



USER INSTRUCTIONS

Worthington[®] Vertical QL and QLC centrifugal pumps

Single stage, double suction, vertical wet pit and canned centrifugal pumps

PCN=85392700 – 06/14 (E) Original instructions

Installation Operation Maintenance



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

CONTENTS:


	PAGE		PAGE
1 INTRODUCTION AND SAFETY	4	6 MAINTENANCE	42
1.1 General	4	6.1 Maintenance schedule.....	42
1.2 CE marking and approvals.....	4	6.2 Spare parts	44
1.3 Disclaimer	4	6.4 Tools required	44
1.4 Copyright.....	4	6.5 Fastener torque	44
1.5 Duty conditions.....	4	6.6 Setting impeller clearance	45
1.6 Safety	5	6.7 Disassembly	45
1.7 Nameplate and safety labels.....	8	6.8 Examination of parts	46
1.8 Specific machine performance.....	8	6.9 Reassemble procedure	50
1.9 Noise level.....	9	7 FAULTS; CAUSES AND REMEDIES	52
2 TRANSPORT AND STORAGE	10	8 PARTS LIST AND DRAWINGS.....	54
2.1 Consignment receipt and unpacking	10		
2.2 Handling	10		
2.3 Lifting.....	10		
2.4 Storage.....	12		
2.5 Recycling and end of product life	14		
3 PUMP DESCRIPTION.....	15		
3.1 Configurations	15		
3.2 Nomenclature.....	15		
3.3 Design of major parts	16		
3.4 Performance and operating limits	17		
4 INSTALLATION.....	19		
4.1 Location.....	19		
4.2 Part assemblies.....	23		
4.3 Foundation	23		
4.4 Grouting	25		
4.5 Initial alignment	26		
4.6 Piping	28		
4.7 Electrical connections	30		
4.8 Protection systems.....	30		
5 COMMISSIONING, STARTUP, OPERATION AND SHUTDOWN.....	32		
5.1 Pre-commissioning procedure	32		
5.2 Pump Lubricants	32		
5.3 Lubrication of thrust bearing	33		
5.4 Impeller adjustment.....	34		
5.5 Direction of rotation.....	36		
5.6 Guarding	36		
5.7 Priming and auxiliary supplies	36		
5.8 Starting the pump.....	36		
5.9 Running or operation	39		
5.10 Stopping and shutdown	40		
5.11 Hydraulic, mechanical and electrical duty... 40			

INDEX:

	PAGE		PAGE
Alignment (4.5)	25	Safety action (1.6.3)	5
Assembly (6.9).....	49	Safety labels (1.7.2)	8
ATEX marking (1.6.4.2)	7	Safety markings (1.6.1)	5
CE marking and approvals (1.2).....	4	Safety, protection systems	30
Clearances (6.6)	44	Sectional drawings (8).....	53
Commissioning and operation (5).....	31	Sound level (see 1.9, Noise level).....	8
Compliance, ATEX (1.6.4.1).....	6	Spare parts (6.2)	43
Configurations (3.1)	15	Specific machine performance (1.8)	8
Copyright (1.4).....	4	Starting the pump (5.8)	35
Design of major parts (3.3)	16	Stop/start frequency (5.8.8).....	38
Direction of rotation (5.5).....	35	Stopping and shutdown (5.10)	39
Disassembly (6.7).....	44	Storage, pump (2.4)	12
Disclaimer (1.3).....	4	Storage, spare parts (6.2.2)	43
Dismantling (see 6.7, Disassembly)	44	Supplementary manuals or info, contacts.....	60
Drawings (8)	55	Tools required (6.4)	43
Duty conditions (1.5).....	4	Torques for fasteners (6.5).....	43
Electrical connections (4.7)	29	Trouble-shooting (see 7)	51
End of product life (2.5)	14	Vibration (5.8.7).....	38
Examination of parts (6.8)	45		
Fastener torques (6.5)	43		
Faults; causes and remedies (7)	51		
General assembly drawings (8.1).....	53		
Grouting (4.4).....	25		
Guarding (5.6).....	35		
Handling (2.2)	10		
Hydraulic, mechanical and electrical duty (5.10).....	39		
Impeller clearance (6.6).....	44		
Inspection (see 6.1, Maintenance schedule).....	41		
Installation (4)	19		
Lifting (2.3).....	10		
Location (4.1).....	19		
Lubrication, thrust bearings (5.3).....	33		
Lubrication, pump (see 5.2, Pump lubricants).....	31		
Maintenance (6).....	41		
Maintenance schedule (6.1)	41		
Name nomenclature (3.2).....	15		
Nameplate (1.7.1)	8		
Operating limits (3.4)	18		
Ordering spare parts (6.2.1)	43		
Part assemblies (4.2).....	23		
Parts lists (8).....	53		
Performance (3.4).....	18		
Piping (4.6)	27		
Pre-commissioning (5.1).....	31		
Protection systems (4.8).....	30		
Priming and auxiliary supplies (5.7).....	35		
Reassembly (see 6.9, Assembly)	49		
Receipt and unpacking (2.1).....	10		
Recommended oil lubricants (5.2.2).....	31		
Recommended spares (6.3)	43		
Recycling (2.5).....	14		
Replacement parts (see 6.2 and 6.3)	43		
Running and operation (5.9).....	38		

1 INTRODUCTION AND SAFETY


1.1 General

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

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

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

1.2 CE marking and approvals

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

Where applicable the Directives and any additional Approvals cover important safety aspects relating to machinery and equipment and the satisfactory provision

of technical documents and safety instructions. Where applicable this document incorporates information relevant to these Directives and Approvals.

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

1.3 Disclaimer

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


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

1.4 Copyright

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

1.5 Duty conditions

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

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


If the conditions of service on your purchase order are going to be changed (for example liquid pumped, temperature or duty) it is requested that the user


seeks the written agreement of Flowserve before start up.


1.6 Safety


1.6.1 Summary of safety markings


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


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

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

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

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

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

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

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

1.6.2 Personnel qualification and training

All personnel involved in the operation, installation, inspection and maintenance of the unit must be qualified to carry out the work involved. If the personnel in question do not already possess the necessary knowledge and skill, appropriate training and instruction must be provided. If required the operator may commission the manufacturer/supplier to provide applicable training.


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


1.6.3 Safety action

This is a summary of conditions and actions to 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.

 **CAUTION** PREVENT EXCESSIVE EXTERNAL PIPE LOAD


Do not use pump as a support for piping. Do not mount expansion joints, unless allowed by Flowserve in writing, so that their force, due to internal pressure, acts on the pump flange.

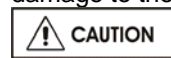
 **CAUTION** ENSURE CORRECT LUBRICATION
(See section 5, *Commissioning, startup, operation and shutdown.*)

 **CAUTION** START THE PUMP WITH OUTLET VALVE 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 startup, operation and shutdown.*)

 **CAUTION** NEVER RUN THE PUMP DRY

 **CAUTION** INLET VALVES TO BE FULLY OPEN WHEN PUMP IS RUNNING
Running the pump at zero flow or below the recommended minimum flow continuously will cause damage to the seal.

 **CAUTION** DO NOT RUN THE PUMP AT ABNORMALLY HIGH OR LOW FLOW RATES
Operating at a flow rate higher than normal or at a flow rate with no 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.

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

 **HAZARDOUS LIQUIDS**
When the pump is handling hazardous liquids care must be taken to avoid exposure to the liquid by appropriate siting of the pump, limiting personnel

access and by operator training. If the liquid is flammable and /or explosive, strict safety procedures must be applied.

Gland packing must not be used when pumping hazardous liquids.



DRAIN THE PUMP AND ISOLATE PIPEWORK BEFORE DISMANTLING THE PUMP

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



FLUORO-ELASTOMERS (When fitted.)

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



HANDLING COMPONENTS

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



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 that can result in damage or breakage of components and should be avoided.



APPLYING HEAT TO REMOVE IMPELLER

There may be occasions when the impeller has become difficult to remove due to products that are corrosive in nature.

