing to prevent burns/injury to personnel

e) Remove the hex bolts clamping the casing cover (1221) to the casing (1100).
f) Use the jacking bolts provided on the casing cover (1221) flange to lift the cover from the casing (1100) and raise the cover above the lower flange of the support head (3160).
g) Attach the pullout element lifting tool to the pullout element, then lift the element out of the casing (1100). (See figure 6.2).

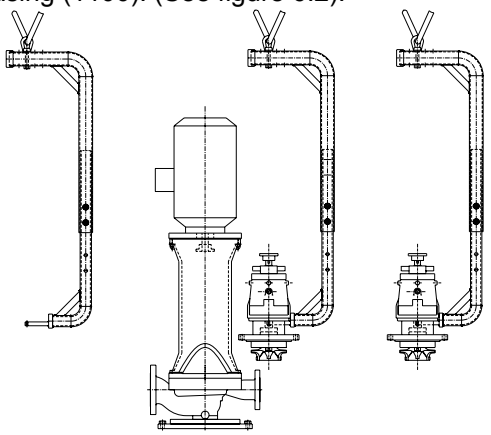


Figure 6.2

Note: *The lifting tool is not part of the pump. It must be ordered separately.*

h) Raise the pullout element upward until the impeller clears the lower flange of the support head (3160) and remove through the large opening in the support head.
i) Remove the casing cover gasket (4510) from the casing (1100) or casing cover (1221) and discard.
j) Move the pullout element to a safe, clean work area for further disassembly.

6.7.2 Pull Out Element Disassembly

CAUTION **All gaskets and O-rings removed during maintenance are to be discarded and replaced with new ones to ensure proper sealing during subsequent operation.**

Note: ***As a reminder of the orientation of the casing cover and the bearing housing you might match mark these parts before separating them; however, the OUTLINE drawing shows the factory orientation.***

To disassemble the pullout element, soft cable (or equivalent) and lifting equipment should be handy and used for heavy parts. Proceed as follows:

a) Secure bearing housing (3130) to workbench in a position that will allow impeller (2200) and casing cover (1221) to be pulled away from shaft (2100) and bearing housing (3130).
b) Secure shaft (2100) to prevent rotation.

Note: ***The impeller cap nut (2912) is left-hand threaded. To remove the impeller cap nut, turn it to the right (clockwise) while facing the impeller.***

c) Untight the security dowel of the cap nut (2912) and remove it from shaft.
d) Use heat, if necessary, on impeller (2200) and remove it from shaft.
e) Remove impeller key (6700.2).
f) Install the mechanical seal spacers to lock the shaft sleeve to the seal plate. Then loosen the set screws which hold the shaft sleeve to the shaft.
g) Unscrew cap screws that hold bearing housing (3130) to casing cover (1221) and tap casing cover and bearing housing with mallet to break cover loose from housing.

Note: ***The impeller cap nut (2912) is left-hand threaded. To remove the impeller cap nut, turn it to the right (clockwise) while facing the impeller.***

h) Hold shaft sleeve in place and carefully slide casing cover (1221) with sleeve and mechanical seal parts off shaft and clear of bearing housing (3130).

Note: ***The stuffing box bushing (4132) is pressed into the casing cover (1221) and should not be removed unless worn or badly scratched or gouged, in which case the old bushing must be pressed out and a new one pressed in***.

i) Set casing cover (1221) on workbench with bearing-housing side up.

To disassemble a mechanical seal follow the seal manufacturer's instructions in the Appendix.

j) Remove the seal plate nuts and the mechanical seal (4200).
k) Note: ***If no pumpage has got into bearing housing and you plan to replace just the mechanical seal, omit the remaining steps; otherwise continue to disassemble pump as outlined.***
l) Evenly heat pump half-coupling using a welding torch with a Rosebud head until you are able to pull half-coupling off with a coupling puller, then remove half-coupling and key (6700.1).
m) Remove outboard fan (if applicable 8161.1) and O-rings (4610.1). Loosen screw on inboard fan (8161.2) and slide off shaft.
n) Unscrew bearing housing end cover cap screws and slide end cover (3260.2) off shaft. If your pump is oil lubricated, remove and retain the cover plate (3260.1). Remove the bearing isolator rotor (2540) and O-ring (4610.2), then push the bearing isolator stator (4330) and O-ring (4610.3) out of the end cover.
o)

Note: ***Although not necessary, it may be worthwhile to lift the bearing housing and block it in a vertical position with the thrust bearing up to facilitate removal of the shaft and bearings. Support shaft as it is moved out of bearing housing by soft cables and hoist or wood blocks.***

p) Remove shaft (2100), with thrust bearings (3013) and radial bearing (3010) installed, from bearing housing (3130).
q) Proceed as follows:
   - If your pump is grease or pure mist lubricated, then slide the deflector ring (2541.1) and O-ring (4610.4) off of the shaft (2100).
   - If your pump is oil lubricated, then loosen the set screws which hold the screw pump to the shaft, then slide the screw pump (2470) off of the shaft.
r) Place shaft in a vice which is covered with a soft material such as copper to prevent marring; then clamp it just enough to keep it from turning when thrust bearing lock nut (3712) is broken loose.
s) Bend back tab on thrust bearing lock washer (6541). Unscrew thrust bearing lock nut (3712). Facing the bearing nut, turn it clockwise to loosen. Remove lock nut and lock washer from shaft.
t) Remove shaft from vice and press bearings (3013 – 3010) off shaft with hydraulic press, if available; otherwise, leave shaft in vice and pull bearings off shaft with a bearing puller. Slide the bearing spacer (3645) or deflector ring (2541.1) (as applicable) off of the shaft.
u) If your pump is oil lubricated: The inner bearing housing cover (3266) should only be removed if there is evidence of leakage. If the cover is to be removed, remove the cap screws and slide the cover out of the bearing housing.

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.

To perform a good visual inspection and to obtain the highest degree of cleanliness, which is essential to the correct fit and balance of all rotating parts, the shaft must be stripped of all parts. The visual inspection consists of examining the following parts for those conditions that commonly impair pump operation. Where the corrective action may not be apparent to a journeyman millwright or a more extensive examination is required, the inspection item is cross-referenced to a detailed procedure. Unless noted below, all damaged parts should be replaced rather than repaired.

6.8.1 Cleaning Agents

When the pump is used in the steam generator feed, the boiler feed, the reactor feed, or other such steam (or water) circuit, all internal metal parts of the pump including the case should be cleaned with a non-petroleum-base cleaning agent such as alcohol or acetone or a steam cleaner that uses steam from demineralised water. The basic concern should be to insure that the solvent is compatible with the pumpage. Petroleum-base agents such as dry cleaning solvent and kerosene may be used for cleaning internal parts when such agent will dissolve in the liquid being pumped without inducing an ill effect. Petroleum-base agents should be used to clean the bearings and their housings.



Fumes from alcohol, acetone, petroleum solvents and other such chemicals are injurious to health and may ignite from a spark; make certain that the area where they are used is well ventilated and have a fire extinguisher handy.

6.8.2 Casing, seal housing and impeller

a) Inspect for erosion, foreign object damage and cracks; erosion and damage must be corrected before final assembly.
b) Inspect impeller cap nut (2912) and impeller (2200) for nicks, gouges, galling and rust.
c) Inspect impeller bore for correct fit with shaft (See Section 6.9.2 ”Checking Fit Between Impeller Bore and Shaft”).
d) Inspect running surfaces of stuffing box bushing (4132), shaft (2100), case wearing ring (1500.1), casing cover wearing ring (1500.2), and impeller wearing rings (2300.1–2300.2) for nicks, burrs, scratches, scouring and excessive wear. Concentric and smooth surfaces are required (See Section 6.9.1 “Wear Rings”).
e) Replace as necessary.

6.8.3 Mechanical seal

a) Mechanical seal stationary and rotating faces should be inspected for signs of wear or cracks and replaced as necessary.
b) It is recommended that when reassembling mechanical seal new "O" rings and gaskets be used.
c) Refer to manufacturers drawing for assembly of mechanical seal. Refer to mechanical seal section within this manual for further details.

6.8.4 Throat Bush (If fitted)

a) Check the throat bush and replace if required. Note that the bush outside diameter should be the same diameter as the adjacent impeller wear ring.

