FLOWSERVE

USER INSTRUCTIONS

Worthington® LPNV *centrifugal pumps*

Installation
Operation
Maintenance

API 610 (BB1), Between Bearings, Axially Spit,
Single Stage, Double Suction Pumps, Vertically Mounted

PCN=87900031 - 06/14 (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, utilizing 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 organizations. 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 authorized 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

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

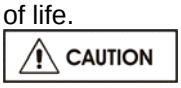
1.6.1 Summary of safety markings

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.

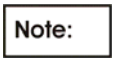

This symbol indicates “hazardous and toxic fluid” safety instructions where non-compliance would affect personal safety and could result in loss of life.



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


This symbol indicates is used in safety instructions to remind not to rub non-metallic surfaces with a dry cloth; ensure cloth is damp. It is used where non-compliance in the hazardous area would cause the risk of an explosion.



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

1.6.2 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 co-ordinate 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, startup, operation and shutdown*.)

START THE PUMP WITH OUTLET VALVE PARTLY OPENED
(Unless otherwise instructed at a specific point in the User Instructions.)
This is recommended to minimize the risk of overloading and damaging the pump motor at full or zero flow. Pumps may be started with the valve further open only on installations where this situation cannot occur. The pump outlet control valve may need to be adjusted to comply with the duty following the run-up process. (See section 5, *Commissioning start-up, operation and shutdown*.)

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 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 backpressure 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 sitting of the pump, limiting personnel access and by operator training. If the liquid is flammable and/or explosive, strict safety procedures must be applied.
Gland seal 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 (example: Viton) will occur. In this condition these are extremely dangerous and skin contact must be avoided.

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

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 vapor 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

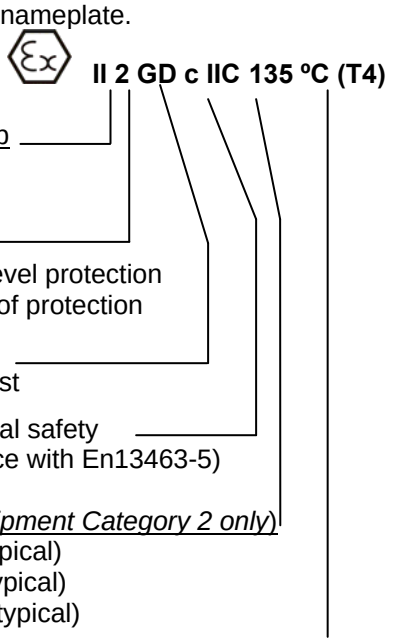
Use equipment only in the zone for which it is appropriate. Always check that the driver, drive coupling assembly, seal and pump equipment are suitably rated and/or certified for the classification of the specific atmosphere in which they are to be installed.

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 the pump could be installed in different hazardous atmospheres. In this case the user is responsible for ensuring that the pump surface temperature does not exceed that permitted in 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 vapor or gas to atmosphere the surrounding area must be well ventilated.

1.6.4.5 Preventing sparks

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

To avoid the potential hazard from random induced current generating a spark, the earth contact on the base plate must be used.
Avoid electrostatic charge: do not rub non-metallic surfaces with a dry cloth ensure cloth is damp.
The coupling must be selected to comply with 2006/42/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.

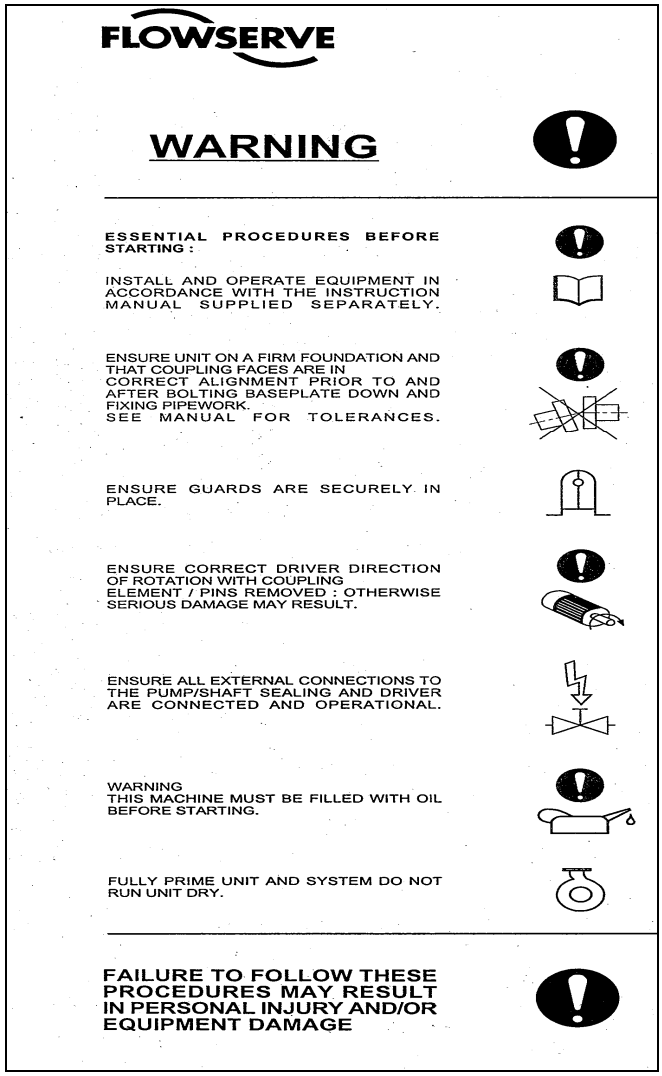
To avoid potential explosion hazards during maintenance, the tools, cleaning and painting materials used must not give rise to sparking or adversely affect the ambient conditions. Where there is a risk from such tools or materials; maintenance must be conducted in a safe area.
It is recommended that a maintenance plan and schedule is adopted.
(See section 6, *Maintenance.)*

1.7 Nameplate and warning labels

1.7.1 Nameplate

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

1.7.2 Warning labels



1.8 Specific machine performance

For performance parameters see section 1.5, *Duty conditions*. Pump performance data are summarized 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 power1 pW where L_{pA} >85 dBA)

Motor size and speed		1750 rpm		1450 rpm	
kW	(hp)	Pump only dBA	Pump & motor dBA	Pump only dBA	Pump & motor dBA
30	(40)	73	73	71	73
37	(50)	73	73	71	73
45	(60)	76	76	74	76
55	(75)	76	76	74	76
75	(100)	77	77	75	77
90	(120)	77	78	75	78
110	(150)	79	80	77	80
132	(175)	79	80	77	80
150	(200)	79	80	77	80
160	(215)	83	84	81	83
200	(270)	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. Check that this number corresponds with that advised and always quote this number in correspondence as well as when ordering spare parts or further accessories.

2.2 Handling

2.2.1 General instructions concerning handling

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

To lift machines or pieces with one or several suspension rings, only use hooks and chains in compliance with the local regulations concerning safety. Never put cables, chains or ropes directly on or in the suspension rings. Cables, chains or lifting ropes must never present excessive bending.

Never bend the lifting hooks, suspension rings, chains, etc., which should only be made to endure stresses within, calculated limits. Remember that the capacity of a lifting device decreases when the direction of the lifting force direction makes an angle with the device axis.

To increase the safety and the efficiency of the lifting device, all the lifting elements must be as perpendicular as possible. If necessary a lifting beam can be placed between the winch and the load.
When heavy pieces are lifted up, never stay or work under the load or in the area, which could be in the path of the load if it were to swing or fall away.

Never leave a load hanging from a winch. The acceleration or the slowing-down of lifting equipment must stay in the safety limits for the staff.

A winch must be positioned in such a way that the load will be raised perpendicularly. Where possible, necessary precautions must be taken to avoid the swing of the load, using for example two winches making approximately the same angle, below 30°, with the vertical.

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

Pump, motor stand and soleplate can be lifted as a unit. Sling from all lifting lugs provided on motor stand (rif. Fig. 2.3).
Failure to do this may result in permanent distortion of the motor stand.

2.3.2 To lift driver

Refer to Manufacturer's Instructions.

2.3.3 To lift complete pump only

Rig lifting straps around the two nozzles on the nozzle half casing, and around the two cast lifting lugs on cover half casing (rif. Fig. 2.1 & 2.2).
Make sure straps are adjusted to obtain an even lift.

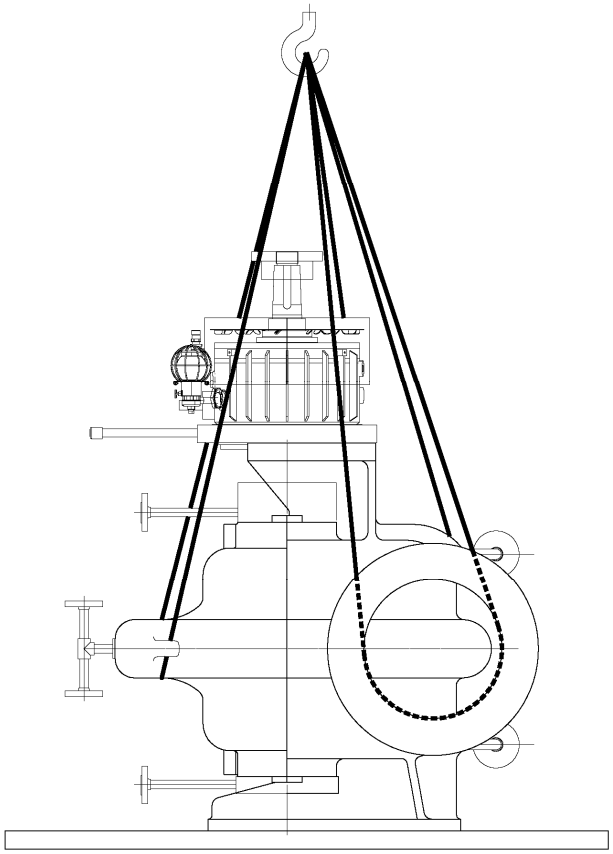
2.3.4 To lift cover half casing

Carefully move away in a horizontal direction the removable covert half casing to prevent damage to casing rings and impeller, using dedicated tools to allow pump casing opening (rif. Fig. 2.4).