If you elect to use heat to remove the impeller, it must be applied with great care and before applying heat, ensure any residual hazardous liquid trapped between the impeller and pump shaft is thoroughly drained out through the impeller keyway to prevent an explosion or emission of toxic vapor.

Impeller design varies and so are the heat, applying location and the duration of heat application. Contact nearest Flowserve Service Center for help.



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

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



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

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 ATEX pump set shall select the coupling, driver and any additional equipment, with the necessary CE Certificate/Declaration of Conformity establishing it is suitable for the area in which it is to be installed.

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

1.6.4.2 Marking

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



II 2 GD c IIC 135 °C (T4)

Equipment Group

- I = Mining
- II = Non-mining

Category

- 2 or M2 = High level protection
- 3 = normal level of protection

Gas and/or Dust

G = Gas; D= Dust

c = Constructional safety
(in accordance with En13463-5)

Gas group

- IIA – Propane (typical)
- IIB – Ethylene (typical)
- IIC – Hydrogen (typical)

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

1.6.4.3 Avoiding excessive surface temperatures



ENSURE THE EQUIPMENT TEMPERATURE CLASS IS SUITABLE FOR THE HAZARD ZONE

Pumps have a temperature class as stated in the 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 liquid handled. The maximum permissible liquid temperature depends on the ATEX temperature class and must not exceed the values in the table that follows.

Temperature class to EN13463-1	Maximum surface temperature permitted	Temperature limit of liquid handled
T6	85 °C (185 °F)	Consult Flowserve
T5	100 °C (212 °F)	Consult Flowserve
T4	135 °C (275 °F)	115 °C (239 °F) *
T3	200 °C (392 °F)	180 °C (356 °F) *
T2	300 °C (572 °F)	275 °C (527 °F) *
T1	450 °C (842 °F)	400 °C (752 °F) *

*The table only takes the ATEX temperature class into consideration. Pump design or material, as well as component design or material, may further limit the maximum working temperature of the liquid.

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

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

Note:

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

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

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

Avoid mechanical, hydraulic or electrical overload by using motor overload trips, temperature monitor or a power monitor. Make routine vibration measurements. In dirty or dusty environments, regular checks shall 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 completely 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, user shall fit an appropriate dry run protection device (eg. liquid detection or a power monitor).

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

1.6.4.5 Preventing sparks

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

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

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

For ATEX the coupling must be selected to comply with 2006/42/EC and correct alignment must be maintained.

1.6.4.6 Preventing leakage

The pump shall 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 auxiliary systems.

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

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

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.

1.7 Nameplate and safety labels

1.7.1 Nameplate

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

1.7.2 Safety labels

FLOWERVE	
WARNING	
ESSENTIAL PROCEDURES BEFORE STARTING :	
INSTALL AND OPERATE EQUIPMENT IN ACCORDANCE WITH THE INSTRUCTION MANUAL SUPPLIED SEPARATELY.	
ENSURE UNIT ON A FIRM FOUNDATION AND THAT COUPLING FACES ARE IN CORRECT ALIGNMENT PRIOR TO AND AFTER BOLTING BASEPLATE DOWN AND FIXING PIPEWORK. SEE MANUAL FOR TOLERANCES.	
ENSURE GUARDS ARE SECURELY IN PLACE.	
ENSURE CORRECT DRIVER DIRECTION OF ROTATION WITH COUPLING ELEMENT / PINS REMOVED ; OTHERWISE SERIOUS DAMAGE MAY RESULT.	
ENSURE ALL EXTERNAL CONNECTIONS TO THE PUMP/SHAFT SEALING AND DRIVER ARE CONNECTED AND OPERATIONAL.	
WARNING THIS MACHINE MUST BE FILLED WITH OIL BEFORE STARTING.	
FULLY PRIME UNIT AND SYSTEM DO NOT RUN UNIT DRY.	
FAILURE TO FOLLOW THESE PROCEDURES MAY RESULT IN PERSONAL INJURY AND/OR EQUIPMENT DAMAGE	

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 80 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.

Typical sound pressure levels measured in dB and A-weighted are shown in the table in section 1.9.1. The figures are indicative only; they are subjected to a +3 dB tolerance and cannot be guaranteed.

The dBA values are based on the noisiest ungeared electric motors that are likely to be encountered. The third column table shows 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. Consult a Noise Specialist for the combined calculation.

If the motor is driven by an inverter, it may show an increase in noise level at some speeds.

1.9.1 Typical vertical motor noise data (Hollow and solid shafts)

Motor Frame Size. NEMA	RPM	Sound Pressure (dBA)	Sound Power (dBA)
180	3600	70.0	78.0
	1800	60.0	68.0
	1200 & slower	55.0	63.0
210	3600	70.0	78.2
	1800	60.0	68.2
	1200 & slower	55.0	63.2
250	3600	75.0	83.4
	1800	70.0	78.4
	1200 & slower	60.0	68.4
280	3600	75.0	83.8
	1800	70.0	78.8
	1200 & slower	60.0	68.8
320	3600	75.0	84.0
	1800	65.0	74.0
	1200 & slower	65.0	74.0
360	3600	75.0	84.2
	1800	65.0	74.2
	1200 & slower	65.0	74.2
400	3600	80.0	89.5
	1800	70.0	79.5
	1200 & slower	65.0	74.5
440	3600	80.0	90.0
	1800	70.0	80.0
	1200 & slower	70.0	80.0
449	1800	85.0	97.8
	1200 & slower	80.0	92.8
5000	3600	90.0	102.8
	1800	85.0	97.8
	1200 & slower	80.0	92.8
5800	3600	90.0	103.7
	1800	90.0	103.7
	1200 & slower	80.0	93.7
6800	1800	90.0	103.9
	1200 & slower	85.0	98.8
8000	1800	90.0	104.7
	1200 & slower	85.0	99.7



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

2 TRANSPORT AND STORAGE

2.1 Consignment receipt and unpacking

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

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

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

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

2.2 Handling

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

2.3 Lifting

CAUTION To avoid distortion, the pump unit should be lifted by using lifting equipment certified to local standards.

CAUTION The pumps are generally very heavy therefore, size/shape factors will have to be considered before attempting to lift them. It is strongly recommended to attempt lifting from a safe distance to prevent any injury or loss of life. Consulting with experts is recommended.

! A crane must be used for all pump sets and components in excess of 25 kg (55 lb.). Fully trained personnel must carry out lifting, in accordance with local regulations. If you are not sure about the driver and pump weights contact Flowserve for information.

Note: Pump heads may be shipped with the seal housing installed. For ease of assembly and to prevent damage, we recommend removing the housing before putting the head on the pump.

For pumps supplied with hollow shaft drivers and one-piece head shaft, attach head shaft to the lineshaft with a coupling and tighten first.

For pumps supplied with two piece head shaft or solid shaft drivers, proceed with the lifting as explained in 2.3.1.

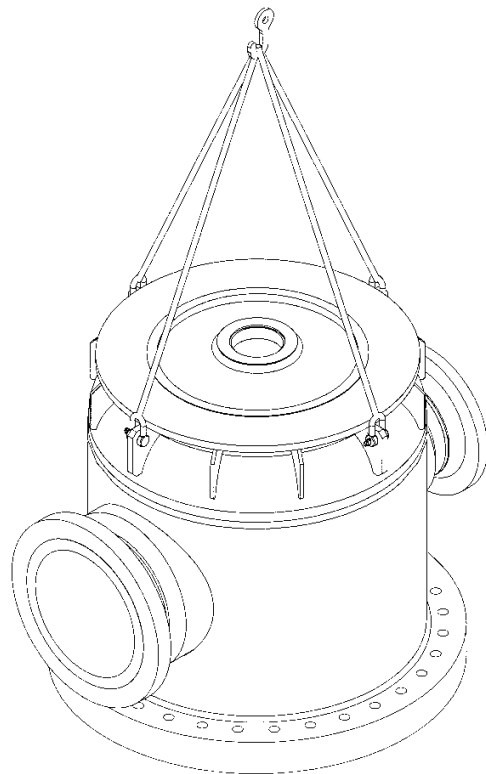
Flowserve will not supply eyebolts neither fixed nor separately with the pump. It is the responsibility of the installer to arrange appropriate hardware that can handle the weights and results in safe and successful installation.