6.8.5 Shaft

Shaft (2100) for scratches, nicks, burrs, and distortion; absolutely smooth surfaces and a straight shaft are required.

After the shaft is inspected for damage as described above, it must be checked for straightness before reassembling the rotating parts. When making the check do not turn the shaft in its lathe centers. It is possible for the lathe centers of a straight shaft to be off center slightly, resulting in a false indication of a bent shaft.

1. Set shaft in soft-faced V-blocks, precision rollers (or equivalent).
2. Check straightness by taking dial indicator readings all along the shaft while it is rotated; total runout of shaft must not exceed 0.04 mm (0.0015 in). If runout is exceeded shaft must be cold-straightened or replaced.

CAUTION **Application of heat to straighten shaft will cause more distortion.**

Note: ***The term "soft-faced V-blocks" refers to V-blocks faced with metal that is softer than the shaft, for example, V-blocks faced with copper.***

6.8.6 Gaskets and O-rings

After dismantling, discard and replace.

6.8.7 Bearings

a) It is recommended that bearings are not re-used after any removal from the shaft. In any case the bearings must be replaced not after 25000 operating hours.

b) If the bearing cannot be removed with the tools available never use a torch under any circumstances. Split the outer ring with a small hand grinder, saw through the ball/roller retainer, and split the inner ring about three quarters through with a grinder and break with a cold steel chisel.

   Note: ***Do not attempt to inspect condition of bearings until they have been cleaned.***

c) Solvent for cleaning bearings should be in a clean container. Place bearings in solvent and let soak for a short time. Agitate the bearing around near the top of the container, giving it a turn now and then until it is clean. Rinse in a clean container of fresh solvent.

   Note: ***Do not spin dirty bearings. Rotate them slowly while washing.***

d) Dry thoroughly cleaned bearings. If an air hose is used for drying, make sure it is clean dry air.

   Note: ***Do not allow the bearings to spin by force of air. Hold the inner and outer rings to prevent bearing from spinning.***

e) Inspect bearings immediately. If there is any question as to the condition of a bearing do not hesitate to replace it. There are many conditions that contribute to the deterioration of the bearings. A qualified bearing representative should be consulted if there is any question of bearing condition.

f) Inspected bearings which will be reused should be packed with new grease or dipped in clean lubricating oil, covered with clean lint free rags or other suitable covering and placed in a clean box or carton until ready for installation.

   Note: ***Under no circumstances the bearings are to be left exposed.***

6.8.8 Labyrinths or bearing isolators (if fitted)

a) 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.

b) 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.

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

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

6.9 Assembly

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

Ensure threads, gasket and O-ring mating faces are clean.

6.9.1 Wear rings

The impeller may be fitted with both front and rear wear rings or front ring only.

The impeller ring(s) are renewable and should be replaced when badly grooved, and/or when pump performance does not meet the system requirements. Whenever it becomes necessary to replace either wear ring, both rings involved (impeller and

casing/casing cover) must be ordered and replaced as a set as they are furnished standard size only.
Spare impeller wear rings are supplied with a material stock over outside diameter which has to be machined off after rings fitting on impeller. If an impeller with its wear rings is ordered as spare, it will be supplied fully machined, including wear rings outside diameter, to original dimensions. Casing wear rings are always supplied fully machined. Be sure to re-establish the original running clearance between the two wear rings involved by machining the fitted impeller ring.

Running clearance is determined by measuring the inside diameter of the stationary part and the outside diameter of the rotating part (for example, the inside diameter of the case wearing ring and outside diameter of the related wearing ring on the impeller), and taking their difference to get the running clearance; that is, the diameter of the stationary part minus the diameter of the rotating part equals the actual running clearance.

Measurement should be taken with a micrometer and each part should be checked for trueness or roundness by taking diametrical readings 90 degrees apart. To determine whether the actual running clearance has increased to a point where replacement of a part is advisable, compare the actual clearance with the design clearance that is given in the cross sectional drawing. Then consider the wear with respect to mechanical and hydraulic efficiency and decide whether to restore the design clearance.

Before final assembly, the trueness and the running clearance of the following should be checked:
1. Stuffing box bushing (4132).
2. Case wearing ring (1500.1), casing cover wearing ring (1500.2), and impeller wearing rings (2300.1–2300.2); restore running clearance that is given in cross sectional drawing and roundness as outlined in section 6.9.1.1 and 6.9.1.2.

6.9.1.1 Impeller wear rings

a) To remove impeller wear rings, mutually remove wear ring set screws or ground off tack weld. Rings can be machined off or grind two slots diametrically opposite across the width of the ring so it can be split apart. Use caution if ring is removed by grinding so as not to damage impeller hubs.

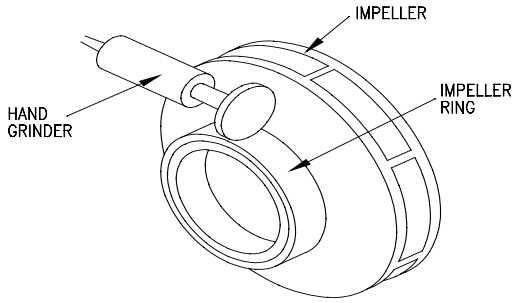


Figure 6.3

b) Determine that impeller has cooled to ambient temperature by feeling with hand; then heat wearing ring using a torch until ring will slip into place on impeller.
c) Verify trueness of wearing-ring-to-impeller fit as outlined below or by an equivalent technique:
   - Make sure ring fits on impeller are free of nicks or burrs. Heat new ring to 107 °C (225 °F). Set impeller with wearing ring face up on table of vertical lathe and parallel with face of table.
   - Align centerline of impeller (that is, centerline of impeller bore) with centerline of table using bore as true surface for dial indicator. Alignment should be within 0.03 mm (0.001 in.).
   - Clamp impeller in centered and parallel position.
   - Set up dial indicator to run outside diameter of wearing ring and rotate table. Total runout must not exceed 0.04 mm (0.0015 in.).
d) Drill and tap new holes in impeller spaced half the circular distance from the previously used holes in the impeller. See sketch below (If tack welding ring, use ER308 or ER309 rod and gas-tungsten arc.

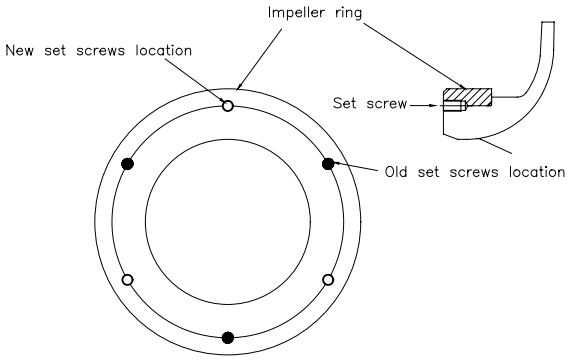


Figure 6.4

Note: ***Impeller wear rings when installed must be machined to establish original diameter and running clearance. Whenever an impeller has new wear rings fitted it must be dynamically balanced before being reassembled. Refer to the Cross Sectional drawing for the requested running clearance.***

6.9.1.2 Case wear rings (and casing cover wear ring when fitted)

Each wear ring is locked against rotation with a cylindrical pin.

a) To remove the wear ring, press it out. If this method does not easily effect removal of the ring, it can be split apart. First, however, drill one or more holes in the face of the worn ring.
b) New rings to be installed must be shrunk by freezing when installing in casing or casing cover. See that temperature of casing / casing cover is above 21 °C (70 °F).
c) Subcool new wearing ring in dry ice to shrink it; then, bottom ring squarely in bore of parent part by using aluminium drift and mallet to strike evenly around circumference of wearing ring.
d) Determine that wearing ring and parent part have warmed to ambient temperature by feeling with hand.
e) Verify trueness of wearing-ring-to-part fit as outlined below or by an equivalent technique:
   - Set up parent part in lathe or milling machine so that register face of part can be used as true side for dial indicator. The centreline of part must be aligned with centreline of machine's table and it must also be parallel with table within 0.03 mm (0.001 in).
   - Set up dial indicator to run on inside diameter of wearing ring and rotate table (or chuck). Total runout must not exceed 0.04 mm (0.0015 in).
f) Fit and secure with a locking pin. Replacement wear rings are furnished standard size in the bore. Check the running clearance between impeller and casing ring against the appropriate value.