2.3.5 To lift pump rotor

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

Figure 2.1
Lifting of complete pump only (side view)



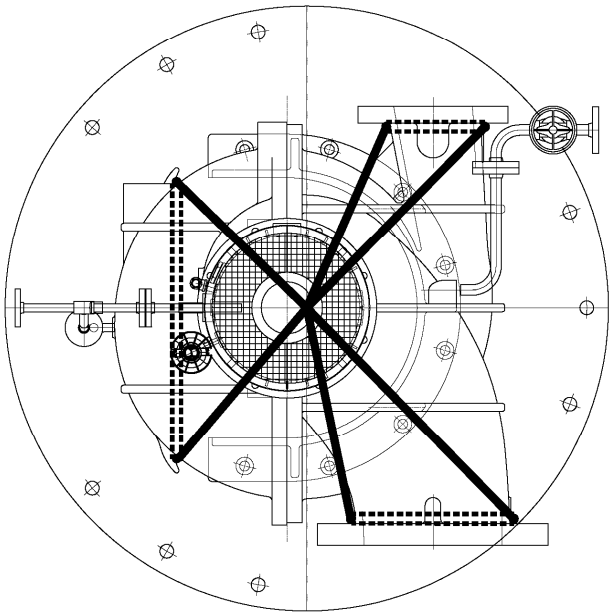


Figure 2.2
Lifting of complete pump only (top view)

Figure 2.3
Lifting of complete unit

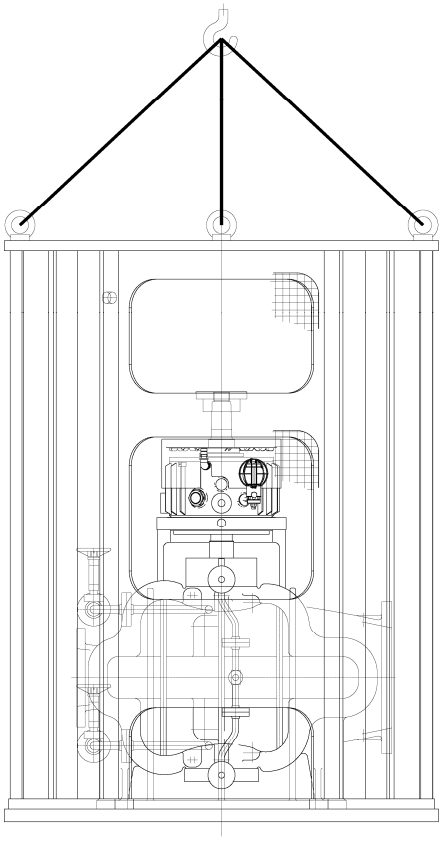
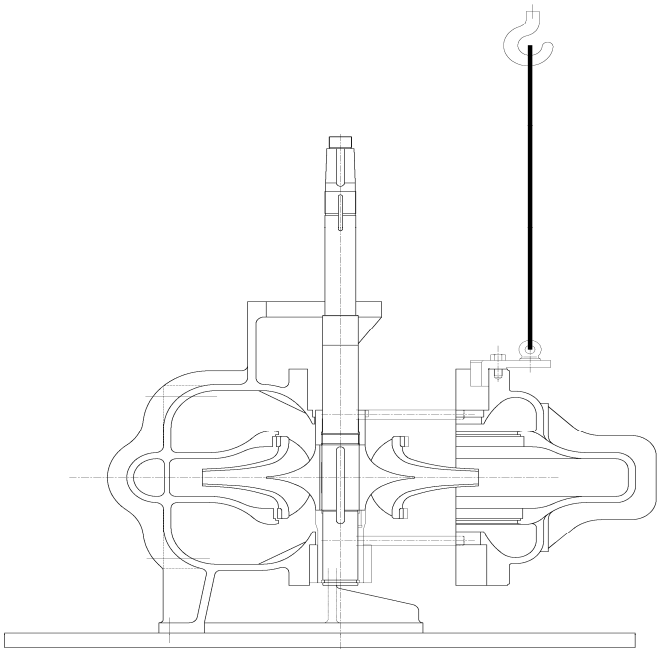
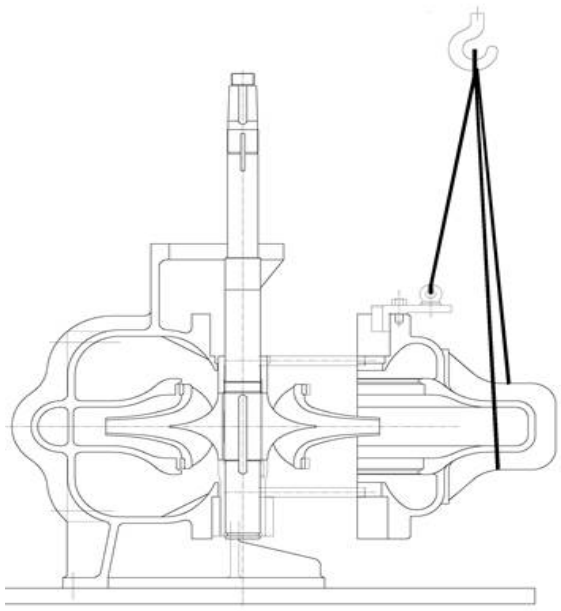


Figure 2.4
Lifting of cover half casing



STANDARD LPNV



ONLY FOR : 28 LPNV 32

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.

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 standby.
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 favorable or unfavorable, 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 labor, 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 LPNV pumps are single stage, double suction impeller, double volute vertically split casing, vertically mounted on a bottom bracket integrally casted with the stationary half-casing, with side/side nozzles, medium pressure pumps, preferred for water cooling, fluid transfer and general services.

LPNV pumps are fully compliant with API 610/ISO 13709, latest edition.

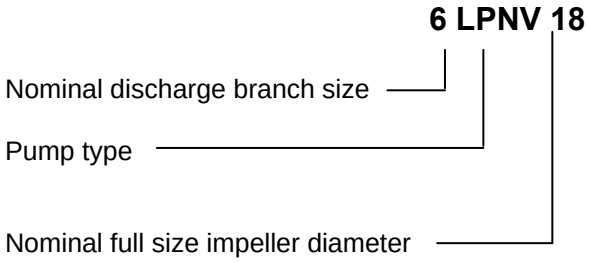
The LPNV pumps provide both outstanding performance and the highest reliability level as required in the most arduous services of the process industry.

The different sizes available, combined with the choice of impellers, ensure optimum efficiency throughout the range.
Various options of construction materials and bearing types are available.

Standard Rotation of LPNV pumps is counter clockwise (CCW) when viewed from the coupling end. Clockwise (CW) rotation can be supplied on request.

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 LPNV 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 vertically split with suction and discharge nozzles cast integral with the stationary half. The removable casing half permits inspection and/or repair of the rotor without disturbing the suction and discharge piping.
The double volute casing minimizes the radial thrust on the pump rotor and gives longer life to the seals, bearings and wear rings. The casing halves are sealed by the use of a confined gasket and are joined together by studs, which are installed in the lower half casing and fastened with cap nuts. Confined gasket design allows metal-to-metal contact for proper gasket compression and eliminates the risk of corrosion of bolts and nuts.
The casing is provided with vent, drain and seal connections.

3.3.2 Impeller

The impeller, designed for maximum hydraulic efficiency, is double suction, closed type.
The double suction design allows minimum NPSH requirement and provides symmetric pressure distribution acting on impeller shrouds, for a complete axial balance of the rotor.
The impeller first, and then the complete rotor, are dynamically balanced for vibration free operation.
The impeller is keyed to the shaft and secured against axial movement by means of a threaded shaft nut on one side, and by means of a split locating ring and a shaft locking nut on the other one.

3.3.3 Wearing Rings

Wear rings fitted both on casing and impellers are smooth depth design.
The diameters of the wear rings are differentiated to maintain a controlled axial load on the bearing under all operating conditions.
Both rings are of the renewable type and are held in place by a press-fit with threaded dowels on the impellers and by grooves and pins on the casing.
Clearances between wear surfaces are in compliance with API 610 Standard.

3.3.4 Rotors

Rotors are of the stiff shaft design, with the first dry critical speed above the maximum rotational speed.
Shafts are of ample diameter, combined with the minimum bearing span to minimize shaft deflectors especially when the pump is operating at off peak conditions.
Shafts are machined and finished throughout their length for positive location of the rotating parts and to ensure minimum runouts. The whole shafts are protected by sleeves and mounted-on parts extending up to throat bushing area.
Shafts are designed to meet API 610 Latest Edition deflection and vibration requirements. Fully assembled rotors are dynamically balanced can accommodate a wide variety of single or dual seal arrangements as standard.

3.3.5 Stuffing Boxes
The stuffing boxes are cast integral with the casing: of sturdy, extra deep design can receive either gland or mechanical seals built fully in accordance with API 682/ISO 21049. Mechanical seals of any type can be fitted to meet special requirements or customer preference.

3.3.6 Shaft seal
The mechanical seal, fitted on the pump shaft, seals the pumped liquid from the environment. Packing seal may be fitted as an option.

3.3.7 Bearing Assembly
Standard bearing design for LPNV pump foresees the use of a combined line bearing at the shaft bottom end and of a thrust bearing at the shaft top end.

The thrust bearing is mounted in a fabricated steel housing which is fixed directly to a bracket integrally cast with the stationary half casing.
The thrust bearing is constituted by two different ball-bearings, a top and a bottom one separated one another by a shaft nut.
The bearings are oil bath lubricated, and a TRICO constant level oiler, is provided as standard.

The line bearing is sleeve bearing product lubricated, and externally flushed from the pump discharge volute.