2.3.1 Lifting of fabricated discharge heads with or without the pump

If the pump is supplied with a fabricated discharge head use the 4 points method of lifting as shown in the details provided below or 2 points method using a lifting beam. This method is applicable to the lifting of the discharge head with or without the pump assembled.

! For pump supplied with motor stand already assembled on the discharge head, the motor stand lifting points shall not be used for lifting. Lift the pump using a lifting beam and two of the four discharge head lifting points.

Example: Lifting of discharge head

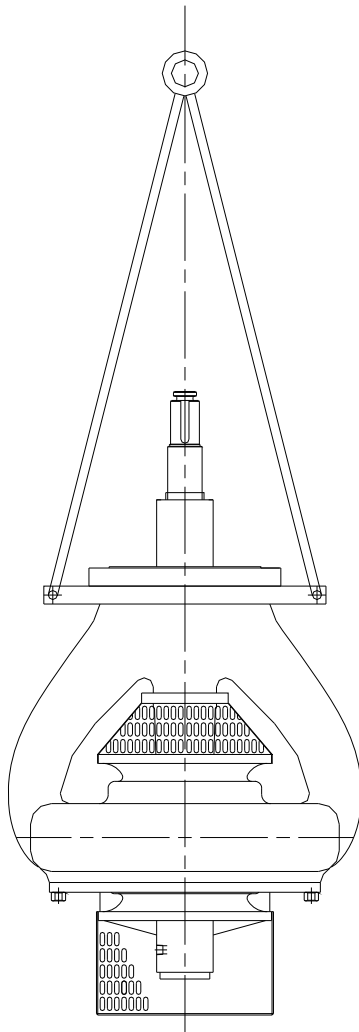


2.3.2 Lifting of bowl assembly only

Clamp the bowl assembly and center the lifting hook for lifting and lowering the assembly into the sump/suction barrel.

- a) Lower the bowl assembly until the clamp extensions rest on the foundation (use appropriate supports).
- b) Build the very first section of the column piping, and lower the entire assembly to assemble the next column section.
- c) Continue to build until it is ready for discharge head assembly.
- d) Install the discharge head.
- e) Assemble the motor.

Example: Lifting of bowl assembly

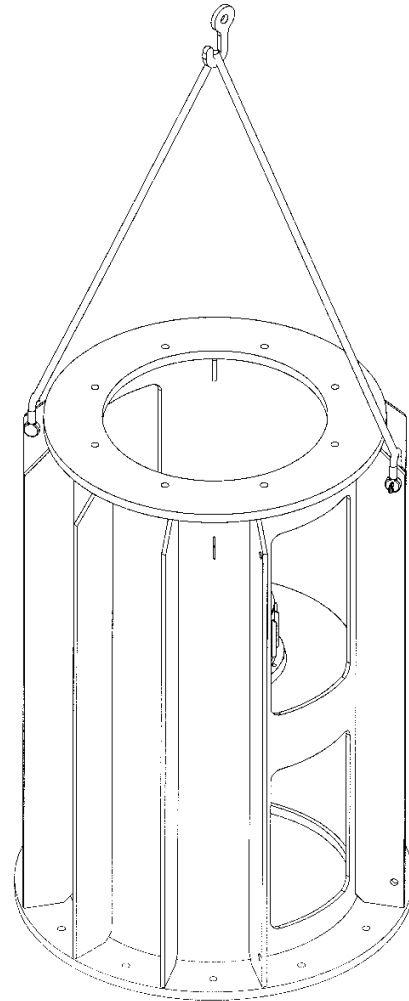


2.3.3 Lifting of the motor stand only

Motor stand shall be lifted using the four lifting points foreseen on the motor stand itself.

The four motor stand lifting points shall not be used for the lift of the assembled pump.

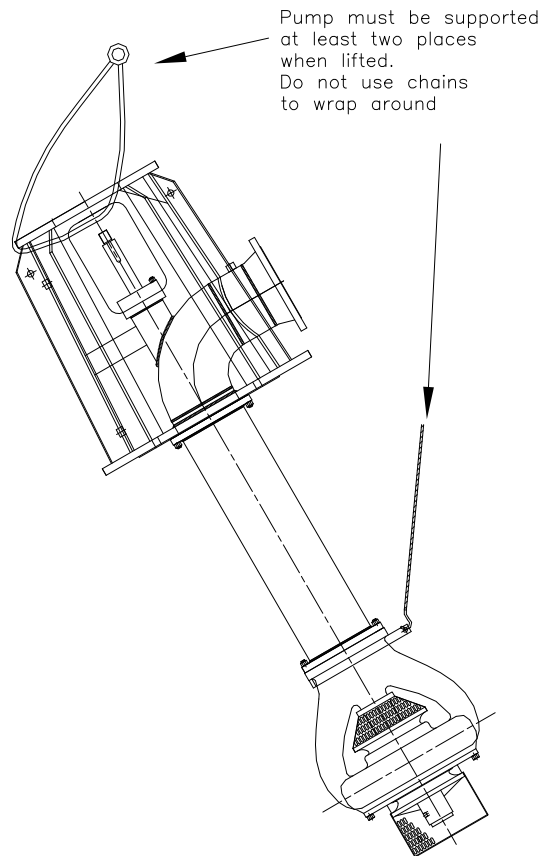
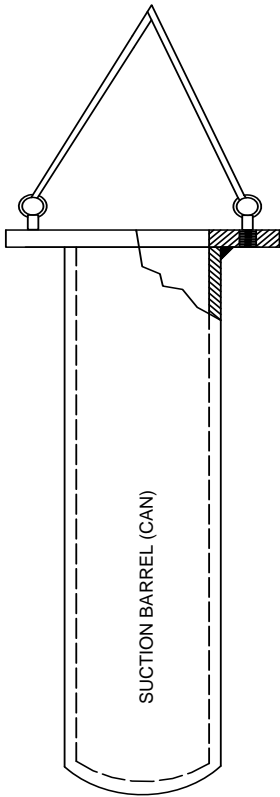
Example: Lifting of motor stand



2.3.4 Lifting of suction barrel

Suction barrel (also referred as 'Can') is always supplied separately and has to be installed into the sump first. Install eyebolts on the flange of the suction barrel and attach slings and straps to bring the suction barrel to a vertical position. Move the barrel for installation. Provide hand support to prevent the suction barrel from swaying during movement.

Example: Lifting of suction barrel

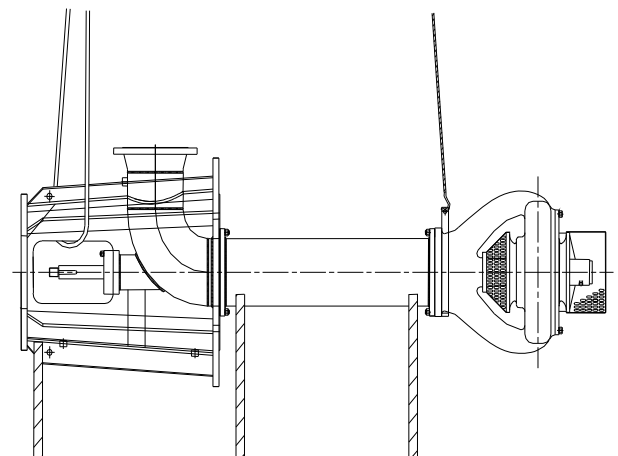


2.3.5 Lifting of fully assembled pumps

If the pump is fully assembled, it has to be adequately strapped and supported at least two places before it can be lifted from the shipping crate and moved to the installation site. See details shown. Same rules are applicable when the pump is pulled out from the sump and moved to another location.



Examples shown here are for illustration only. See section 2.3 1~2.3.4 for specific lifting instructions based on design variations. The pumps vary in weight, length and physical appearances from the types shown here. Therefore, before lifting is attempted, exercise caution to prevent any injuries or loss of life.