6.9.2 Checking Fit Between Impeller Bore and Shaft.

The fit between the impeller bore and the shaft must be correct or vibration is apt to occur.
To check the fit, proceed as follows:

a) Verify shaft straightness (See Section 6.8.5).

   Note: A three-point micrometer is the preferred instrument for measuring bore; a stick micrometer is its alternate. When measuring with the three-point micrometer, measure close to the keyway. With stick micrometer, measure three places at 120-degree intervals.

b) Determine nominal fit of impellers with shaft:
   - by using micrometers to measure diameter of bore under thickest metal near each end of keyway of impeller and the corresponding diameter of shaft,
   - then by comparing diameter of bore of impeller with corresponding diameter of shaft. Diameter of bore of impeller should be 0.013 mm (0.0005 in.) to 0.38 mm (0.0015 in.) oversize of the corresponding diameter of shaft.

CAUTION ***The diameter of the impeller bore must never be oversize of its counterpart on shaft by more than the allowable tolerance. If the impeller bore is not within tolerance, you should contact the nearest FLOWSERVE Pump Sales Office for recommendations concerning your particular circumstance.***

6.9.3 Oil Thrower (if applicable)

In case of Oil Cascade Lubrication, install thrower onto shaft. Secure thrower to shaft by tightening set screws into the location groove in the shaft.

6.9.4 Bearings Housing

The ball bearings require correct handling and installation to ensure optimum performance. The following information is intended as a minimum to ensure that the bearings are handled and installed correctly. As you assemble the pullout element, keep soft cables or nylon lifting straps and hoist handy for heavy parts.

Note: If you have not match-marked the casing cover, the bearing housing, and seal plate to identify their orientation, you should determine their correction orientation by studying the OUTLINE drawing before commencing assembly of the pullout element.

If the intent is to replace only the Mechanical Seal Part proceed to section 6.9.4.1

1. Make certain that all visual inspection requirements have been met, including verification of shaft straightness, wearing ring running clearance, stuffing box bushing running clearance, and fit between impeller and shaft (see Section 6.8 "*Examination of parts*").

2. Place shaft in a soft-faced vise (that is, a vise with faces covered with a soft material such as copper) to prevent marring; then clamp it so that the radial and thrust bearings can be slipped onto shaft.

6.9.4.1 Bearings handling

a) Do not remove new bearings from their storage package except for inspection, when stored for a long period of time or just prior to their installation.
b) Work area must be clean to ensure that no dirt or other contaminates will enter the bearings. Handle bearings with clean, dry hands and with clean, lint free rags. Lay bearings on clean paper and keep covered. Never expose bearings on a dirty bench or floor.
c) Do not wash a new bearing. It is already clean and the preservative should not be removed.
d) Before mounting, be sure shaft bearing areas are clean and free of nicks and burrs. Check the dimensions of these areas to ensure correct fit of bearings.

6.9.4.2 Bearing installation

Install the thrust and radial bearings in the same sequence and direction as removed.

⚠ CAUTION If your pump is grease lubricated, the disk spacer (3645) must be positioned on the shaft (2100) so that the flat side is away from the thrust bearing (3013) before the bearing assembly, as illustrated on Figure 6.5b.

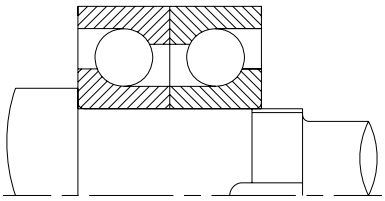


Figure 6.5a - Oil Cascade and Oil Mist Lubrication -

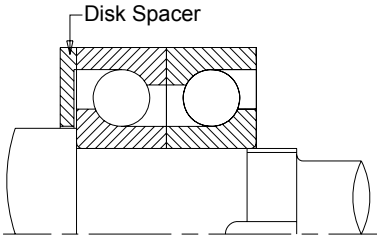


Figure 6.5b - Grease Lubrication –

There are two simple methods of providing a heat source for expanding the inner race of the bearings to facilitate mounting.

a) In the first method, bearings still wrapped in their original intimate wrap are placed on a shelf in a temperature controlled oven, or in an enclosure lined with foil and heated with electric light bulbs. A temperature of 66 °C (150 °F) for one half hour should be sufficient.
b) A second method consists of locating a light bulb 100 to 150 Watt (0.13 to 0.15 hp) in the bore of the bearing. The light bulb will heat, primarily, the inner ring and the bearing can usually be handled by the outer ring without special gloves. Care must be taken to keep the bearing clean and uncontaminated.

Note: ***The old and once popular method of heating bearings in an oil bath is DEFINITELY DISCOURAGED. HEATING INNER RING WITH A GAS TORCH IS PROHIBITED. In either case, it is difficult to control the heating rate and final temperature and even more difficult to keep the oil and/or bearing clean.***

c) When bearings are installed on the shaft make sure the bearing is installed squarely and is firmly seated. Hold bearing in place until it has cooled sufficiently so that it will not move from position. Cover bearings to protect them from dirt.

Note: ***When installing the bearings the mounting pressure should never be applied in such a manner that it is transmitted through the rolling element. Apply the mounting force directly against, and only against, the inner ring.***

Note: ***Inner thrust bearing must be assembled against shoulder on shaft with the wide flange of the outer race towards the coupling. The outer thrust bearings is to be placed on the shaft with the wide flange of the outer race towards the inner bearing***.

d) When installing bearings on shaft, heat thrust bearing, radial bearing and screw pump (oil cascade lubricated bearing housing) to 200-230°F (95-110°C) and slide them up against their shoulders on shaft (thrust bearing on coupling end of shaft and radial bearing and screw pump on impeller end). Heat for approximately 20 - 30 minutes.
e) Install the lock washer and locknut as per figure 6.6a (oil cascade and oil mist lubrication) and figure 6.6b (grease lubrication).

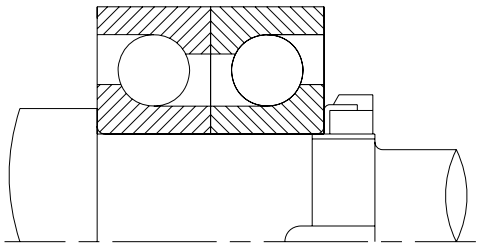


Figure 6.6a - Oil Cascade and Oil Mist Lubrication -

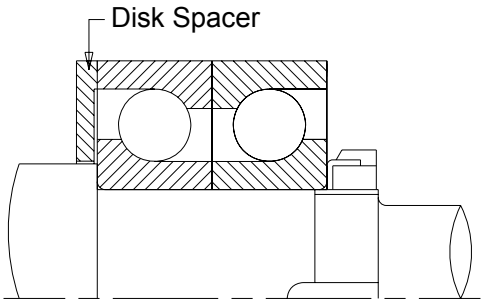


Figure 6.6b - Grease Lubrication -

- Slide thrust bearing lock washer onto shaft, then thread lock nut onto shaft hand tight.
- Spin outer races of thrust bearing several times, then tighten the lock nut. The lock nut should be tightened such that the outer races of the thrust bearing do not turn independently when spun, but can be moved independently by hand.
- Allow the thrust bearings to cool to ambient temperature.
- Loosen the thrust bearing lock nut to hand tight, then re-torque the lock nut to 122 Nm (90 ft-lb).
- Mount a dial indicator on the shaft to read on the outer thrust bearing races. Runout on the outer thrust bearing races should not exceed 0.04 mm (0.0015 in.). Tap the bearing races into place with a soft-faced mallet if necessary.
- When bearing nut has been properly tightened and runout are within specification, bend a lock washer tab into a slot on the lock nut.

f) Remove shaft from vise.

g) Place the bearing housing in a vertical position on blocks in preparation for installation of shaft assembly. Make sure blocking is of sufficient height so that shaft will not contact the floor. There should be 0.03 mm (0.001 in.) diametrical clearance between outer race of each bearing and its bore in the bearing housing.

h) Suspend shaft vertically for installation into bearing housing.