Cooling Systems is not standard and generally neither required.
It can be provided as an option in case of technical evaluation of particularly severe condition of service (high power – high fluid temperatures – high speed), in case of high ambient temperature, or in case of Customer request.
In these cases the thrust bearing housing can be air-cooled through the provision of an external fan, or alternatively it can be water-cooled through the provision of an internal coil.

3.3.8 Driver
The driver is normally an electric motor. Different drive configurations may be fitted such as internal combustion engines, turbines, hydraulic motors etc driving via couplings, belts, gearboxes etc.

3.3.9 Coupling
An all-metal-flexible coupling with a spacer (API feature for easy mechanical seal dismantling) is adopted.
The coupling can be provided in various makes and models to suit customer preference.

3.3.10 Motor stand
Depending from Customer preference combined with technical evaluation about the pump size, the motor size, pump's performances and the type of application, there are two possible different types of motor stand:

a) EXTERNAL MOTOR STAND
In this case the motor stand is a separated welded steel construction that supports the motor weight directly on the foundation (ref. Par. 8, Fig. 8.1).

b) INTEGRATED MOTOR STAND
In this case the motor stand is fixed directly on a bracket integrally cast with the pump-casing, and the motor weight is supported directly by the pump itself (ref. Par. 8, Fig. 8.2).

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

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

The pump must be operated at the rated speed defined in the contract, corresponding to the motor speed or to the maximum speed specified in case of VFD (variable frequency driver).
In case that it is needed to operate the pump at increased speed, it is mandatory to refer to the Pump Manufacturer.

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 refer to the Pump Manufacturer in order to ensure that the maximum pump working pressure is not exceeded, that the driver is not overloaded, that $NPSH_A > NPSH_R$, 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 vapor 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 vapor 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 (MCSF)

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

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

4.1 Location

The pump should always be located as near as possible to the suction supply.
Install the unit close to the source of the liquid to be pumped.
It is desired to simplify the suction and discharge piping layout. When selecting the location, be sure to allow adequate space for operation as well as for maintenance operations involving dismantling and inspections of parts.
Head room is an important consideration as an overhead lift of some type is required.
There should be ample head room to allow the use of an overhead crane or other lifting device with sufficient capacity to handle the assembled pump and the pump motor individually.

4.2 Foundation

The foundation may consist of any material that will afford permanent, rigid support to the full area of the pump supporting member and will absorb expected stresses and shocks that may be encountered in service. Concrete foundations should be level and built on solid ground. Foundation bolts of the specified size should be located according to the pump template drawing.
When the pump unit is mounted directly on structural steel framing, it should be located directly over or as near as possible to the main building members, beams, or walls. The soleplate should be bolted to the steel supports to avoid distortion, prevent vibration, and retain proper alignment.

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 baseplate 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 foundation 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 4.1 - 4.2) or by the foundation itself if proper pockets have been provided in primary concrete.

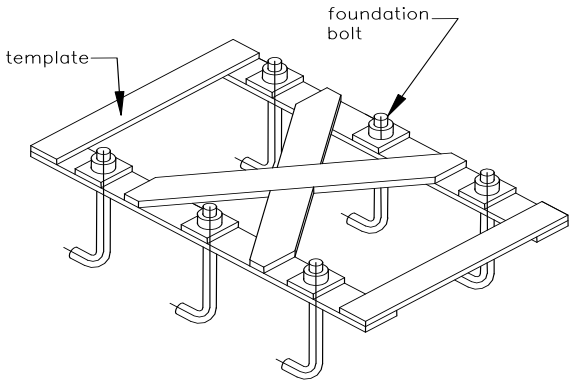


Figure 4.1
Template for Hanging Foundation Bolts

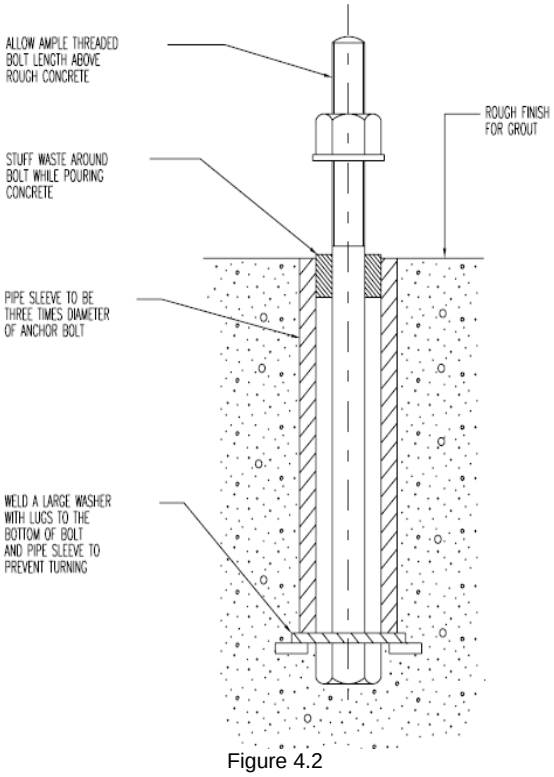


Figure 4.2

4.3 Installation and alignment

Normally the pump and motor stand are shipped mounted on the soleplate, whereas the motor is sent separately.

4.3.1 Pump

- Clean all debris from pump and foundation before making the installation
- Lift pump assembly using lifting lugs provided on motor stand.
- Slowly lower pump onto foundation guiding pump until discharge and suction nozzles face proper direction to mate with discharge and suction piping respectively, and soleplate mounting holes align with foundation bolts.
- Seat pump on foundation and level, using shims under pump soleplate at each foundation bolt. The levelling tolerance is 0.4 mm/m (0.005 inch per foot), to be checked in both directions on machined surfaces.
- Uniformly tighten foundation bolts.
- Connect suction and discharge piping to pump flanges taking care that no excessive strains are applied to pump nozzles.
- Recheck leveling tolerance. Any eventual distortion affecting the alignment must be corrected by varying shims between soleplate and foundation.
- Ensure that shaft alignment per Section 4.3.3 can be achieved prior to grouting the soleplate.

4.3.2 Electric motor

- Fit half coupling on pump shaft, if not already fitted.
- Install driver half of coupling on motor shaft.
- Lift motor and center over pump shaft.
- Slowly lower motor onto motor stand making certain that mounting holes in motor flange and motor stand are aligned.

CAUTION ***During pump assembly at factory, the pump shaft is axially positioned by the adjusting nut so that the impeller is centered in respect of the casing volute, and the space between coupling halves is as specified on pump elevation drawing.***
Make certain that above value is maintained. If necessary, rotate the adjusting nut to lift or lower the pump rotor.

CAUTION ***When the pump is provided with mechanical seal, the shaft collar drive screws must be loosened prior to screwing/unscrewing of the adjusting nut.***

CAUTION ***Driver and driven shafts should not be rotated unless bearings are pre-lubricated before aligning starts.***

4.3.3 Alignment of spacer - couplings

- Check the gap between the coupling halves against the dimensions shown on the elevation drawing or as stamped on the coupling hub. For any necessary adjustment move the driver rather than the driven machine.
- Using the coupling nut or the draw holes, clamp on the driven machine half-coupling a suitable extension arm or bracket sufficiently long to extend across the space between the driven machine and driver coupling hubs.
  Attach to the bracket as shown in Fig.4.3 a dial indicator with the probe resting on the outer diameter of the driver half-coupling to check both parallel and angular alignment.
  For angular alignment rotate both the driver and driven shafts together making sure that the indicator probe always rests on the same point. Take readings at every quarter turn.
  For parallel alignment rotate the driven shaft with the probe resting on the O.D. of the driver half-coupling. Take readings at every quarter turn.
  For detailed alignment procedure refer to API RP686.

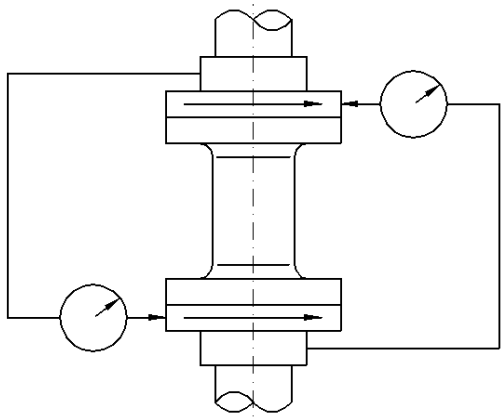


Figure 4.3

Maximum permissible misalignment at working temperature:

Parallel 0.05 mm (0.002 in.) TIR
Angular 0.05mm/100mm (0.0005In/In)

- Recheck alignment by reversing bracket and repeating angular and parallel check readings
- Assemble coupling-spacer as per the manufacturer's instructions.

4.3.4 Shims

The shims under pump soleplate at each foundation bolt should be clean and dry. This is especially critical for pumps in service for sometime and need to be realigned. Water, dirt and rust may change the height of the shim pack over a period of time. Do not use many thin shims as this may result in a spongy mounting.

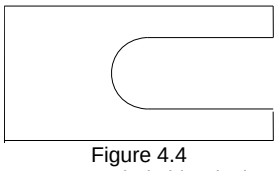


Figure 4.4
Recommended shim design

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

4.3.5 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 center line of the shafts intersect, but are not on the same axis.

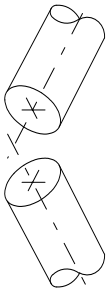


Figure 4.5

B) Offset misalignment

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

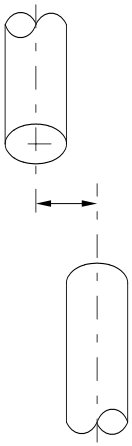


Figure 4.6 – offset misalignment

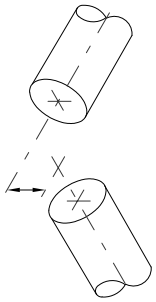


Figure 4.7 – combination of offset and angular misalignment

4.3.6 Cases that require to check alignment

It is necessary to check alignment

a) Prior to fix the soleplate to foundation to ensure soleplate is not twisted.
b) After securing the soleplate.
c) After securing suction and discharge piping.
d) While unit is at operating temperature:

On factory assembled units dowels are fitted between motor stand and soleplate.