2.4 Storage



Store the pump in a clean, dry location away from vibration. Leave piping connection covers in place to keep dirt and other foreign material out of pump casing. Turn the pump at frequent intervals (refer to section 2.4.1.2) 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



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 unfavorable 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 turn monthly 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 be accounted to the purchaser. All necessary labour, tools and cranes will be supplied by the purchaser.
- b) It is advisable, for a long term permanence on the plant before startup, that blind flanges are interposed between the pump nozzles and the relevant pipe, to avoid the possibility that foreign material can be introduced into the pump. In case such flange s not installed, it is advisable that the inner parts of the pumps is carefully inspected (by disassembling, if necessary) to verify the absence of foreign material before the startup.
 - c) During the period between installation and startup the same maintenance checks described in point 2.4.1.3 shall be carried out.

2.4.1.5 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.

2.4.1.6 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.

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 be 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 Delay in the startup

Startup of the pumps, after installation on the plant, should be executed within two months as a maximum.

In case, for any reason, the period between installation and startup should exceed the two months, the following precautions must be taken:

- a) If acid descaling are foreseen on the plant, the pump must be by-passed during these operations, or, otherwise, shall be fully disassembled, washed with basic solution, dried and reassembled. All these operations shall be executed by Flowserve personnel or under Flowserve supervision.

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 using an environmentally acceptable method and in accordance with local regulations. If the product contains substances which are harmful to the environment, these should be removed and disposed in accordance with current local regulations. This also includes the liquids and/or gases that may be used in the "seal system" or other utilities.



Make sure that hazardous substances are disposed of safely and that the correct personal protective equipment is used. The safety specifications must be in accordance with the current local regulations at all times.

3 PUMP DESCRIPTION

Should questions arise concerning the pump, Flowserve pump division will require the complete serial number to be of assistance. The serial number is stamped on a metal nameplate affixed to the discharge head assembly. The driver will have a separate nameplate attached to it. If you are requesting information on the driver, please provide both the driver serial number and the pump serial number to Flowserve representative.

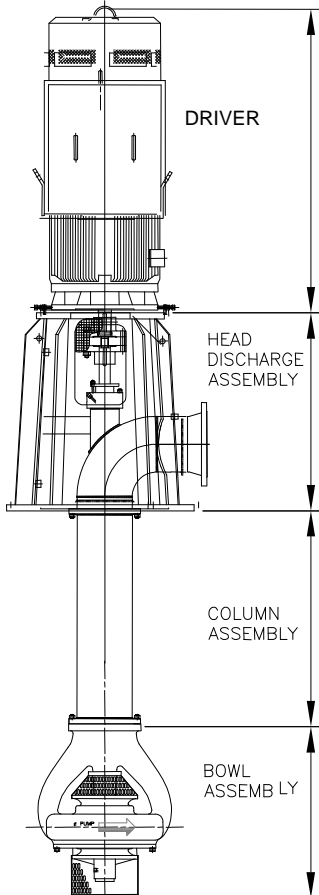
3.1 Configurations

QLs, are engineered pumps as:

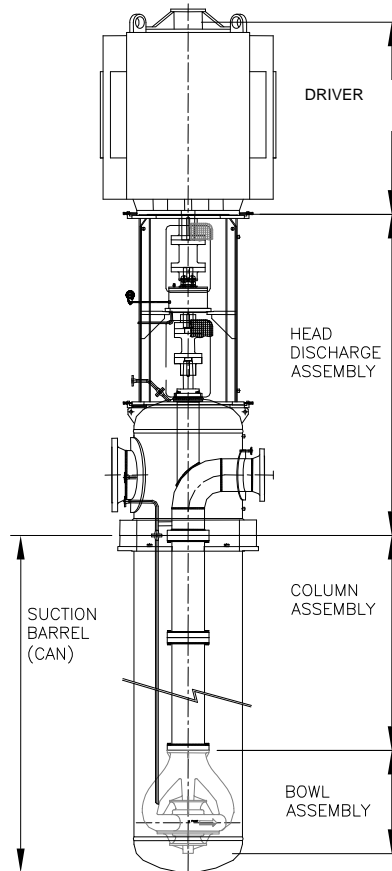
- (a) Wet pit (sump) type
- (b) Double casing (can) type pumps.

Most pumps are built with customer specific features and for applications such as water pumping stations, storm water service, industrial, O & G, power applications. The pumps vary in size, impeller types and length, whether it is an open shaft or enclosed shaft designs and type of discharge head used.

3.1.1 Wet Pit (sump) Type QL



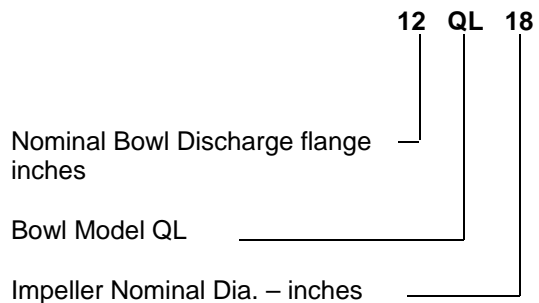
3.1.2 Suction barrel (Can) QL



3.2 Nomenclature

The pump size/ serial number will be engraved on the nameplate typically as below: The nameplate is attached to the discharge head assembly.

3.2.1 Bowl assembly nomenclature



The typical nomenclature above is the general guide to the QL configuration description. Identify the actual pump size and serial number from the pump nameplate. The driver will have a separate nameplate attached it.

3.3 Design of major parts

3.3.1 Case assembly

Case assembly is designed to operate completely submerged in the liquid. It consists of suction bells, impeller, pump shaft and double suction casing. The suction bells serve as the input- ports to the impeller. Internal vanes support the housing of the suction bell bearing.

The casing is made of lower and upper bell-mouth with bearing, double volute and discharge branches with bearing. Twin volute is made efficiently to convert to pressure the velocity added to the liquid by the impeller.

3.3.2 Impellers

QLs are supplied with enclosed, double suction impeller types. Impellers are low, medium and high capacity type designed for maximum coverage of all QL applications. Impellers are cast and machined to match each order and to provide required surface finish to achieve hydraulic characteristics. Impellers are dynamically balanced and held in position on the shaft by key and locking nut.

3.3.3 Column assembly

The column assembly consists of column pipe, which connects the bowl assembly to the discharge head and carries the pumped fluid to the discharge head. Houses and supports the shaft and may contain bearings. Typical column assemblies are flanged, with integrated bearing support.

The column supports shaft assembly, that is either

a) Open lineshaft construction utilizing the fluid being pumped to lubricate the lineshaft bearings.

or

b) Enclosed lineshaft construction has an enclosing tube around the lineshaft and utilizes oil or other clean fluid to lubricate the lineshaft bearings.

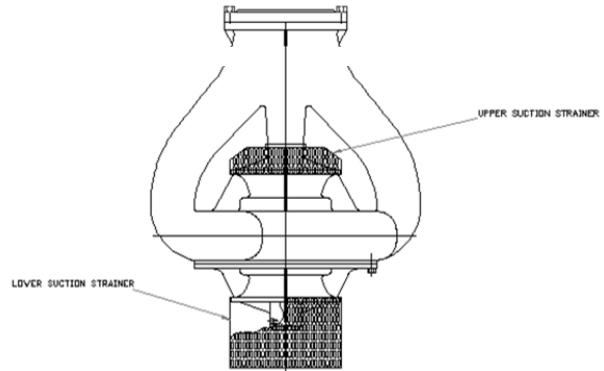
The shafts are key coupled with thrust stud design or clamp ring design.

The column shaft is usually divided in more sections to facilitate the assembly during installation and maintenance.

See sectional drawings supplied with the pump for exact column assembly details as per the order. The size and configuration vary depending upon the specific order requirements and application criteria

3.3.4 Suction strainers

Wet Pit (sump) QLs can also be fitted with strainers to prevent foreign particles from entering the pump. The type of strainers and the mesh size depends on the application. An example is shown below. Strainers are usually fastened directly to the suction bells .