i) If your pump is oil lubricated, and the inner bearing housing cover (3260.1) has been removed, then install a new O-ring, or coat the mating surfaces of the bearing housing (3130) and cover with Loctite Gasket Eliminator 504 sealant (or equivalent), as indicated in the Cross Sectional Drawing in the back of this manual. Install bearing housing end cover and evenly tighten cap screws.

j) Lubricate outer races of thrust bearings (3013) and radial bearing (3010); then slide the shaft with bearings installed into the bearing housing (3130). Push or tap on the outer thrust bearing race with a soft brass or plastic rod to position bearings in their bores in bearing housing.

k) Install the bearing isolator stator (4330) with a new O-ring (4610.3) in the bearing housing end cover (3260.2).

l) Coat the mating surfaces of the bearing housing (3130) and bearing housing end cover (3260.2) with Loctite Gasket Eliminator 504 sealant (or equivalent). If your pump is oil lubricated, then coat and install the cover plate (3260.1) as well. Install bearing housing end cover (and cover plate, if applicable) and evenly tighten cap screws.

m) Install the bearing isolator rotor (2540) with a new O-ring (4610.2) by pushing it onto the coupling end of the shaft until it rests against the bearing isolator stator (4330).

n) Determine thrust bearing axial play as follows:
   - Mount a dial indicator to read on end of shaft. Push on coupling end of shaft until shaft is all the way toward impeller end; then set the dial indicator to "0".
   - Thrust shaft toward coupling end and read indicator: Repeat the procedure to confirm reading.
   - Clearance is correct if dial indicator is between 0.05 mm (0.002 in.) and 0.100 mm (0.004 in.).
   - If dial indicator indicates play less than 0.05 mm (0.002 in.) or more than 0.100 mm (0.004 in.), correct by machining end cover or installing appropriate gasket between bearing housing and end cover gasket.

o) Install inboard fan (8161.2) and tighten cap screw. Install outboard fan (8161.1) with new O-rings (4610.1).

p) Determine shaft and impeller wearing ring runout as follows:
   - With bearing housing clamped in position, fix dial indicator to bearing housing (3130) and

touch dial indicator button to shaft (2100). Indicator must be fixed tightly to housing.

- Slowly, rotate shaft and record readings at 12, 3, 6, and 9 o'clock points. Total indicated reading (TIR) shall not exceed 0.04 mm (0.0015 in.). If readings are excessive, set up may not be rigid.

  Note: If runout (i.e., TIR) at any surface is excessive, check all parts for burrs, dirt and rough surfaces; register face of bearing housing for squareness, and its bore for roundness; bearings for bottoming against shaft shoulders.

  If you disassemble bearing housing, reassemble it in accordance with the procedure outlined above
- Remove the dial indicator.
- Install the impeller key (6700.2) and impeller (2200).

  Note: As you face the impeller end of the shaft, thread the impeller cap screw by turning it counter-clockwise.
- Remove the dial indicator.
- Install impeller washer (2430) and impeller lock washer against impeller (2200) and screw impeller cap screw (2912) tightly against washer, but do not bend a lock washer tab. The impeller must be tight against the shaft shoulder with no play.
- Fix dial indicator to bearing housing register face or another point so that it is rigid and touch indicator button to either wearing ring (2300.1 – 2300.2).
- Slowly, rotate shaft and record readings at 12, 3, 6, and 9 o'clock points; TIR shall not exceed 0.04 mm (0.0015 in).
- Repeat the two steps above to verify concentricity of other wearing ring.

  Note: If runout is excessive, check fit of impeller on shaft (see Section 6.9.2) and wearing ring installations (see Section 6.9.1). Should you be unable to determine the cause of excessive runout, contact the nearest FLOWSERVE Pump Sales Office.
- Remove impeller cap screw (2912), impeller lock washer, impeller washer, and impeller (2200).

6.9.5 Shaft seal

6.9.5.1 Shaft seal – mechanical seal

a) Install, mechanical seal (4200), and seal plate nuts. Tighten nuts evenly, then turn casing cover (1221) over, placing impeller-side up.
b) Use heat, if necessary, on impeller and slide it over key (6700.2) and against shaft shoulder.
c) Secure shaft (2100) so that it will not move.
d) Install impeller washer and impeller lock washer against impeller and tightly screw impeller cap screw (2912) against washer to hold impeller on shaft without any play. Bend a tab of the lock washer against a face of the cap screw to secure it in place.
e) Rotate the mechanical seal setting washers which hold the shaft sleeve to the seal plate out of the way and secure them for future use.
f) Heat half-coupling in dry heat convection oven to 300°F (149°C). Install the coupling key (6700.1) on shaft, then slide the half-coupling onto the shaft until it is positioned as shown by the Outline Drawing.
g) Wrap soft cables or nylon lifting strap around casing cover (1221) and bearing housing (3130), then raise pullout element and transport it to case (1100).

Refer to any special instructions supplied with the mechanical seal.

6.9.6 Pullout Element Installation

a) Install a new casing cover gasket (4510) in the casing (1100).
b) Attach the pullout element lifting tool to the pullout element, then install rigging gear to lift the element.

   Note: ***Ensure that the pullout element is properly aligned with the casing and auxiliary equipment in accordance with the Outline Drawing.***
c) Raise the pullout element upward until the impeller clears the lower flange of the support head (3160) and install through the large opening in the support head.
d) Install the hex bolts clamping the casing cover (1221) to the casing (1100). Torque the bolts evenly in a star pattern to the torque value specified on Section 6.6.
e) Turn shaft by hand to ensure that rotor turns freely without binding or rubbing.

CAUTION ***Use of odd size bolts and nuts to couple half-couplings and spacer will cause imbalance; use only bolts and nuts specified by the coupling manufacturer.***

f) Install coupling spacer in accordance with the manufacturer's instructions in the back of this manual.

g) Install the coupling guard halves, then install bolts and nuts holding the guard together. Slide coupling guard (1342) up to support head (3160) and install bolts and washers which hold guard to head.

h) Install all seal piping, related instrumentation, and electrical equipment that was removed prior to disassembly.

i) Perform an alignment check of the pump in accordance with Section 4.5, "Initial Alignment"

j) Ensure that bearing lubrication is provided prior to operating the pump in accordance with Section 5.1.1, "Lubrication".