⚠ ***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.***

4.3.7 Hot alignment check

CAUTION ***As both pump and driver may rise when they reach operating temperature, it is necessary to allow for this expansion when aligning the shafts. Refer to elevation drawing for approximate rise of pump and driver. Consult driver manufacturer's instructions. A final alignment check (hot check) must be made as soon as possible after both driver and pump are heated to their normal operating temperatures.***

A hot check can only be made after the unit has been in operation a sufficient length of time to assume its normal operating temperature and conditions. If the unit has been correctly cold set, the parallel misalignment will be within the limits stated on par 4.3.3 when in operation. If not make adjustments.

4.4 Piping

CAUTION Never use the pump as a support for piping.

4.4.1 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 8 to 10 times the pipe diameter is desired directly upstream of the suction nozzle.
In order to minimize friction losses and hydraulic noise in the pipework it is good practice to choose pipework that is one or two sizes larger than the pump suction and discharge. Typically main pipework velocities should not exceed 2 m/s (6 ft/sec) suction and 3 m/s (9 ft/sec) on the discharge.

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 minimize these forces and moments that may, if excessive, cause misalignment, hot bearings, worn couplings, vibration and the possible failure of the pump casing, the following points should be strictly followed:

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

CAUTION ***Ensure piping and fittings are flushed before use.***

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

4.4.2 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) Use only eccentric reducers with the straight side on the top.
e) Flow should enter the pump suction with uniform flow, to minimize noise and wear.
f) A gate valve is recommended in the suction line.
g) 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 4.4.2.1)

4.4.2.1 Suction Strainer

It is recommended that a temporary strainer be placed in the suction pipe to prevent lodging of foreign material in the pump. A pipe spool of sufficient size should be provided with gauge taps to accommodate the suction strainer.
The strainer should be installed as close to the pump as possible.
The open area of the strainer should have a minimum of a 3 to 4 ratio to the area of the pump inlet.
The strainer is usually conical and should be made of 40x40 mesh screen (corresponding to an aperture lower than 0.4 mm - 0.0157 in.), backed up by 4x4 mesh hardware cloth (corresponding to an aperture lower than 4.7 mm - 0.185 in).
Pressure gauges should be installed on both sides of the strainer, so the pressure drop across the strainer can be measured when the unit is operated.

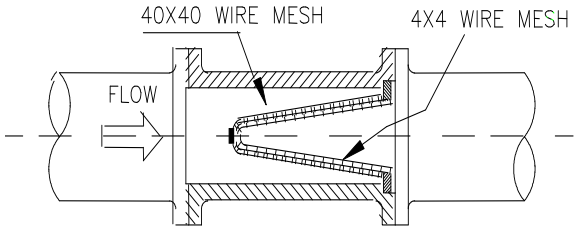


Figure **4.8 Typical temporary suction strainer**

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.

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.***

4.4.2.2 Bypass Line

CAUTION ***Operation at low flows results in pump horsepower heating the liquid. A bypass may be required to prevent vaporization 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.***

4.4.3 Discharge piping

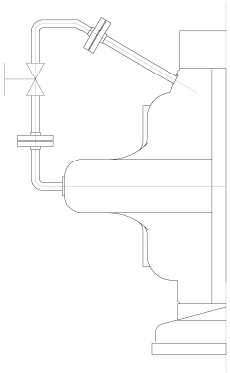
a) Install a check valve and a gate valve in the discharge pipe of the pump. When the pump is stopped, the check valve will protect the pump against excessive pressure and will prevent the pump from running backward. The check valve should be installed between the gate valve and the pump nozzle in order 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.

4.4.4 Drains and Vents

Pipe pump casing drains and vent to a convenient disposal point.

4.4.5.1 Pumps fitted with gland seal

When suction pressure is below ambient pressure it is necessary to feed the gland packing with liquid to provide lubrication and prevent the ingress of air. This is normally achieved with a supply from the pump discharge volute to the stuffing box.
A control valve is fitted in the line to enable the pressure to the gland to be controlled.



If the pumped liquid is dirty and cannot be used for sealing, a separate clean compatible liquid supply to the gland at 1 bar (15 psi) above suction pressure is recommended.

4.4.5.2 Pumps fitted with mechanical seals

Single seals requiring re-circulation will normally be provided with auxiliary piping from pump casing already fitted. Symbols which FLOWSERVE work on seal connections are as follows:

Q	-	quench
F	-	flush
D	-	drain outlet
BI	-	barrier fluid in
BO	-	barrier fluid out

Single seals which require external flushing or auxiliary quench must be connected to a specific supply.
Double seals require a barrier liquid compatible with the pumped liquid.
With back-to-back double seals, the barrier liquid should be at a minimum pressure of 2 bar above the maximum pressure on the pump side of the inner seal. The barrier liquid pressure must not exceed limitations of the seal on the atmospheric side. For toxic service the barrier liquid supply and discharge must be in a safe area.
For specific information refer to the mechanical seals manufacturer's instructions.

4.4.6 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.

4.5 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.

4.6 Electrical connections

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

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

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

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

A device to provide emergency stopping must be fitted.
If not supplied pre-wired to the pump unit, the controller/starter electrical details will also be supplied within the controller/starter.
For electrical details on pump sets with controllers see the separate wiring diagram.

CAUTION See section 5.3, Direction of rotation before connecting the motor to the electrical supply

4.7 Protection systems

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

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

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

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

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

5 COMMISSIONING, START-UP, OPERATION AND SHUTDOWN

The following procedures are presented to outline the most important steps involved in pump operation. Any modification of these procedures due to particular installation peculiarities should conform to good engineering practices.

CAUTION Never operate the pump with suction valve closed.

CAUTION Never operate the pump unless it is filled with liquid and vented**.**

CAUTION Never operate the pump unless a liquid source is available.

CAUTION Never operate the pump with discharge valve closed or below the minimum specified flow rate. If reduced capacity operation is required on occasion, a recirculation line should be installed according FLOWSERVE recommendations.

CAUTION Where possible avoid severe thermal shocks due to sudden changes of liquid temperature. Warm-up the pump at all times before start-up if the pumped liquid is hot or subject to crystallize

CAUTION Lubricate the unit prior to starting.

Do not operate the unit unless coupling guards are bolted in place**.**

CAUTION Never operate the pump above the name plate conditions.

CAUTION During pump operation, keep the vent and drain valves in closed position, to prevent any liquid from a high pressure point flowing into a low pressure point.

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

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 4.4.2.1).
d) Activate lubrication; fill the bearing housings with the appropriate oil to the correct level. 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) Turn pump rotor by hand or with a strap wrench to make sure it turns smoothly.
f) Assure that correct seal piping has been installed and has not been damaged.
g) If the pump is fitted with mechanical seal, ensure it is correctly assembled and tightened.

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

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, and pump and driver is satisfactorily doweled. (Refer to Section 4.3).

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.

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

5.1.1 Lubrication of the thrust bearing

In LPNV pumps the thrust bearing is positioned on the top of the shaft and it is oil lubricated.
The thrust bearing is constituted by two different antifriction bearings, a bottom one separated through a nut by a top one.

Before filling the bearing housing reservoir, flush out the housing thoroughly with safety solvent and a leading grade of flushing oil, compatible with the lubrication oil that will be used.
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 from the labyrinth seals.
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 5.1.

The oil circulation inside the bearing housing is ensured by the rotation of the bottom ball bearing, according to the description as follow.

- The oil level inside the bearing housing is designed to bath half of the ball's elements of the bottom antifriction bearing.
- With the rotation of the pump, the wet part of the ball's elements is splashing oil to the bearing housing walls.
- The dropping of oil from the bearing housing walls is reaching and lubricating also the top antifriction bearing.

5.1.2 TRICO oiler setting (standard)

Constant level oil control inside the bearing housing is ensured adopting a TRICO oiler as standard:

a) Initial fill via top of housing, using overflow plug to establish correct level.
b) Release thumb screw and remove bottle. Establish a measurement from the center 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 5.6.
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 center line of oiler connection. Adjust upper cross arm as required and lock in place with lower arm.

CAUTION Never fill reservoir through the air vent opening**.**

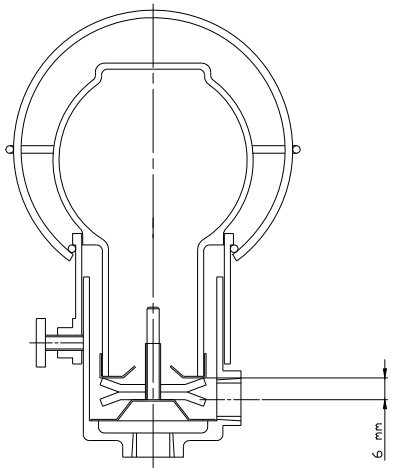


Figure 5.1

The constant level oil control maintains a constant level of oil in the reservoir. The control feeds only enough oil to maintain the required level. It operates on the liquid seal principle, feeding only when the level in the reservoir is low enough to break the liquid seal at the end of the shank, thus permitting air to enter the bottle. It will cease to feed when there is sufficient oil in the reservoir to cover the hole in the end of the shank.

5.1.3 Inspection

Inspect the oil level in the bearing housing at least once a day. Inspect 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).

5.1.4 Replenishment

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

5.1.5 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 or every six months, after the initial change.