3.3.5 Suction Can

Suction can is designed to allow the impeller to have the proper level of NPSH to run properly, when the available NPSH is insufficient at ground level.

It's connected with the Suction Head, and can be directly installed on the foundations or through a separate foundation plate,

According to the specification, it can be designed to withstand the maximum Suction Pressure or to withstand the Maximum Allowable Working Pressure. Consult the dedicated pump document for more details on it.

3.3.6 Discharge Head Assembly

The discharge head supports the driver and bowl assembly as well as supplying a discharge connection in most cases. A shaft sealing arrangement is located in the discharge head to seal the shaft at its exit from the liquid chamber. The shaft seal will usually be either a mechanical seal assembly or packing seal with an open lineshaft or a tube-packing box with an enclosed lineshaft.

If the pump is required to have its own thrust bearing, it is installed in the discharge head has the pump thrust bearing integrated.

The different types of discharge heads can be summarized in two types.

3.3.6.1 Head for Wet pit (sump) pumps

The head has the suction nozzle and the thrust bearing (if installed in the pump) integrated.

The head is fixed to the ground by means of a foundation plate or by foundation beams on which the head is placed.

3.3.6.2 Head for double casing (can) pumps

The head has the suction nozzle, the discharge nozzle, the thrust bearing (if installed on the pump) integrated. The head is connected to the suction barrel (can) through a flange; the head can have provisions to be fixed directly to the ground or to be fixed on a separate foundation plate.

For special layouts the suction nozzle can be placed below the mounting level (refer to the dedicated General Arrangement drawing for reference).

3.3.7 Motor Stool

The motor stool is a fabricated steel structure designed to maintain the proper alignment between pump and electric motor.

It can be integrated with the pump head or it can be a separate piece fixed upon the suction head.

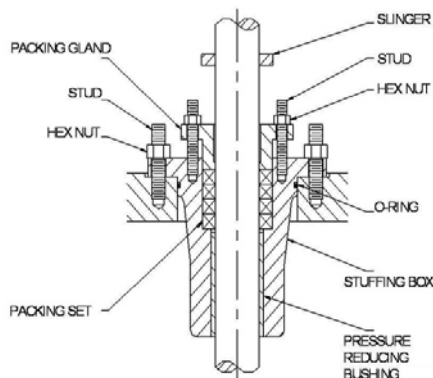
3.3.8 Drivers

A variety of drivers may be used, however, electric motors are most common. For the purposes of this manual, all types of drivers can be grouped into two categories.

- a) Hollow shaft drivers: where the head shaft extends through a tube in the center of the rotor and is connected to the driver by a clutch assembly at the top of the driver.
- b) Solid shaft drivers: where the rotor shaft is solid and projects below the driver-mounting base. This type driver requires an adjustable coupling for connecting to the pump.

3.3.9 Stuffing box

QLs are fitted with stuffing boxes which are adequate for the pump working pressure. Stuffing boxes may fit a mechanical or packing seal.



3.3.10 Mechanical shaft seal

QLs can be fitted with single or double mechanical seal. Depending on the services specified, the mechanical seal has different plan to provide the

proper flushing to the faces through appropriate piping either installed on the pump or to be provided and mounted when the pump is installed.

3.3.11 Thrust Bearing (if installed)

The pump shall be equipped with a thrust bearing installed in the suction head (alternatively, the thrust bearing of the driver can be designed to withstand the thrusts of the pump).

The thrust bearing is designed to withstand the axial loads (static weights of rotors and hydraulic loads) occurring throughout the pump operating range.

The thrust bearings can be ball type, roller type or tilting pad.

The bearings are housed in a fabricated steel support directly mounted on the upper side of the discharge head.

Lubrication of the thrust bearings is provided by oil bath.

As standard option, an oil sight glass is installed outside the bearing house to check oil level and refilling.

3.3.12 Flexible coupling with spacer (if installed)

If the pump is equipped with thrust bearing, the pump shaft is joined to the driver shaft with a flexible coupling with spacer.

The flexible coupling allow the transmission of the torque to the pump, but not the axial loads.

3.3.13 Rigid Coupling with spacer between mechanical seal and bearing support (if installed)

If the pump is equipped with mechanical seal and thrust bearing, a rigid coupling with spacer is placed between the thrust bearing and the mechanical seal. By the removal of the coupling hub and the spacer only the removal of the mechanical seal is without the need to dismantle the thrust bearing, simplifying the maintenance operations.

3.3.14 Rigid coupling between motor and pump (if installed)

If the pump is not equipped with the thrust bearing, a rigid coupling provides the torque and the axial load transmission between pump and driver.

3.3.15 Accessories

Accessories (instrumentation, special flushing plans) may be fitted when specified by the customer.



3.4 Performance and operating limits

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

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

3.4.1 Operating limits

Pumped liquid temperature limits*	-45 °C (-50 °F) to +205 °C (400 °F)
Maximum ambient temperature*	Up to +55 °C (130 °F)
Maximum pump speed	refer to the nameplate

*Subject to written agreement from Flowserve. Special designs and materials may be available for pumps operating above and below these specified limits. Contact Flowserve for upgrade options available for your specific application.

4 INSTALLATION



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

Six months prior to the scheduled installation date, a Flowserve Pump Division representative is to be employed to conduct an inspection of the equipment and the facility. If any deterioration of equipment is noticed, the Flowserve Pump Division representative may require a partial or complete dismantling of the equipment including restoration and replacement of some components.

4.1 Location

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

4.1.1 General installation check-list

The following checks should be made before starting actual installation.

- Make sure that motor nameplate ratings and the power supply system match correctly.
- Check the sump depth and pump length match-up.
- Check the liquid level in the sump.
- Check the installation equipment to be sure that it will safely handle the pump weight and size.
- Check all pump connections (bolts, nuts etc.) for any shipping and handling related problems.



Always support shafting in at least three places when lifting or installing. No installation should be attempted without adequate equipment necessary for a successful installation.

Note:

- On hollow shaft drivers, check the clutch size against the shaft size, which must go through the clutch
- On solid shaft drivers, check the motor shaft size against the coupling bore size



Apply thread lubricant sparingly to male shaft threads only at the time of making up shaft connection. Excess lubricant should be avoided.

4.1.2 General installation instructions

As standard option the pumps are shipped with the suction bowl, column and suction head fully assembled and the suction barrel (if is supplied) shipped separately.

4.1.2.1 Lifting

See lifting methods in section 2.3.

4.1.2.2 Equipment and tools required for installation of a fully assembled pump

- Mobile crane capable of hoisting and lowering the entire weight of the pump and motor.
- Cable sling for attaching to the pump and motor lifting eyes.
- Ordinary hand tools: Pipe wrenches, end wrenches, socket set, screwdrivers, Allen wrenches, wire brush, scraper and fine emery cloth.
- Thread sealing compound designed for type of connection and light machinery oil.

Note:

The single most common cause of pump vibration is from a bent shaft. Shafting is straightened to stringent tolerances prior to shipping and great care must be exercised in its handling.

Always support shafting in at least three places when lifting or installing.



Parts and accessories may be placed inside shipping containers, or attached to skids in individual packages.

Inspect all containers, crates and skids for attached parts before discarding.

Lifting heavy objects is dangerous. Use of appropriate tools and procedures is must.

4.1.2.3 Uncrating and cleaning of a fully assembled pump

- Clean the parts of all dirt, packing material and other foreign matter.
- Clean all machined surfaces. Remove any rust spots found on the machined surfaces with fine emery cloth.

- c) Clean all threaded connections and any accessory equipment.
- d) Kerosene is recommended as the best solvent for rust preventive applied by Flowserve, however any coal tar distillate may be used as a solvent.



Be sure that all traces of rust preventive are removed from the discharge (and suction) flanges, the exposed shafting and all coupling surfaces.



Sump and piping should be thoroughly cleaned of all loose debris before starting installation.