7 FAULTS; CAUSES AND REMEDIES

FAULT SYMPTOM

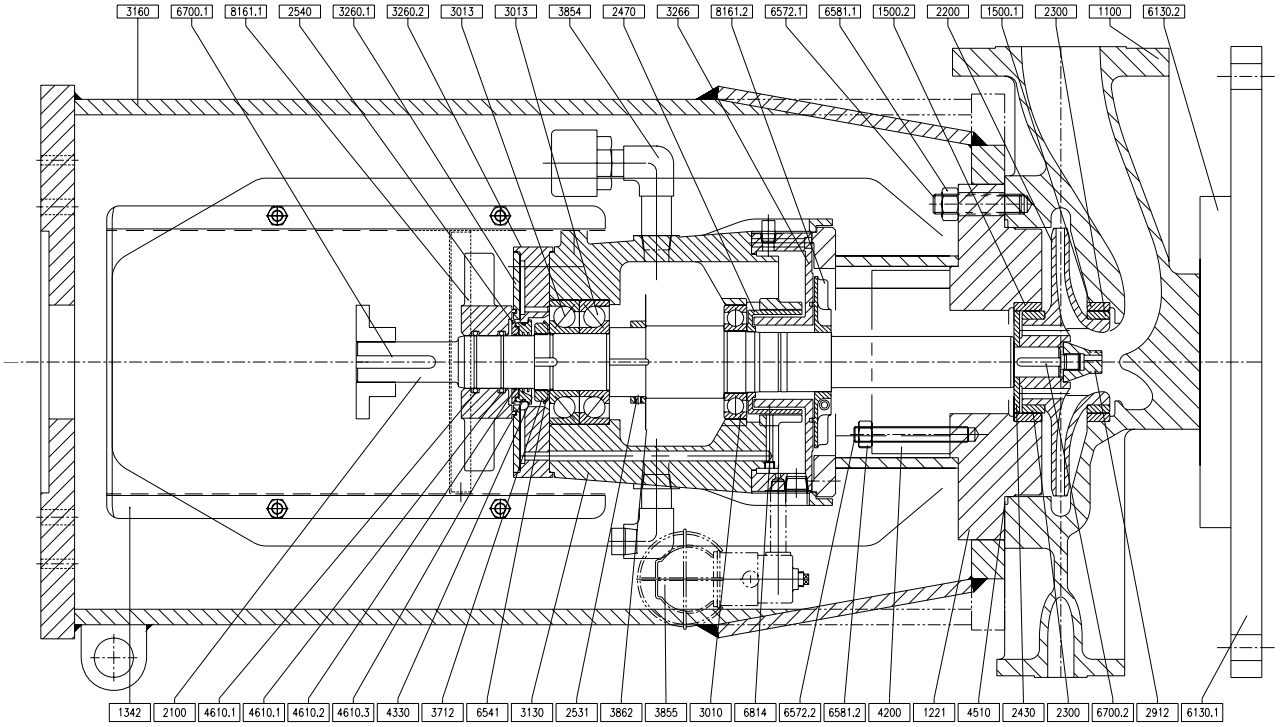
Pump overheats and seizes	Bearings have short life	Pump vibrates or is noisy	Mechanical seal has short life	Mechanical seal leaks excessively	Pump requires excessive power	Pump loses prime after starting	Insufficient pressure developed	Insufficient capacity delivered	Pump does not deliver liquid	PROBABLE CAUSES	POSSIBLE REMEDIES
										A. System troubles	
●									●	Pump not primed.	Check complete filling. Vent and/or prime.
		●				●		●	●	Pump or suction pipe not completely filled with liquid.	
		●				●		●	●	Suction lift too high or level too low.	Check NPSHa>NPSHr, proper submergence, losses at strainers/fittings.
●		●						●	●	Insufficient margin between suction pressure and vapour pressure.	
						●	●	●		Excessive amount of air or gas in liquid.	Check and purge pipes and system.
						●		●	●	Air or vapour pocket in suction line.	Check suction line design for vapour pockets.
						●		●		Air leaks into suction line.	Check suction pipe is airtight.
						●		●		Air leaks into pump through mechanical seal, sleeve joints, casing joint or pipe plugs.	Check and replace faulty parts. CONSULT FLOWSERVE.
		●						●		Foot valve too small.	Investigate replacing the foot valve.
		●						●		Foot valve partially clogged.	Clean foot valve.
		●				●		●	●	Inlet of suction pipe insufficiently submerged.	Check out system design.
							●	●	●	Speed too low.	CONSULT FLOWSERVE.
					●					Speed too high.	CONSULT FLOWSERVE.
							●	●	●	Total head of system higher than differential head of pump.	Check system losses. Remedy or CONSULT FLOWSERVE.
					●					Total head of system lower than pump design head.	
					●					Specific gravity of liquid different from design.	Check and CONSULT FLOWSERVE.
					●		●	●		Viscosity of liquid differs from that for which designed.	
●		●								Operation at very low capacity.	Measure value and check minimum permitted. Remedy or CONSULT FLOWSERVE.
	●	●			●					Operation at high capacity.	Measure value and check maximum permitted. Remedy or CONSULT FLOWSERVE.
										B. Mechanical troubles	
●	●	●	●	●	●					Misalignment due to pipe strain.	Check the flange connections and eliminate strains using elastic couplings or a method permitted.
		●								Improperly designed foundation.	Check setting of baseplate: tighten, adjust, grout base as required.
	●	●	●	●	●					Shaft bent.	Check shaft runouts are within acceptable values.

FAULT SYMPTOM

Pump overheats and seizes	Bearings have short life	Pump vibrates or is noisy	Mechanical seal has short life	Mechanical seal leaks excessively	Pump requires excessive power	Pump loses prime after starting	Insufficient pressure developed	Insufficient capacity delivered	Pump does not deliver liquid	PROBABLE CAUSES	POSSIBLE REMEDIES
											CONSULT FLOWSERVE.
●	●	●			●					Rotating part rubbing on stationary part internally.	Check and CONSULT FLOWSERVE, if necessary.
●	●	●	●	●						Bearings worn	Replace bearings.
					●		●	●		Wearing ring surfaces worn.	Replace worn wear ring/surfaces.
		●					●	●		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.
			●	●	●					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 PARTS LIST AND DRAWINGS

8.1 Frame 1, Oil Cascade, Single Volute

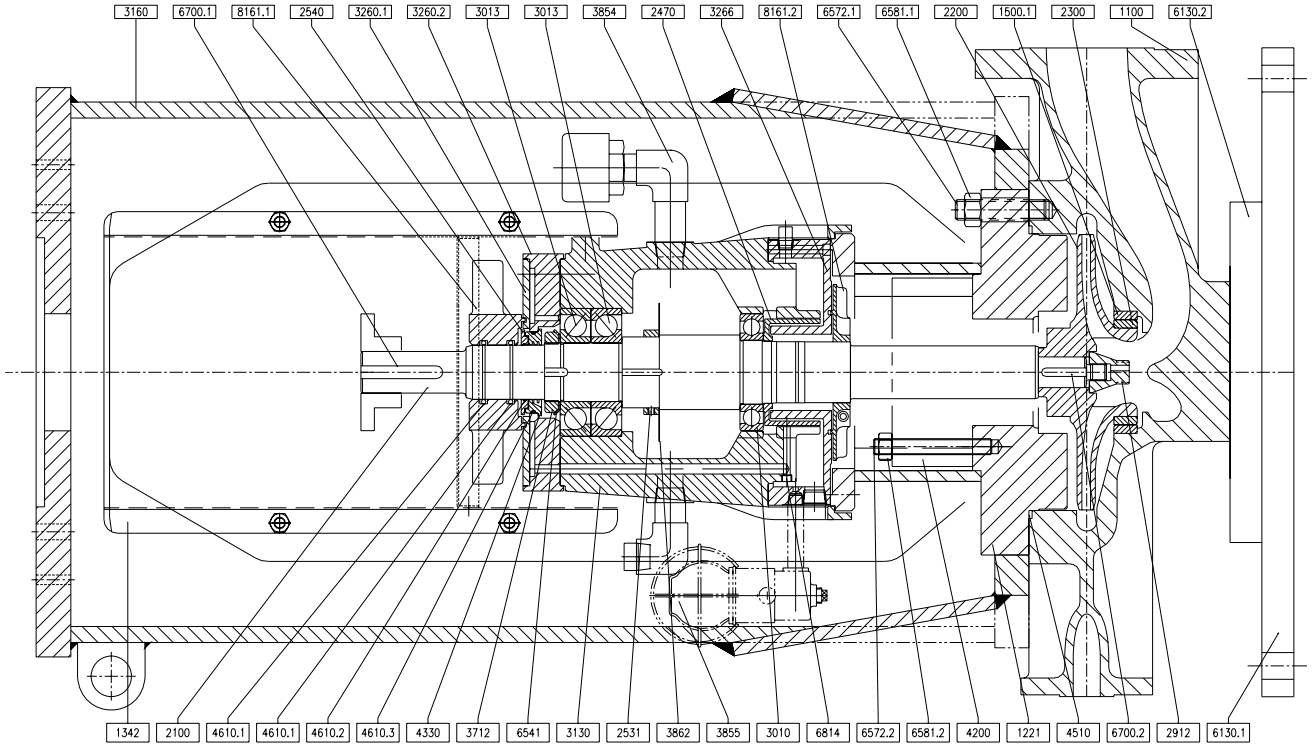


8.1.1 Parts list

Ref no	Description
1100	Casing
1221	Casing Cover
1342	Intermediate Lantern
1500.1	Casing Wear ring
1500.2	Casing Wear ring
2100	Shaft
2200	Impeller
2300	Impeller Wear Ring
2430	Throttling Sleeve
2470	Centering Sleeve
2531	Split Retaining Ring
2540	Deflector
2912	Impeller Nut
3010	Anti-Friction Bearing
3013	Thrust Ball bearing
3130	Bearing Bracket
3160	Motor Stool
3260.1	Bearing Cover
3260.2	Bearing Cover
3266	Bearing End Cover
3712	Bearing Nut