5.1.6 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]	46	68	100
	Oil temperature range * ºC (ºF)	-5 to 75 (up to 167)	up to 85 (up to 185)	-30 and above (59 and above)
	Approx. Consumption continuous operation	0.12 liters ¼ pint per month	0.12 liters ¼ pint per month	0.12 liters ¼ pint per month
	Running in Period	500 hours	500 hours	500 hours
	First Oil Charge	500 hours	500 hours	500 hours
	Further Oil Changes	4000 hours	4000 hours	4000 hours
	One Year Consumption	1.44 liters approx. max	1.44 liters approx. max	1.44 liters approx. max
	Designation according to DIN51502 ISO VG	46	68	100
Oil Companies and Lubricants	**BP**	BP Energol HL46 BP Energol HLP46	BP Energol HL68 BP Energol HLP68	-
	CASTROL	Perfecto T46	Perfecto T68	-
	Elf	TURBELF SA46 ELFOLNA DS46	TURBELF SA68 ELFOLNA DS68	-
	Esso	TERESSO 46 NUTO H46	TERESSO 68 NUTO H68	-
	Mobil	Mobil DTE oil medium Mobil DTE15M Mobil DTE25	Mobil DTE oil heavy medium Mobil DTE26	-
	Q8	Q8 Verdi 46 Q8 Haydn 46	Q8 Verdi 68 Q8 Haydn 68	-
	Shell	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 46 Rando Oil HD B-46	Rando Oil 68 Rando Oil HD C-68	-
	Total	Azolla ZS46	Azolla ZS68	-

(*) 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.

5.2.2 Bearing housing oil limitations

Recommended Oil Temperature At Start Up	15.6 °C 60 °F
Desirable Operating Temperature	60-71 °C 140-160 °F
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 a synthetic oil. Other drivers and gearboxes, if appropriate, should be lubricated in accordance with their manuals.

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.

5.2.3 Lubrication schedule

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 optimizing 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.
Based on the specified operating conditions and an ambient temperature of 43°C (110 F) for ring-oiled or splash systems, oil sump temperature below 82 C (180°F) is expected.

CAUTION A continuously rising temperature, or an abrupt rise, indicate a fault.

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.**

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) Prepare the driver for start up in accordance with the driver manufacturer's instructions.
c) 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 utilizing vents, drains or bypass from discharge. Preheat pump slowly at a rate not to exceed 55 °C per hour (100 °F per hour).
d) 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.***

e) Ensure pump re circulation line (if required) is open, clear and free of obstructions.
f) 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.
g) If the pump is equipped with mechanical seal, make sure seal piping is turned on.
h) Turn on cooling liquid and assure correct flow exists as specified (to cooler, bearing coil etc. if provided.).
i) Prepare the driver for start-up in accordance with the driver manufacturer's instructions.
j) 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.***

k) Start the driver and bring it up to speed quickly.
l) 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.
m) 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 vaporization 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) Regulate the amount of fluid circulated to mechanical seal, if applicable
d) Check for excessive leakage at seal areas.
e) Check for unusual noises.
f) Verify lubrication: check oil level in bearing housing. (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.***

g) Check for vibrations.
h) Check for adequate flow of cooling water, if applicable.
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

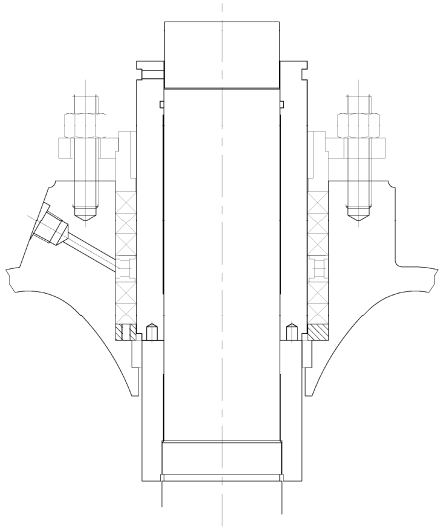
alignment check must be made (Refer to Section 4.3).

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 Gland seal



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

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

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

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

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

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

5.7.3 Pumps fitted with mechanical seal

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

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

⚠ 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.

5.7.4 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 stabilized (see 5.2.2 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 (200 °F) and the trip at 105 °C (220 °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.

5.7.5 Normal vibration levels, alarm and trip

For guidance, pumps generally fall under a classification for rigid support machines within the International rotating machinery standards 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.**	**LPNV 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)

5.7.6 Stop/start frequency

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

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

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

5.8 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 Step (J) 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 the pump

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 discharge valve, while the suction valve normally remains open.

c) Close valve in bypass line and closed whenever possible, switch off flushing and/or cooling liquid supplies.

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

CAUTION ***For pumping hot liquid or fluid subject to crystallize, the flush supply must be maintained on completion of pumping, to avoid seals damage.***

Note: In some installations the use of a check valve is not feasible due to the creation of pressure surges or water hammer as a result of the sudden closing of the valve under high discharge pressure. In such cases the discharge valve should be closed slowly prior to stopping the driver to eliminate the possibility of water hammer.

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 authorized and qualified personnel who have adequately familiarized themselves with the subject matter by studying this manual in detail. (See also section 1.6)

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) Gland seal must be adjusted correctly to give visible leakage and concentric alignment of the gland follower to prevent excessive temperature of the packing or follower.
c) Check for any leaks from gaskets and seals. The correct functioning of the shaft seal must be checked regularly.
d) Check bearing lubricant level, and if the hours run show a lubricant change is required.
e) Check that the duty condition is in the safe operating range for the pump.
f) Check vibration, noise level and surface temperature at the bearings to confirm satisfactory operation.
g) Check dirt and dust is removed from areas around close clearances, bearing housings and motors.
h) 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) is full and operating normally.
e) Check for leakage from seals, joints or packing.
f) Check all lubricant levels i.e. bearing housing oilers, seal Plan 52/53, seal supply systems as applicable.

g) Check any auxiliary supplies as heating/cooling (if fitted) are functioning correctly.
h) 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 unit alignment
d) Check calibration of instruments.
e) 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
d) Check calibration of instruments.
e) Check coupling teeth or discs for wear.

6.2.5 Re-lubrication

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

6.2.5.1 Oil lubrication (if provided*)*

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 center of the glass window.

Refer to the instructions of this manual for methods of oil fill, for oil grade recommendations and for the schedule and temperature limits.

6.2.6 Mechanical seals (for pumps with mechanical seal)

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

6.2.7 Gland packing (for pumps with gland seal)

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

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

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

6.3 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.

Note: ***If rings are ordered as repair parts after the pump has been put into service:***

- ***Fully machined stationary rings***
- ***Oversized impeller rings***

will be furnished as standard unless differently requested by the customer.

If undersize or oversize rings are desired, the amount of undersize or oversize required on the I.D. or the O.D. must be stated by the customer in the repair order**.**

It is recommended as insurance against delays that spare parts be purchased at the time the order for the complete unit is placed or as soon after receiving the pump as possible.

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)

The severity of the conditions of service, the extent to which repairs can be carried out in the field, and the number of units installed will determine to a great extent the minimum number of spare parts which should be carried in stock at the site of the installation.
The minimum spare parts for a pump of the LPNV line should include the following:

For start up purposes:
1 – set of bearings
2 – sets of gaskets and o-ring
2 – set of wear rings (2 rotating + 2 stationary)
According to pump provision:
1 - set of mechanical seal or gland packing

For normal maintenance:
1 – set of bearings
2 – sets of gaskets and o-ring
2 – wear rings set (2 rotating + 2 stationary)
According to pump provision:
1 - set of mechanical seals or gland packing
1 – set of shaft sleeves
1 – set of bushings
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

6.6 Fastener torques

Main Flange Studs/Nuts (Top Casing to Bottom Casing)		
Stud Size	**Torque Value Materials: A193Gr.B7(AISI4140), 17-4PH, Monel K 500**	
	N•m	**(lb•ft)**
3/8" 16UNC	29	(22)
1/2"13UNC	78	(58)
5/8" 11UNC	147	(108)
3/4" 10UNC	245	(181)
7/8" 9UNC	392	(289)
1" 8UNC	638	(470)
1 1/8" 8UN	883	(651)
1 1/4" 8UN	1226	(904)
1 3/8" 8UN	1668	(1230)
1 1/2" 8UN	2060	(1519)
1 5/8" 8UN	2943	(2170)
1 3/4" 8UN	3728	(2749)
1 7/8" 8UN	4905	(3617)
2" 8UN	5396	(3978)
2 ¼" 8UN	7848	(5786)
2 ½" 8UN	10497	(7739)

Main Flange Studs/Nuts (Top Casing to Bottom Casing)		
Stud Size	**Torque Value Materials: A193Gr.B8M(AISI316), S31803(duplex), S32760(superduplex)**	
	N•m	**(lb•ft)**
3/8" 16UNC	25	(18)
1/2"13UNC	59	(43)
5/8" 11UNC	118	(87)
3/4" 10UNC	196	(145)
7/8" 9UNC	294	(217)
1" 8UNC	491	(362)
1 1/8" 8UN	687	(506)
1 1/4" 8UN	981	(723)
1 3/8" 8UN	1275	(940)
1 1/2" 8UN	1570	(1157)
1 5/8" 8UN	2256	(1664)
1 3/4" 8UN	2943	(2170)
1 7/8" 8UN	3787	(2792)
2" 8UN	4415	(3255)
2 ¼" 8UN	5886	(4340)
2 ½" 8UN	7848	(5786)

Mechanical Seal to Casing Cover		
Stud/Nut Size	**Torque Value (A193Gr.B8M material)**	
	N•m	**(lb•ft)**
1/2"	35-41	(26-30)
5/8"	58-68	(45-50)
3/4"	130-150	(95-110)

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 NILS Wega 2 containing molybdenum disulphide is used. Torque should be periodically checked to ensure that it is at the recommended value.

6.7 Disassembly

Frequency of a complete overhaul depends upon the hours of operation of the pump, the severity of the condition and the care the pump receive in operation. It is not necessary to open your pump for inspection unless there is definite evidence that the capacity has fallen off excessively or unless there is indication of trouble inside the pump or in the bearings.
Before performing any disassembly, maintenance and/or inspection on the unit, the following steps should be taken and warnings observed.