4.1.3 Installation of pump with the suction barrel (also referred as 'can')

If the pump includes a suction barrel (can), follow the procedure as listed below. (See lifting instructions in section 2.3)

4.1.3.1 Pump equipped with separate foundation plate

- a) Install and level the foundation plate as first. Refer to section 4.3 for foundation, grouting and foundation bolts.
- b) Install the suction barrel, level and fix it to the foundation plate.
- c) Install the complete pump into the suction barrel.
- d) Fix the suction head to the suction barrel tightening the bolts.
- e) If pump is equipped with thrust bearing and mechanical seal, refer to special instruction described in section 4.1.6.
- f) Install the motor stool (if separate from suction head).

4.1.3.2 Pump equipped without separate foundation plate

- a) Install the suction barrel first and grout the mounting flange and bolts directly to the foundation. Refer to section 4.3 for foundation, grouting and foundation bolts.
- b) Install the complete pump into the suction barrel.
- c) Fix the suction head to the suction barrel tightening the bolts.
- d) If pump is equipped with thrust bearing and mechanical seal, refer to special instruction described in section 4.1.6.
- e) Install the motor stool.
- f) Install the driver and fix it on the motor stool flange following the instructions in section 4.1.8.
- g) Follow the alignment procedure as per Section 4.5.

4.1.4 Installation of pump in wet pit (sump)

See sections 4.3.1–4.3.2 for pump leveling details.

Position lifting equipment so it will center over the foundation opening.

Refer to section 2.3.1 for handling instruction

4.1.4.1 Pump equipped with foundation plate

- a) Install and level the foundation plate as first. Refer to section 4.3 for foundation, grouting and foundation bolts.
- b) Lift the pump to a vertical position. Check that the strainers, if present, are correctly installed and secured.
- c) Position pump over sump. Align the discharge of the pump with external piping then lower onto the base.
- d) If pump is equipped with thrust bearing and mechanical seal, refer to special instruction described in section 4.1.6.
- e) Install the motor stool (if it's a separate piece) and fix it to the discharge head.

4.1.4.2 Pump equipped with support beams

- a) Install and level the supporting plates to support the beams as first. Refer to section 4.3 for foundation, grouting and foundation bolts.
- b) Place the supporting beams near the well or pit border, leaving the opening full accessible.
- c) Lift the pump to a vertical position. If a strainer is used, attach it to the bowl assembly.
- d) Position pump over sump or suction barrel. Align the discharge of the pump with external piping then lower onto the well.
- e) Keeping the pump suspended, place the support beams in their position across the well and fix them to the supporting plates.
- f) Lower the pump, and fix the suction head to the supporting beams.
- g) If pump is equipped with thrust bearing and mechanical seal, refer to special instruction described in section 4.1.6.
- h) Install the motor stool (if it's a separate piece) and fix it to the discharge head.



Provide to install grids to close the open spaces between the support beams and the pit opening

Leaving unprotected and open room could cause dangerous injuries to operators and accidental fall down of materials/objects into the pit, with risk of damages of the pump.

4.1.5 Installation of pumps that are shipped unassembled

If the pump has been shipped unassembled, refer to dedicated special instruction for pump installation included in the IOM book, or ask for Flowserve support/ supervision for a correct installation. General guidelines for pump assembly are provided in Section 6.9 of this manual.

Note: Parts and accessories may be placed inside shipping containers or attached to skids in individual packages. Inspect all containers, crates and skids for attached parts before discarding.

Note: If headroom permits, it is recommended that the pump is assembled in horizontal position and lowered as one complete unit into the sump or can

4.1.5.1 Uncrating and cleaning of unassembled pump

- Clean the parts of any dirt, packing material and other foreign matter.
- Flush the pump inside and outside with clean water.
- Clean all machined surfaces.
- Remove any rust spots found on the machined surfaces with fine emery cloth.
- Clean all threaded connections and any accessory equipment.
- Kerosene is recommended as the best solvent for rust preventive applied by Flowserve, however any coal tar distillate may be used as a solvent.

CAUTION Be sure that all traces of rust preventive are removed from the discharge (and suction) flanges, the exposed shafting and all coupling surfaces.

CAUTION Lineshaft when shipped separately should be left in the crate to avoid damage or loss of straightness.

4.1.6 Special Instruction for installation of pumps with thrust bearing and mechanical seal

The pumps with both mechanical seal and thrust bearing have two separate spacers (rigid and flexible) and require special instruction for alignment and rotor axial positioning (see also sections 4.5.3.3~4.5.3.4). Once the suction head is fixed with the bearing support assembled, proceed as follow:


- Place the spacer of the rigid coupling without fixing it with the bolts.
- Align the two hubs of the rigid coupling located on the top of the pump shaft and below the thrust bearing support by measuring with a dial indicator the displacement between the rigid coupling upper hub and the external machined surface of the stuffing box. For alignment tolerances refer to 4.5.3.3.
- Do not tighten the rigid coupling bolts.
- If not already done, install the flexible coupling hubs on the motor shaft and the thrust bearing shaft.
- Lift the motor by proper equipment and carefully place it on the motor stool.
- Check the Distance Between Shaft Ends (DBSE) between the hubs of the flexible coupling, and compare it with the value stated on the GA drawing.
- By turning the regulating nut on the top of the bearing support, regulate the DBSE in accordance with the value stated on the general arrangement drawing.
- Proceed with alignment of the flexible coupling hubs in the same way as described above.
- Once aligned, install the flexible coupling spacer, referring to the manufacturer instruction, and fix it by tightening the bolts.
- Not having fixed the rigid coupling spacer, the rotor is placed in its lower position. By turning the regulating nut on the rigid coupling regulate the position of the rotor as to have 4÷5mm (0.16÷0.2 in) between the upper coupling hub and the rigid coupling spacer.
- Fix at this stage the bolts of the rigid spacer. By tightening them, the rotor will be lifted in its correct position.


4.1.7 Installation of drivers

Note: Drivers will come with either hollow shaft or solid shaft as specified on the order/contract. Choose the correct installation procedure from the following paragraphs and the driver manufacturing instructions.

CAUTION Reverse rotation with the pump shaft connected can cause extensive damage to the pump. Always check rotation before connecting driver to pump.

4.1.7.1 Installation of solid shaft driver

 When lowering the motor and driver half of coupling onto pump, do not let pump half of the coupling touch the driver half of the coupling.


 If the pump is not equipped with a thrust bearing, double check on pump and motor documentation that the thrust generated by the pump can be withstood by the driver bearing. Running the pump with a driver that cannot withstand the load generated may cause severe damage to the driver.

Refer also to section 4.1.6 if the pump is equipped with mechanical seal and thrust bearing.

Before bumping motor make sure coupling halves are not touching and that the driver can rotate freely, without rotating the pump.

Driver half coupling must be in proper position so the circular key will not come out.


- a) Install the driven half of the pump coupling on pump top shaft. Hub is shrink fitted.
- b) Install the driver half of motor coupling on motor shaft. Hub is shrink fitted.
- c) Clean driver mounting flange on discharge head and check for burrs or nicks on the register and mounting face. Oil lightly.
- d) Center motor over pump and rotate to align mounting holes.
Electric motors - Rotate junction box into desired position.
Gear Drives - Rotate input shaft into desired position.
- e) Lower driver carefully into place making certain that the female register on the driver mates over the male register on the pump.
- f) If rigid coupling is provided, install coupling spacer, if any, without inserting the coupling bolts
- g) Align the coupling hubs, as described in section 4.5.
- h) Remove sling from motor and remove hoisting equipment.
- i) Check driver manufacturer's instructions for special instructions including lubrication instructions and follow all "startup" instructions.
- j) Electric drivers should be checked for rotation at this time. Make electrical connections "bump" motor (momentarily start, then stop) to check rotation. **DRIVER MUST ROTATE COUNTERCLOCKWISE** when looking down at top end of motor.

 In case you realize that the driver has a wrong rotating direction, contact immediately Flowserve representative or Motor manufacturer to get the proper corrective action to be done. Improper attempt to change motor rotation might result in motor damages or improper driver function.

- k) See impeller adjustment instructions (section 5.4) and alignment instruction (section 4.5) before bolting the pump and driver half of the coupling together.