Ref no	Description
3854	Oil Filter Plug
3855	Constant Level Oiler
3862	Lubricating Disk Thrower
4200	Mechanical Seal
4330	Labyrinth Ring
4510	Gasket
4610.1	“O” Ring
4610.2	“O” Ring
4610.3	“O” Ring
6130.1	Sole Plate
6130.2	Sole Plate
6541	Lockwasher
6572.2	Stud
6572.1	Stud
6581.1	Hexagon Nut
6581.2	Hexagon Nut
6700.1	Key
6700.2	Key
6814	Grub Screw
8161.1	Fan
8161.2	Fan

8.2 Frame 1, Oil Cascade, Single Volute Without Back Wear Rings

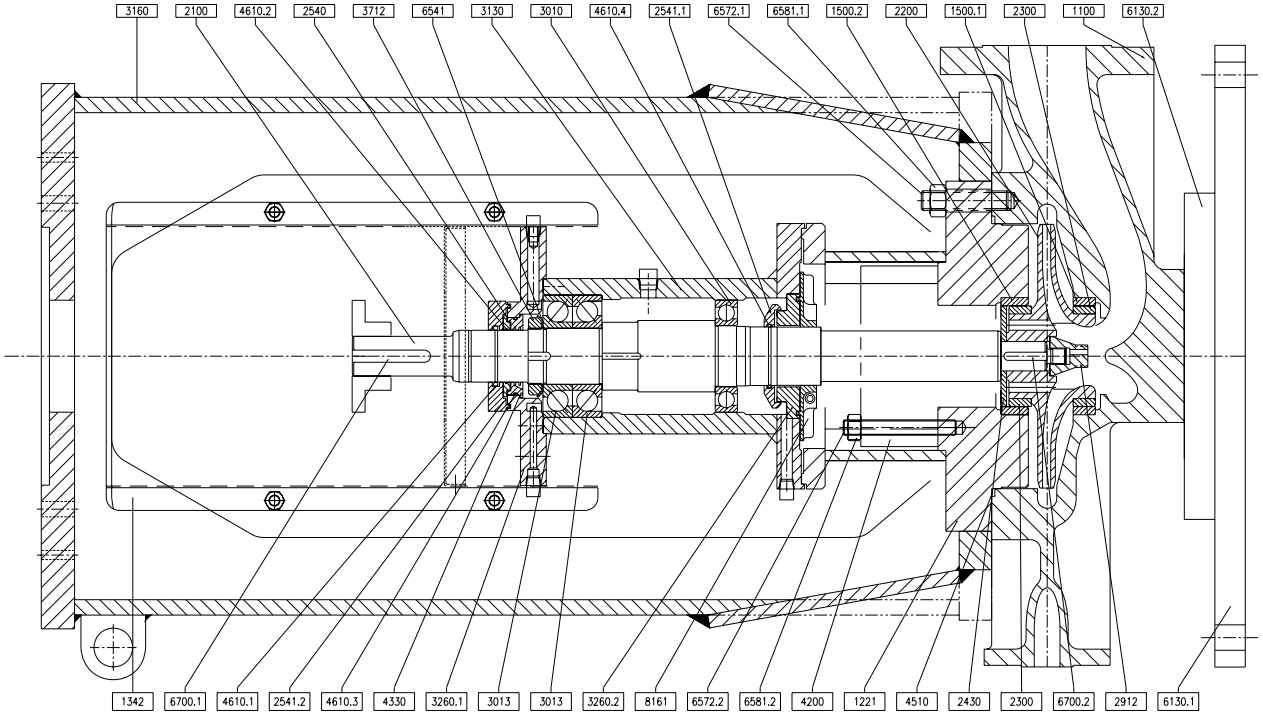


8.2.1 Parts list

Ref no	Description
1100	Casing
1221	Casing Cover
1342	Intermediate Lantern
1500.1	Casing Wear ring
2100	Shaft
2200	Impeller
2300	Impeller Wear Ring
2430	Throttling Sleeve
2470	Centering Sleeve
2531	Split Retaining Ring
2540	Deflector
2912	Impeller Nut
3010	Anti-Friction Bearing
3013	Thrust Ball bearing
3130	Bearing Bracket
3160	Motor Stool
3260.1	Bearing Cover
3260.2	Bearing Cover
3266	Bearing End Cover
3712	Bearing Nut
3854	Oil Filter Plug

Ref no	Description
3855	Constant Level Oiler
3862	Lubricating Disk Thrower
4200	Mechanical Seal
4330	Labyrinth Ring
4510	Gasket
4610.1	“O” Ring
4610.2	“O” Ring
4610.3	“O” Ring
6130.1	Sole Plate
6130.2	Sole Plate
6541	Lockwasher
6572.2	Stud
6572.1	Stud
6581.1	Hexagon Nut
6581.2	Hexagon Nut
6700.1	Key
6700.2	Key
6814	Grub Screw
8161.1	Fan
8161.2	Fan

8.3 Frame 1, Pure Oil Mist, Single Volute

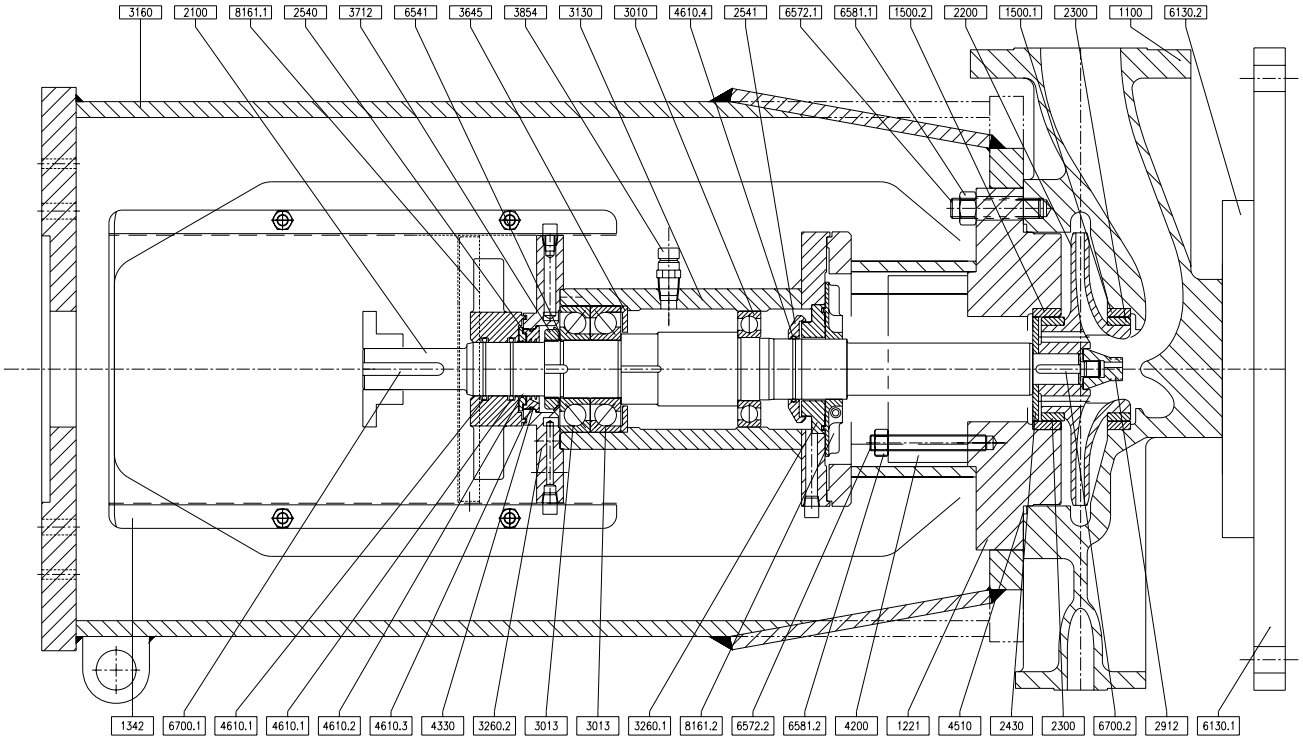


8.3.1 Parts list

Ref no	Description
1100	Casing
1221	Casing Cover
1342	Intermediate Lantern
1500.1	Casing Wear ring
1500.2	Casing Wear ring
2100	Shaft
2200	Impeller
2300	Impeller Wear Ring
2430	Throttling Sleeve
2540	Deflector
2541.1	Deflector
2541.2	Deflector
2912	Impeller Nut
3010	Anti-Friction Bearing
3013	Thrust Ball bearing
3130	Bearing Bracket
3160	Motor Stool
3260.1	Bearing Cover
3260.2	Bearing Cover