⚠ 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.***

⚠ ***Tag driver control in the "off" position. 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.***

⚠ ***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.***

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

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

⚠ ***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 Disassembly procedure

Care must be exercised in the dismantling operation to prevent damages to internal parts of the pump. Lay out all parts in the same order in which they are removed for convenience at reassembly.
Protect all machined faces against metal-to-metal contact and corrosion.

6.7.1.1 Disassembly procedure for inspection of thrust bearing and mechanical seal

a) Switch off, lock and tag the motor circuit breakers. Disconnect and tag electrical leads at motor. This operation must be done by a qualified electrician.
b) Switch off, isolate and tag all instrumentation and monitoring equipment.
c) Close the pump suction valve. If discharge valve has not already been closed this must be done prior to dismantling.
d) Drain the pump casing. This can be done by first opening the vent connections and then opening the drains.
e) Drain bearing housing of oil by removing the drain plug. Remove oilers.

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

f) Disconnect and remove all vents and seal flush pipework and allow to drain.
g) It is advisable to thoroughly drain and dry off the foundation and soleplate before attempting any maintenance work on the pump.

This could eliminate the risk of slipping on a wet surface causing personal injury or mechanical damage.

h) Remove pump monitoring equipment, auxiliary services or any other plant or equipment that may interfere with safe dismantling of the pump.
i) Remove pump coupling guard.
j) Disconnect coupling spacer (Refer to coupling instructions).
k) Loosen set screw securing pump coupling nut and remove nut.
l) Remove pump coupling hub, using a puller. Remove coupling key.
m) In case the pump is provided with mechanical seal (no gland seal option): loose mechanical seal and insert setting tab or spacer, according to manufacturer's instructions
n) Unscrew lock screw and remove adjusting nut from upper end of pump shaft.
o) Unscrew grub screws and remove protecting shield from thrust bearing assembly.
p) Remove shaft guide bushing key.
q) Remove bolts and dowels that secure thrust bearing assembly to bracket on stationary half casing.
r) Slip off complete thrust bearing assembly from shaft top, or dismantle the same according to Chapter 6.7.2)
s) According to pump provision:
- Remove gland packing (ref. 6.7.3)
- Remove mechanical seal assembly (ref. 6.7.4)
t) Unscrew bolts and remove bottom bearing cover. Pay attention to falling of bearing bushing onto soleplate.

Note: ***Bearing bushing is pinned to end cover, to prevent its rotation.***

6.7.1.2 Disassembly procedure in case of overall dismantling

In case of overall dismantling of the pump, continue dismantling procedure of the chapter 6.7.1.1 with the following steps:

u) Remove bolts and dowels that secure motor to motor stand.
v) Lift motor vertically. Provide a suitable support and lower motor on it.
w) Remove bolts and dowels that secure motor stand to pump-bracket (integrated stand option) or to soleplate (external stand option).
x) Lift vertically and clear away motor stand.
y) Sling and suspend vertically and independently rotor shaft and removable casing half. Use appropriate lifting eyes.
z) Remove dowel pins and casing stud nuts, then break casing joint using forcing-off bolts provided on removable casing half.
aa) Carefully move away in a horizontal direction the removable casing half to prevent damage to casing rings and impeller, using dedicated tools to allow pump casing opening (rif. Chapter 6.5 and Chapter 2.3 Figure n° 2.4)
bb) Secure bottom casing ring to the impeller with tape or wire to prevent its falling.
cc) Carefully move away in a horizontal direction the rotor assembly to prevent damage to casing rings, bushings and impeller.

Note: ***Casing rings and throttle bushing are pinned to stationary casing half, to prevent their rotation.***

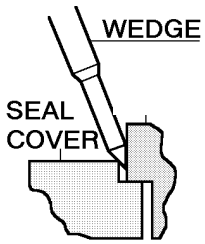
dd) Place rotor on "V" blocks for further disassembly.

6.7.2 Thrust bearing disassembly
Disassemble the thrust bearing as follows:

a) Unbolt and remove cover from thrust bearing housing.
b) Remove springs and shaft guide bushing complete with line bearing, locking nut and thrust bearing.
c) Unscrew locking nut and pull out the upper thrust bearing.
d) Remove the shaft nut and pull out the bottom thrust bearing.

6.7.3 Shaft seal - gland packing
a) Remove gland nuts and gland.
b) Lever out gland ring using its grip groove.
c) Remove gland packing rings and lantern rings using a bent wire.

6.7.4 Shaft seal - mechanical seal
d) Remove seal cover screws and pull off seal cover complete with the stationary seal ring which is held in place by the O-ring seal.
e) The mechanical seal cover can also be removed by placing a wedge into the gland chamfer, as below:



Refer to any special instructions supplied with the mechanical seal.

6.7.5 Rotor disassembly
Disassemble the rotor as follows:

a) Remove throttle bushing and casing rings.
b) Unscrew locking nut and remove impeller and impeller key.
c) Slide out shaft sleeve and remove locating ring in two halves.

6.8 Examination of parts

As the pump and rotor are dismantled, all individual parts, all important joints and all wearing surfaces should be carefully examined. As a general rule, regardless of the performance of the unit, parts appreciably worn should be renewed if it is not intended to examine the pump until the next overhaul period. It should be remembered that when parts in new or good condition with metal seats are assembled in contact with dirty or worn parts, the new parts are very likely to wear out rapidly.

CAUTION Used parts must be inspected before assembly to ensure the pump will subsequently run properly.
In particular, fault diagnosis is essential to enhance pump and plant reliability.

6.8.1 Half casings
a) Inspect for excessive wear, pitting, corrosion, erosion or damage and any sealing surface irregularities. New casing gasket should be installed whenever the pump is disassembled. Remove all traces of all gasket material. When using any tool to remove gasket material, take great care not to damage the machined surfaces.
b) Replace as necessary.

6.8.2 Impeller
a) Remove worn impeller rings by mechanical turning.

Slightly eroded parts can be repaired by welding. Dynamically balance impellers after any machine work. To balance remove metal from the front or back shroud of the impeller at the point of unbalance.

6.8.3 Mechanical seal (if fitted)
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 Bearing housing
Thoroughly flush and clean the oil passages, then coat the inner surfaces with a thin film of lubricating oil.
Cover the bearing body to keep it clean until ready for installation.

6.8.5 Shaft

When the pump is dismantled, examine the shaft carefully. Its condition should be checked at the impeller hub fit, under the shaft sleeve and at the bearings.
The shaft may become damaged by rusting or pitting because of leakage along the shaft at the impeller or shaft sleeve.
Check the shaft keyway for distortion.
Excessive thermal stresses or corrosion may loosen the impeller on the shaft and subject the keyway to excessive shock. Replace a shaft that is bent or distorted. Check a shaft that has been repaired for possible runout (maximum 0.050 mm).
The shaft sleeve is subject to wear and may require replacement, depending on the severity of service. Replace it if grooved, pitted or worn.

6.8.6 Gaskets and O-rings

After dismantling, discard and replace.
The gasket must be of the same material and of the same thickness as the original gasket

6.8.7 Bearings

6.8.7.1 Bearing bushing

If the bearing bushing shows wear upon inspection it should be replaced. Worn bearings can cause pump vibration and can result in damage to the wearing rings and mechanical seal.
The bearing bushing is pinned to bearing cover to prevent its rotation.

6.8.7.2 Antifriction bearings

Anti-friction bearings are shrunk on the shaft guide bushing and a pulling device must be used to remove them. The pulling jaws or fingers must be located behind the shoulder of the inner race.

Note: ***Unless extreme care is used when removing an anti-friction bearing, the bearing may be damaged to the extent that is no longer useable.***
Always check the bearing immediately after removal for any imperfections or any play between the races. It is recommended that new bearings be used for replacement of removed bearings since very often damage caused by removal cannot be detected until the pump is put into operation.

When mounting anti-friction bearings on the pump shaft guide bushing remember that the satisfactory operation of anti-friction bearings requires that the inner be firmly held on the bushing so that it cannot turn on the bushing.
Heat the bearing to expand the inner race and shrink it on the bushing.
Place bearings on a shelf in a temperature controlled oven. A temperature of 80° for one half hour should be sufficient.
Care must be taken to keep the bearing clean and uncontaminated.
Check the position of the bearing on the bushing with a feeler gage to make sure it is pressing firmly against the shoulder.

6.8.8 Wear rings

Impeller wearing rings are pressed into place and held by set screws. To remove these rings for replacement it is necessary to remove the recessed screws and pry off the rings using wedges of some other suitable device. Care must be exercised to make sure the impeller is not damaged during this operation. Preferably remove rings by mechanical turning.

6.9 Reassembly

To reassemble 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 is fitted with both front and rear wear rings.
The impeller rings 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 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 rings.

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.

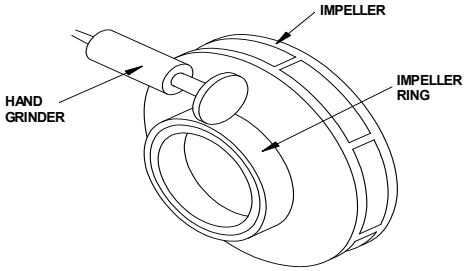


Figure 6.3

b) To fit new weaqr rings:
Make sure ring fits on impeller are free of nicks or burrs. Heat new ring to 107 °C (225 °F) and install on impeller. Drill and tap new holes in impeller spaced half the circular distance from the previously used holes in the impeller. See sketch below.