4.1.7.2 Installation of hollow shaft driver

- a) Clean driver mounting flange on discharge head and check for burrs or nicks on the register and mounting face. Oil lightly.
- b) Remove driver clutch.
- c) See (j) regarding installation of motor guide bushing, if required.
- d) Lift driver and clean mounting flange, checking for burrs and nicks.
- e) Center motor over pump and rotate to align mounting holes.
Electric motors - rotate junction box into desired position.
Gear Drives - rotate input shaft into desired position.
- f) Lower carefully into place making certain that the female register on the driver mates over the male register on the pump.
- g) Bolt driver to discharge head.
- h) Check the driver manufacturer's instruction manual for special instructions including lubrication instructions and follow all "startup" directions.
Electric motors should be checked for rotation at this time. Make certain the driver clutch has been removed. Make electrical connections and "bump" motor (momentarily start, then stop) to check rotation. **DRIVER MUST ROTATE COUNTERCLOCKWISE** when looking down at top end of motor.

 In case you realize that the driver has a wrong rotating direction, contact immediately Flowserve representative or Motor manufacturer to get the proper corrective action to be done. Improper attempt to change motor rotation might result in motor damages or improper driver function.

- i) Some motors will be supplied with a "lower guide bushing" or "steady bushing" which is installed at the bottom of the motor to stabilize the shaft at this point. Some motor manufacturers mount this guide bushing before shipping while others will ship the guide bushing with instructions for field mounting.

Check the packing slip to see if a guide bushing is required, if so, determine if the bushing is already mounted or not and proceed accordingly. Refer to motor instruction manual.

- j) Carefully install drive clutch on driver making sure that it fits down properly.
- k) Clean threads on top of head shaft and head shaft nut. Lubricate male threads lightly. Install head shaft.
- l) Install gib key in clutch and shaft. This must be a sliding fit and may require filing and dressing. Do not force.
- m) Thread adjusting nut down on shaft until it bears against clutch. (Threads on 43 mm (1.1 larger head shaft adjusting nuts are l and all others are right handed). Do not further at this time. See impeller instructions in section 5.3.

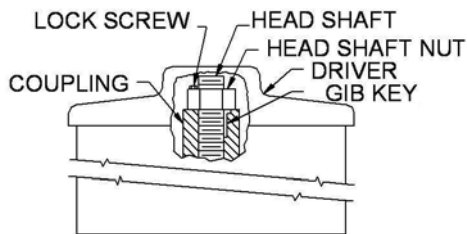


Figure 4.1

4.2 Part assemblies

Motors may be supplied separately from the pumps. It is the responsibility of the installer to ensure that the motor is assembled to the pump and aligned as detailed in section 4.5. Discharge head column piping and the pump assembly are supplied either separately or as fully assembled depending upon the pump size and weight. If the parts are shipped separately, it is the customer's responsibility to install and align the pump with driver to the satisfaction of Flowserve's installation instructions.

4.3 Foundation



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

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

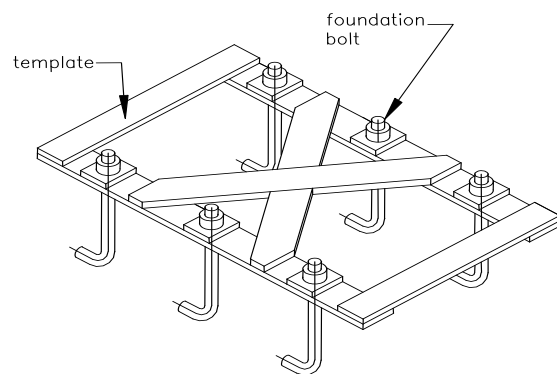


Figure 4.2
Template for Hanging Foundation Bolts

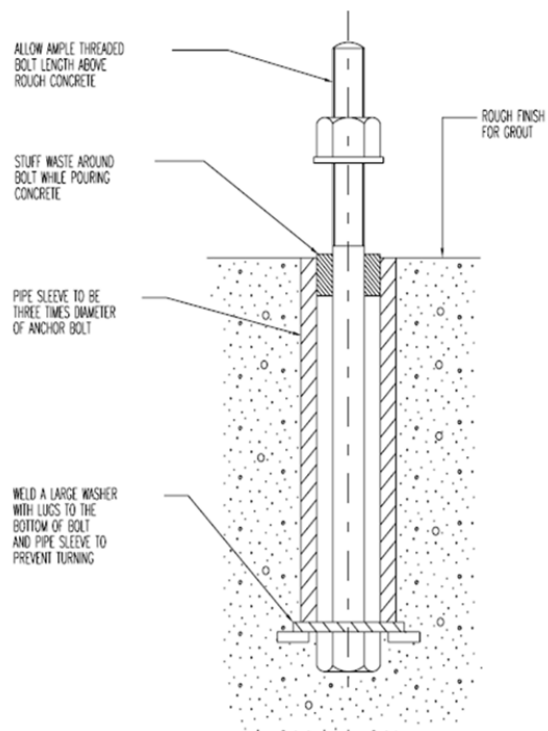


Figure 4.3

Figure 4.3 illustrates an alternative foundation bolt arrangement which can be used in lieu of standard foundation bolts. Notice the large washer with lugs at the bottom. It should be welded to the bolt and pipe sleeve to prevent turning.

Allow a little more than the specified threaded bolt length above the rail of the foundation plate. The excess can always be cut off if it is not needed.

A rough finish top surface is best when applying grout.

4.3.1 Leveling of pumps with suction barrel

4.3.1.1 Pumps equipped with foundation plate

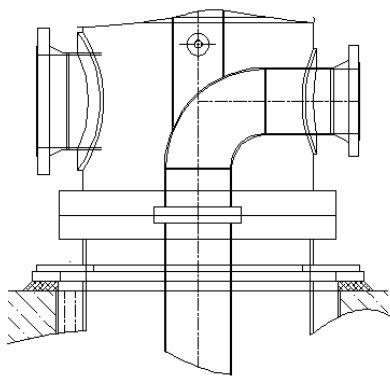


Figure 4.4

The soleplate is installed on the foundation and aligned with the anchor bolts. Level the soleplate with the help of a machinist's level to within 0.25 mm per m (0.0035 in. per ft.). Grout the plate. Cure and allow grout to set for 72~80 hours. Tighten the nuts. Lower the suction barrel into the pit and level again with respect to the soleplate to within 0.25 mm per m (0.0035 in. per ft.). The pump is now lowered into the suction barrel and installed.

4.3.1.2 Pumps equipped without foundation plate

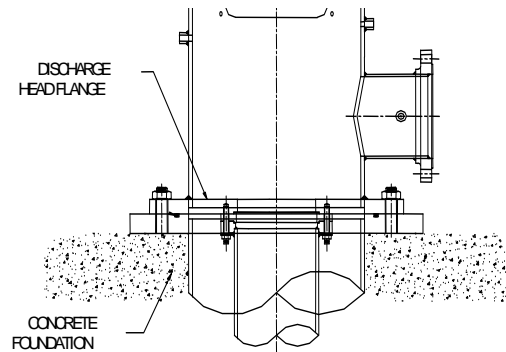


Figure 4.5

The suction barrel is first lowered into the pit and aligned with the anchor bolts. The suction barrel flange is leveled by using a master level or a precision machinist's level. Levels should be taken on the equipment mounting surfaces. The suction barrel flange mounting surface needs to be leveled to within 0.25 mm per m (0.0035 in. per ft.) using shims and grouted. Allow the grout to set for at least 72~80 hours before the pump is installed. Check the barrel mounting surface level after the grout is set and then proceed with the pump installation. Lower the pump assembly into the pit and align the discharge head flange bolt holes to the anchor bolts.