Ref no	Description
3712	Bearing Nut
4200	Mechanical Seal
4330	Labyrinth Ring
4510	Gasket
4610.1	“O” Ring
4610.2	“O” Ring
4610.3	“O” Ring
4610.4	“O” Ring
6130.1	Sole Plate
6130.2	Sole Plate
6541	Lockwasher
6572.2	Stud
6572.1	Stud
6581.1	Hexagon Nut
6581.2	Hexagon Nut
6700.1	Key
6700.2	Key
8161	Fan

8.4 Frame 1, Grease, Single Volute

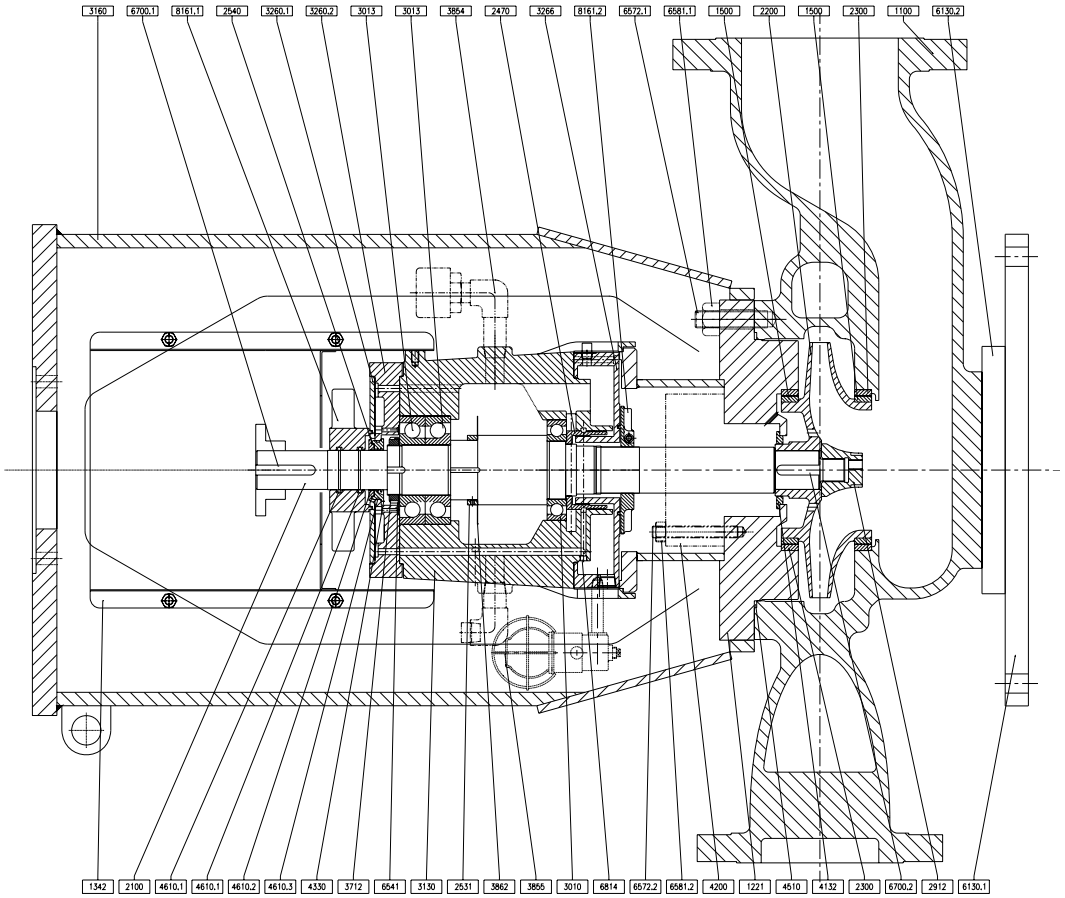


8.4.1 Parts list

Ref no	Description
1100	Casing
1221	Casing Cover
1342	Intermediate Lantern
1500.1	Casing Wear ring
1500.2	Casing Wear ring
2100	Shaft
2200	Impeller
2300	Impeller Wear Ring
2430	Throttling Sleeve
2540	Deflector
2541	Deflector
2912	Impeller Nut
3010	Anti-Friction Bearing
3013	Thrust Ball bearing
3130	Bearing Bracket
3160	Motor Stool
3260.1	Bearing Cover
3260.2	Bearing Cover
3645	Disk Spacer
3712	Bearing Nut

Ref no	Description
3854	Oil Filter Plug
4200	Mechanical Seal
4330	Labyrinth Ring
4510	Gasket
4610.1	“O” Ring
4610.2	“O” Ring
4610.3	“O” Ring
4610.4	“O” Ring
6130.1	Sole Plate
6130.2	Sole Plate
6541	Lockwasher
6572.2	Stud
6572.1	Stud
6581.1	Hexagon Nut
6581.2	Hexagon Nut
6700.1	Key
6700.2	Key
8161.1	Fan
8161.2	Fan