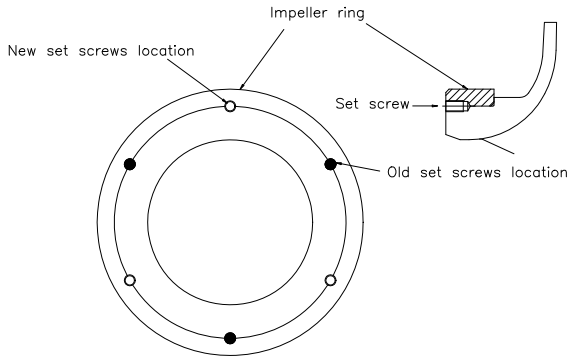


Figure 6.4

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.***

Note: ***The impeller wear ring bore is relieved at one edge. Ensure that the ring is installed on the impeller so that the chamfered edge is sitting against the impeller.***

CAUTION ***Do not tighten set screws excessively, as this will distort the wearing ring. Lock set screws by prick punching.***

6.9.1.2 Casing wear rings

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 -20°C (-4°F) when installing in casing cover. 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 Rotor Assembly

To reassemble the pump, reverse the dismantling procedure previously described.
The torque table value in Chapter 6.6 provides a guide for properly assembling the equipment.
Proceed as follows:

a) Place split locating ring in relevant shaft groove.
b) Install shaft sleeve against locating ring.
c) Place impeller key in relevant shaft key-way.
d) Install impeller against shaft sleeve.

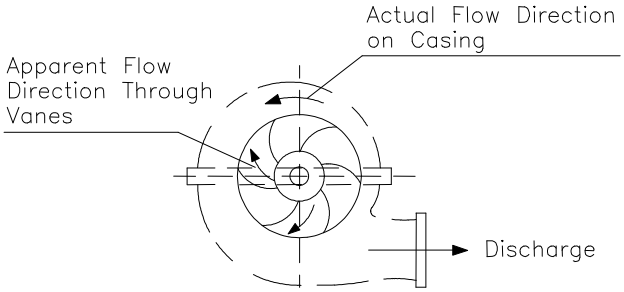


Figure 6.5

Note: ***Take care to mount the impeller so that the vane tips point away from the apparent flow direction (See figure 6.5).***

e) Install impeller locking nut. Screw nut until it butt against the impeller hub.
f) Locate casing rings on impeller. Secure bottom casing ring to the impeller with tape or wire.
g) Place in position stuffing box throat bushing.

6.9.3 Pump completion

a) Sling and suspend rotating element vertically against the stationary casing half, taking care that the impeller is centered as closely as possible in its volute and throttling bushing, shaft guide bushing and casing rings are inserted in their respective seats.

Note: ***Bottom bearing bushing is pinned to end cover. Bolt (snug up) end cover to stationary casing half.***

b) Install removable casing half against the stationary one. Close up pump, applying the torque values recommended on in Chapter 6.6, tightening first of all the central studs and then proceeding towards the periphery and outer ends.
c) Fix end cover to the casing.
d) Lower pump rotor until rotor weight is borne by the casing.
e) Stuffing box assembly
- Gland packing: Insert inner two rings of packing, then lantern ring halves and finally 2 or 3 more rings of packing. Loosely fit the gland and connect flush line.
- Mechanical seal: Fasten seal covers complete with O-ring and connect flush line. Connect any auxiliary piping.

CAUTION ***At this tag don't lock mechanical seal sleeve to pump shaft and don't remove setting tab or spacer.***

f) Assemble and install complete thrust bearing assembly. Adjust bearing housing until dowel pins can be driven into place on bearing bracket.
g) Centralize impeller in its volute, acting on adjusting nut. Lift rotor against upper stop in the casing and measure total axial clearance. Lower rotor an amount equal to half of above measurement.
h) Screw adjusting nut lock screws.
i) Lock mechanical seal sleeve (if fitted) to pump shaft and remove setting tab or spacer.
j) Install coupling key and pump half coupling (if fitted), coupling nut and coupling nut set screws.
k) Turn rotor by hand to ensure there are no rubs or binding.

6.9.4 Unit reinstallation

a) Install motor stand on soleplate and set electric motor as described under Section 6.7.1.
b) Check driver/driven shafts alignment and assemble flexible coupling.
c) Replace all auxiliary piping, instrumentation and pipe plugs.
d) Install oiler and fill thrust bearing housing to correct oil level (refer to Section 5.1.1 "Lubrication").
e) Install coupling guards.
f) Refer to section 5.6 "Operation" for starting procedure.

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 vapor pressure.	
						●	●	●		Excessive amount of air or gas in liquid.	Check and purge pipes and system.
						●		●	●	Air or vapor pocket in suction line.	Check suction line design for vapor 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. CONSULT FLOWSERVE.
●	●	●			●					Rotating part rubbing on stationary part internally.	Check and CONSULT FLOWSERVE, if necessary.

FAULT SYMPTOM

Pump overheats and seizes	Bearings have short life	Pump vibrates or is noisy	Mechanical seal has short life	Mechanical seal leaks excessively	Pump requires excessive power	Pump loses prime after starting	Insufficient pressure developed	Insufficient capacity delivered	Pump does not deliver liquid	PROBABLE CAUSES	POSSIBLE REMEDIES
●	●	●	●	●						Bearings worn	Replace bearings.
					●		●	●		Wearing ring surfaces worn.	Replace worn wear ring/surfaces.
		●					●	●		Impeller damaged or eroded.	Replace or CONSULT FLOWSERVE for improved material selection.
				●						Leakage under sleeve due to joint failure.	Replace joint and check for damage.
			●	●	●					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 center 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.
	●	●								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 GENERAL ARRANGEMENT, SECTIONAL DRAWINGS AND PART LIST

The specific sectional drawing, the specific 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.