8.5 Frame 2, Oil Cascade, Double Volute

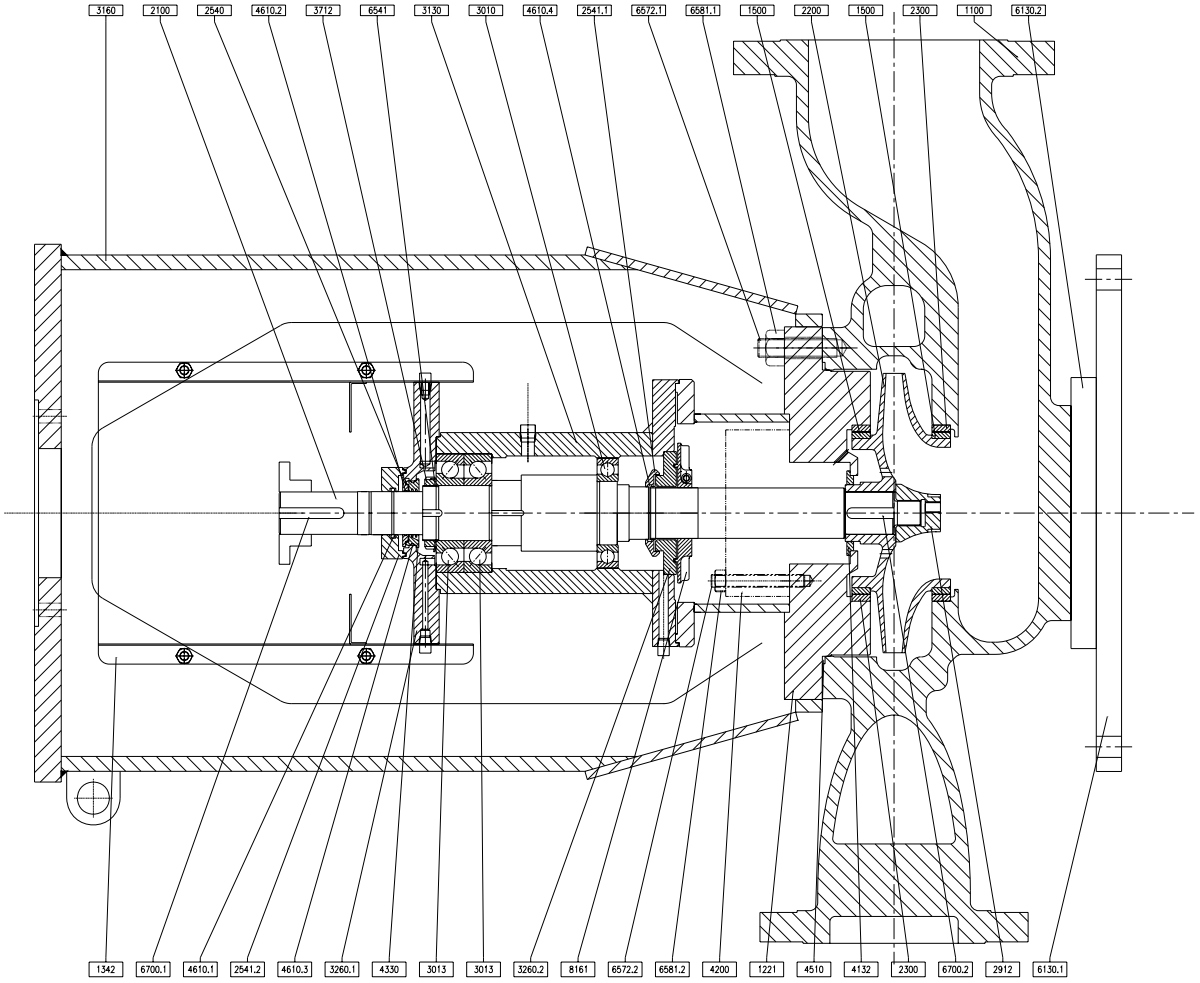


8.5.1 Parts list

Ref no	Description
1100	Casing
1221	Casing Cover
1342	Intermediate Lantern
1500	Casing Wear ring
2100	Shaft
2200	Impeller
2300	Impeller Wear Ring
2470	Centering Sleeve
2531	Split Retaining Ring
2540	Deflector
2912	Impeller Nut
3010	Anti-Friction Bearing
3013	Thrust Ball bearing
3130	Bearing Bracket
3160	Motor Stool
3260.1	Bearing Cover
3260.2	Bearing Cover
3266	Bearing End Cover
3712	Bearing Nut
3854	Oil Filter Plug
3855	Constant Level Oiler

Ref no	Description
3862	Lubricating Disk Thrower
4132	Stuffing Box Bushing
4200	Mechanical Seal
4330	Labyrinth Ring
4510	Gasket
4610.1	“O” Ring
4610.2	“O” Ring
4610.3	“O” Ring
6130.1	Sole Plate
6130.2	Sole Plate
6541	Lockwasher
6572.2	Stud
6572.1	Stud
6581.1	Hexagon Nut
6581.2	Hexagon Nut
6700.1	Key
6700.2	Key
6814	Grub Screw
8161.1	Fan
8161.2	Fan

8.6 Frame 2, Pure Oil Mist, Double Volute

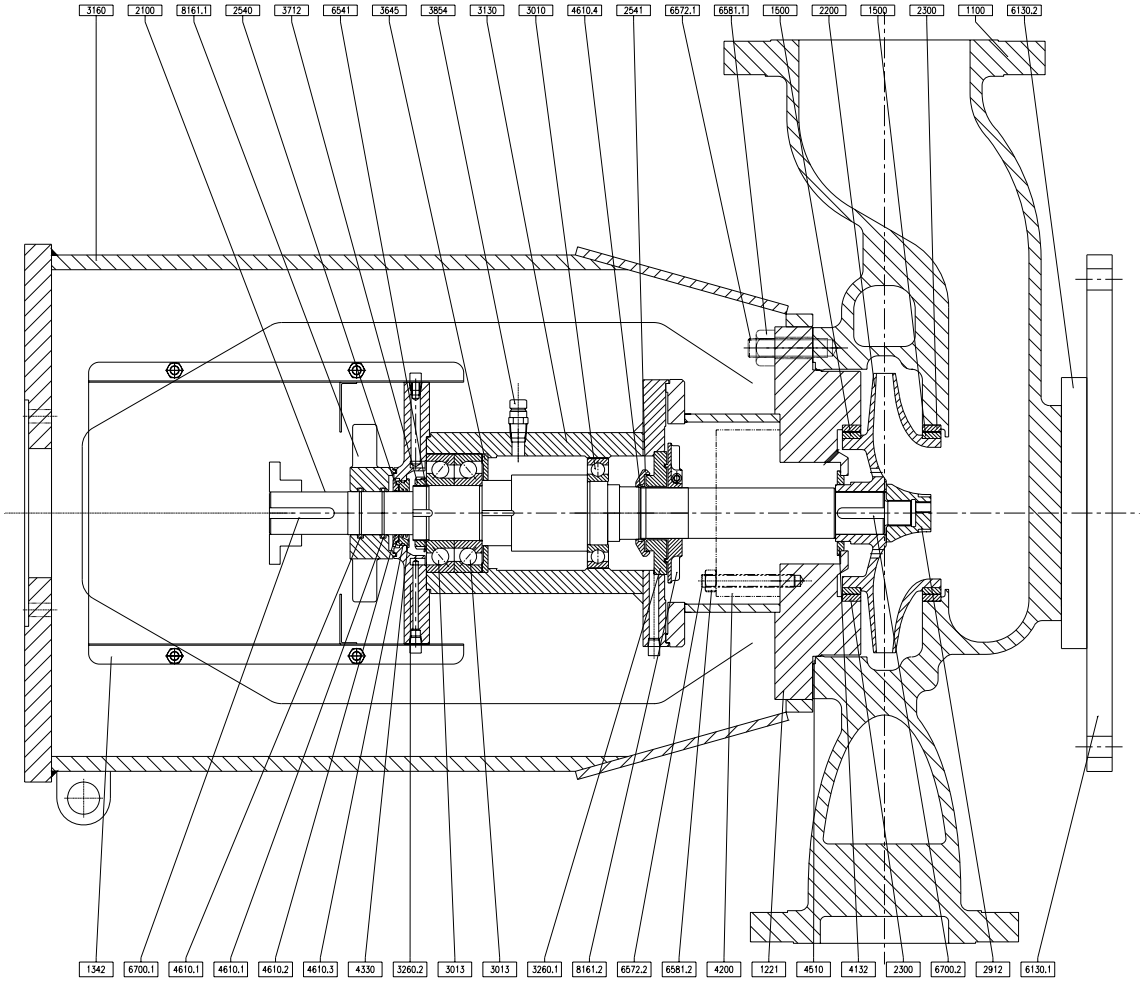


8.6.1 Parts list

Ref no	Description
1100	Casing
1221	Casing Cover
1342	Intermediate Lantern
1500	Casing Wear ring
2100	Shaft
2200	Impeller
2300	Impeller Wear Ring
2540	Deflector
2541.1	Deflector
2541.2	Deflector
2912	Impeller Nut
3010	Anti-Friction Bearing
3013	Thrust Ball bearing
3130	Bearing Bracket
3160	Motor Stool
3260.1	Bearing Cover
3260.2	Bearing Cover
3712	Bearing Nut

Ref no	Description
4132	Stuffing Box Bushing
4200	Mechanical Seal
4330	Labyrinth Ring
4510	Gasket
4610.1	“O” Ring
4610.2	“O” Ring
4610.3	“O” Ring
4610.4	“O” Ring
6130.1	Sole Plate
6130.2	Sole Plate
6541	Lockwasher
6572.2	Stud
6572.1	Stud
6581.1	Hexagon Nut
6581.2	Hexagon Nut
6700.1	Key
6700.2	Key
8161	Fan

8.7 Frame 2, Grease, Double Volute



8.7.1 Parts list

Ref no	Description
1100	Casing
1221	Casing Cover
1342	Intermediate Lantern
1500	Casing Wear ring
2100	Shaft
2200	Impeller
2300	Impeller Wear Ring
2540	Deflector
2541	Deflector
2912	Impeller Nut
3010	Anti-Friction Bearing
3013	Thrust Ball bearing
3130	Bearing Bracket
3160	Motor Stool
3260.1	Bearing Cover
3260.2	Bearing Cover
3645	Disk Spacer
3712	Bearing Nut
3854	Oil Filter Plug

Ref no	Description
4132	Stuffing Box Bushing
4200	Mechanical Seal
4330	Labyrinth Ring
4510	Gasket
4610.1	“O” Ring
4610.2	“O” Ring
4610.3	“O” Ring
4610.4	“O” Ring
6130.1	Sole Plate
6130.2	Sole Plate
6541	Lockwasher
6572.2	Stud
6572.1	Stud
6581.1	Hexagon Nut
6581.2	Hexagon Nut
6700.1	Key
6700.2	Key
8161.1	Fan
8161.2	Fan

8.8 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 will be provided with this instructions where applicable. Examples are certificates for CE marking and ATEX marking. If required, copies of other certificates sent separately to the Purchaser should be obtained from Purchaser for retention with the 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.

10.2 Change notes

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

10.3 Additional sources of information

Reference 1:
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.

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Your Flowserve factory contacts:

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Fax +39 0362 628882
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Local Flowserve factory representatives:

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

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