8.1 Motor Stand layout

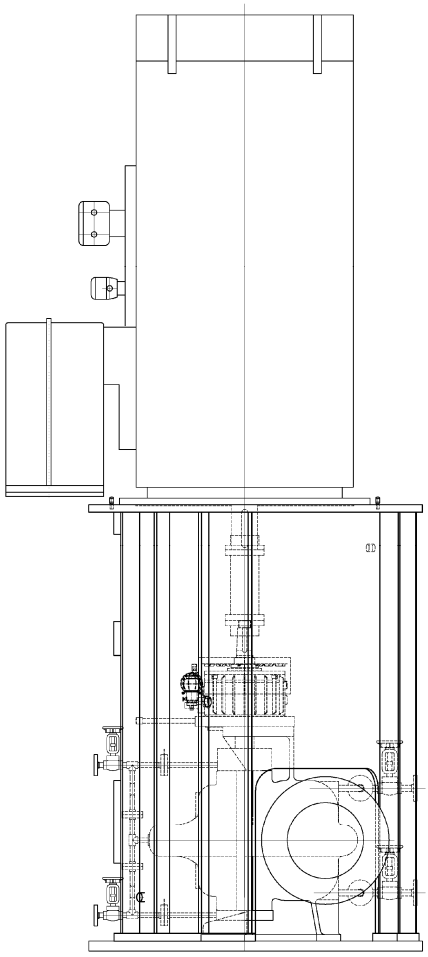


Figure 8.1 – External motor stand layout

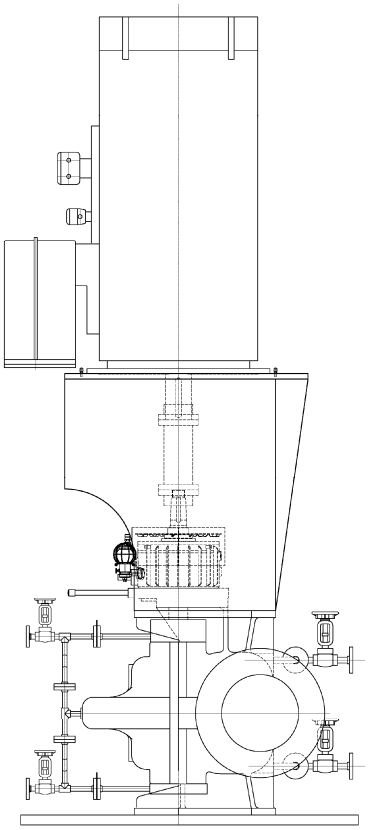


Figure 8. 2 – Integrated motor stand layout

8.2 Sectional Drawing and Part List

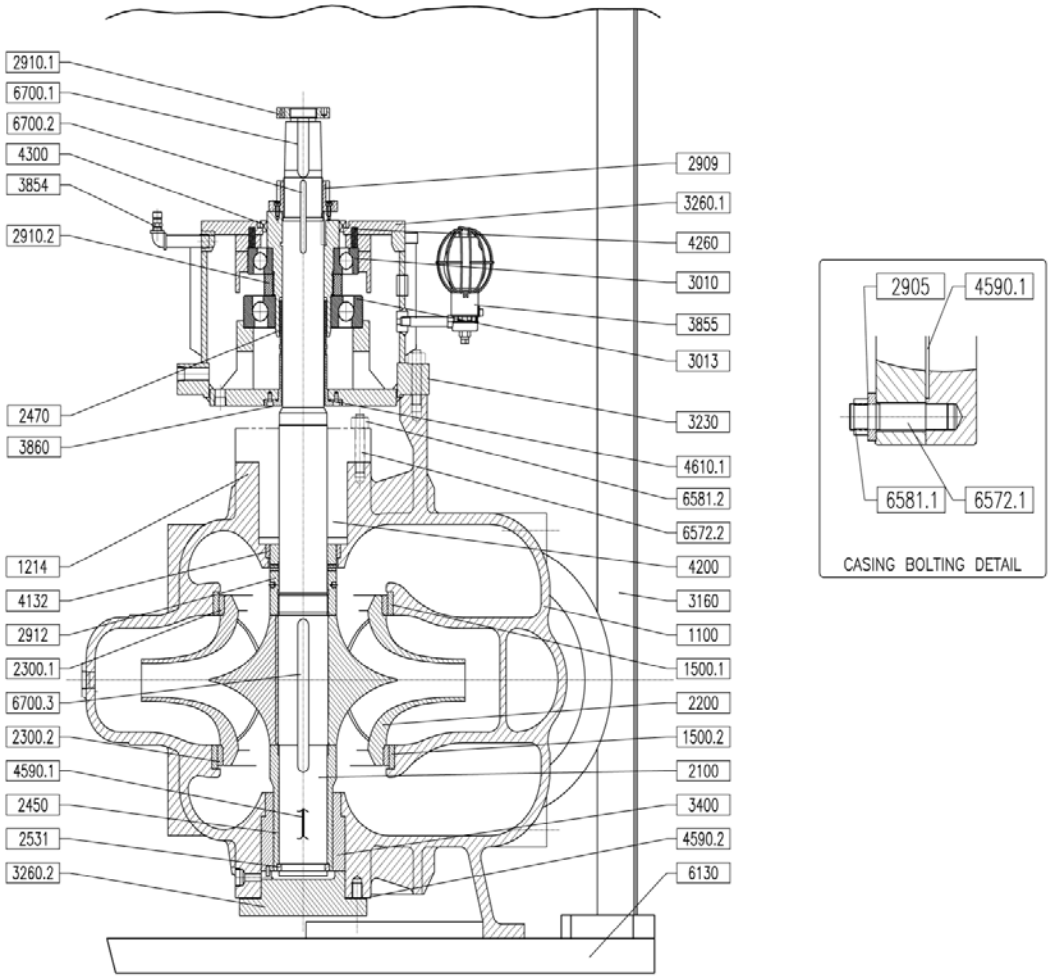


Figure 8.3 – LPNV Sectional Drawing

8.3.1 Parts list

Ref no	Description
2910.2	LOCKING NUT
2910.1	SHAFT NUT
2909	ADJUSTING NUT
2905	WASHER
2531	SPLIT RETAINING RING
2470	BEARING HOUSING
2450	SLEEVE
2300.2	IMPELLER WEAR RING
2300.1	IMPELLER WEAR RING
2200	IMPELLER
2100	SHAFT
1500.2	CASING WEAR RING
1500.1	CASING WEAR RING
1214	UPPER PUMP CASING
1100	CASING

4300	BEARING ISOLATOR (INPROSEAL VBXX)
4260	SPRING
4200	MECHANICAL SEAL
4132	THROAT BUSHING
3860	OIL CONTAINING BUSHING
3855	CONSTANT LEVEL OILER
3854	BREATHER PLUG
3400	CASING BUSHING
3260.2	CASING COVER
3260.1	BEARING COVER
3230	THRUST BEARING HOUSING
3160	MOTOR STAND
3013	THRUST BALL BEARING
3010	ANTI-FRICTION BEARING
2912	IMPELLER NUT

6700.3	KEY
6700.2	KEY
6700.1	KEY
6581.2	NUT
6581.1	NUT
6572.2	STUD
6572.1	STUD
6130	FOUNDATION PLATE
4610.1	O-RING
4590.2	FLAT GASKET
4590.1	FLAT GASKET

8.3 Thrust bearing details

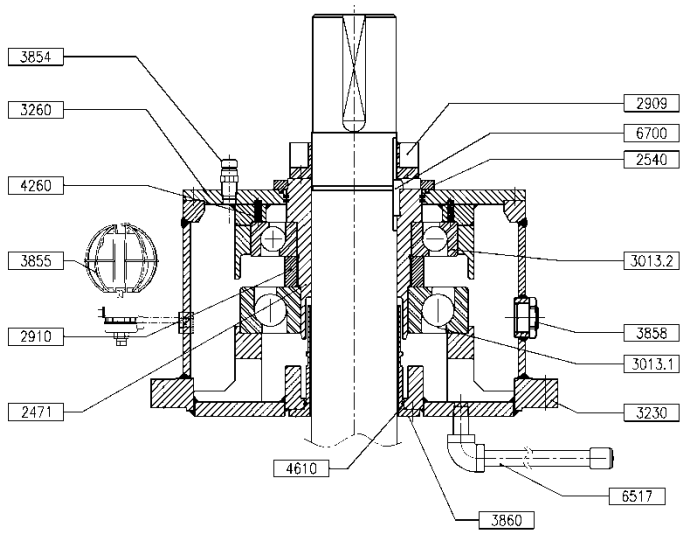


Figure 8.4 – Thrust Bearing with ball bearings and without cooling

8.4.1 Parts list

Ref no	Description
6700	KEY
6517	DRAIN PIPE
4610	O-RING
4260	SPRING
3860	OIL RETAINING TUBE
3858	OIL LEVEL SIGHT GLASS
3855	COSTANT LEVEL OILER
3854	OIL FILTER PLUG
3260	BEARING COVER
3200	BEARING HOUSING
3013.2	THRUST BALL BEARING
3013.1	THRUST BALL BEARING
2910	SHAFT NUT
2909	ADJUSTING NUT
2905	WASHER
2540	DEFLECTOR
2471	INNER RACE CENTRING SLEEVE

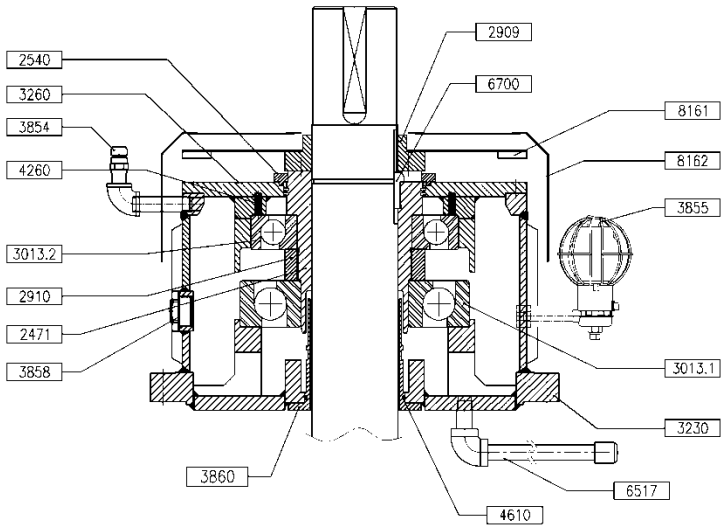


Figure 8.5 – Thrust Bearing with ball bearings and fan cooling

8.5.1 Parts list

Ref no	Description
8162	COVER
8161	FAN
6700	KEY
6517	DRAIN PIPE
4610	O-RING
4260	SPRING
3860	OIL RETAINING TUBE
3858	OIL LEVEL SIGHT GLASS
3855	COSTANT LEVEL OILER
3854	OIL FILTER PLUG
3260	BEARING COVER
3200	BEARING HOUSING
3013.2	THRUST BALL BEARING
3013.1	THRUST BALL BEARING
2910	SHAFT NUT
2909	ADJUSTING NUT
2905	WASHER
2540	DEFLECTOR
2471	INNER RACE CENTRING SLEEVE

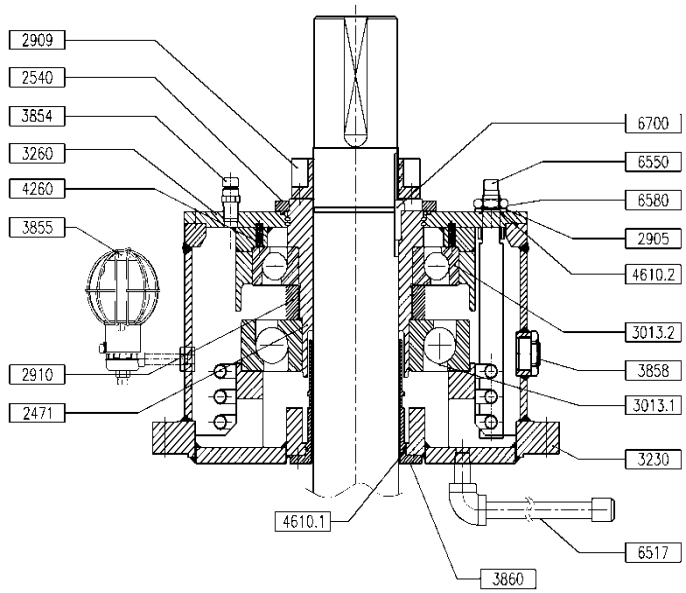


Figure 8.6 – Thrust Bearing with ball bearings and liquid cooling

8.6.1 Parts list

Ref no	Description
6700	KEY
6580	NUT
6551	COOLING COIL
6517	DRAIN PIPE
4610.2	O-RING
4610.1	O-RING
4260	SPRING
3860	OIL RETAINING TUBE
3858	OIL LEVEL SIGHT GLASS
3855	COSTANT LEVEL OILER
3854	OIL FILTER PLUG
3260	BEARING COVER
3200	BEARING HOUSING
3013.2	THRUST BALL BEARING
3013.1	THRUST BALL BEARING
2910	SHAFT NUT
2909	ADJUSTING NUT
2905	WASHER
2540	DEFLECTOR
2471	INNER RACE CENTRING SLEEVE

9 CERTIFICATION

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

10 OTHER RELEVANT DOCUMENTATION AND MANUALS

10.1 Supplementary User Instruction manuals

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

10.2 Change notes

If any changes, agreed with Flowserve, 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 B 31 3- Process Piping.

NOTES:

Your Flowserve factory contact:

Service & Warranty
Flowserve – Italy
Worthington S.r.l,
Via Rossini, 90/92
20832 Desio (MB)
Italy

Telephone (24 hours) +39 0362 6121
Fax +39 0362 628882
+39 0362 620750

Spare Parts & Repair
Flowserve – Italy
Worthington S.r.l,
S.S.Sannitica, 87 – km 19
81025 Marcianise (Caserta)
Italy

Telephone (24 hours) +39 0823 634111
Fax +39 0823 821747
+39 0823 634218

Your local Flowserve representative:

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

FLOWSERVE REGIONAL SALES OFFICES:

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

Europe, Middle East, Africa
Worthing S.r.l.
Flowserve Corporation
Via Rossini 90/92
20832 Desio (MB) Italy
Telephone 39 0362 6121
Fax 39 0362 303396

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

Asia Pacific
Flowserve Pte. Ltd
10 Tuas Loop
Singapore 637345
Telephone +65 6771 0600
Fax +65 6779 4607