4.3.2 Leveling of pumps in wet pit (sump)

4.3.2.1 Pump equipped with support beams

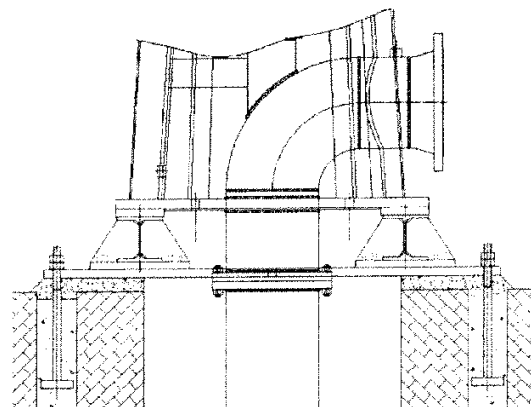


Figure 4.6

Some pumps are mounted on two beams supporting the suction head. The beams are fixed through bolts to plates, that need to be grouted, that act as soleplate.

The two plates are installed on the foundation and aligned with the anchor bolts. Level the plates with the help of a machinist's level to within 0.25 mm per m (0.0035 in. per ft.). Grout the foundation plates. Allow the grout to set for at least 72~80 hours before the pump is installed. Tighten the nuts. Proceed according to the procedure described in section 4.1.4.2.

4.3.2.2 Pump equipped with foundation plate

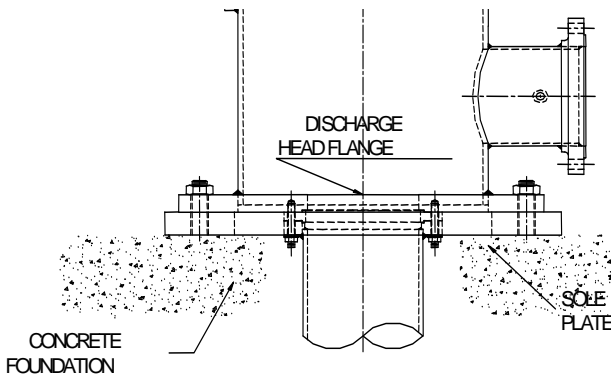


Figure 4.7

Some pumps are mounted on a separate plate known as soleplate. In such cases, the level shall be set with a master level or a precision machinist's level. The mounting surface needs to be leveled to within 0.25 mm per m (0.0035 in. per ft.) using shims and grouted.

Accurate shimming and grouting of the soleplate is very important. Record the leveling data for future reference. Grout the soleplate and allow to set at least 72~80 hours (cure as required) before the pump is lowered into the pit. Align the discharge head bolt holes with the anchor bolts. torque the nuts to the required level.

4.3.2.3 Pump equipped without foundation plate

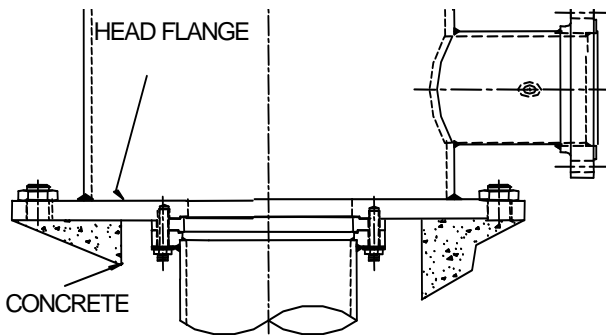


Figure 4.8

Some wet pit pumps are installed directly by using the flange that comes as an integral part of the discharge head. The pump is lowered into the pit and aligned with the anchor bolts.

The mounting flange is shimmed to achieve required level by using a precision machinist's level. The pump is to be leveled to within 0.25 mm per m (0.0035 in. per ft.). The data to be recorded for future reference. Anchor bolt nuts are tightened sufficient enough to hold down the pump in place.

Grout is poured and allowed to set for at least 72~80 hours (cure as required) before any further work is done on the pump.

CAUTION If leveling nuts are used to level the base, they must be backed off as far as possible prior to grouting.

Always shim near foundation bolts and then back off the leveling nuts. Now tighten the foundation bolts. If done otherwise there is a risk of significantly lowering the structural natural frequency that could result in separation of the base from the grout.

Note: Directly mounted pumps are not user friendly for service. Re-installation of these pumps requires re-leveling and re-grouting.

4.4 Grouting

Where applicable, grout in the foundation bolts. After adding pipe work connections and re-checking the coupling alignment, the mounting plate/soleplate should then be grouted in accordance with good engineering practice. If in any doubt, please contact Flowserve service center for advice.

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

CAUTION Foundation bolts should only be fully tightened after the grout has been cured.

4.5 Initial alignment

4.5.1 Thermal expansion

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

4.5.2 Preparation before alignment

To ensure proper alignment the following items are very important.

- All machined mating surfaces (such as the mating flanges of pump and motor) must be clean and free of burrs and nicks.
- Exterior strain must not be transmitted to the pump. The most common cause of trouble is forcing the piping to mate with the pump. It is recommended that flexible connectors be installed in the piping adjacent to the pump.
- All threads should be checked for damage and repaired if necessary. Lubricate all threaded connections with a suitable thread lubricant (an anti-galling compound).

4.5.3 Alignment methods

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

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

Note: The motor assembly has to be adjusted in the horizontal direction to line up the driver and shaft centers. Alignment screws are provided to lock the motor assembly in its final aligned position.

See section 5.3.2.1 for final coupling alignment for solid shaft.

CAUTION Check the direction of pump rotation before the coupling is fully connected. The power supply to the driver to be connected only after the final alignment is complete.

4.5.3.1 Shaft./Coupling alignment

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

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

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

4.5.3.2 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.

- Angular misalignment**
In angular misalignment, the center line of the shafts intersect, but are not on the same axis.

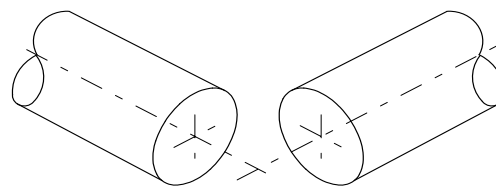


Figure 4.9

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

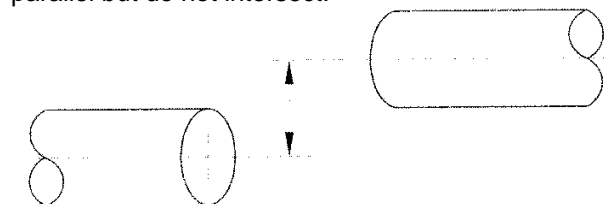


Figure 4.10 – offset misalignment

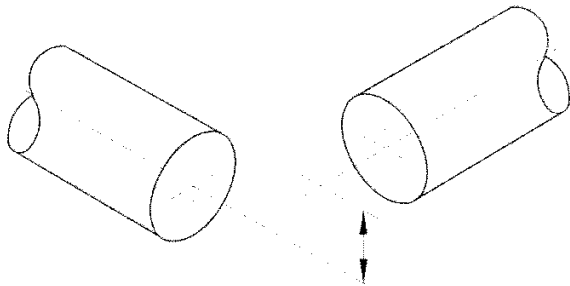


Figure 4.11 – combination of offset and angular misalignment

4.5.3.3 Alignment of flex coupling

For flexible couplings with narrow flanges use a dial indicator as shown on figure 4.12 to check both parallel and angular alignment. For detailed alignment procedure refer to API RP686.

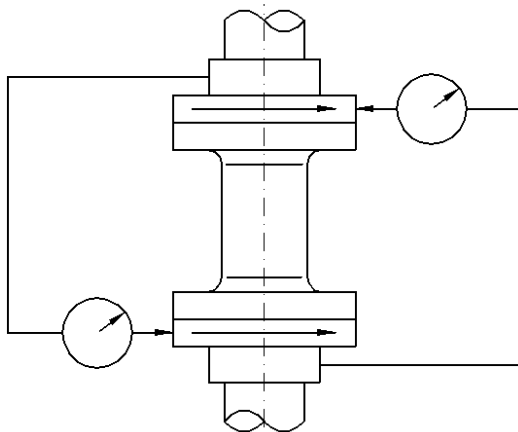


Figure 4.12

Maximum permissible misalignment at working temperature:

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

4.5.3.4 Alignment of rigid coupling

Place the indicator of the machined surface of the stuffing box. If the pump is equipped with a packing seal, a 2-halved ring is provided to be inserted in the stuffing box to keep the shaft centered in the correct position

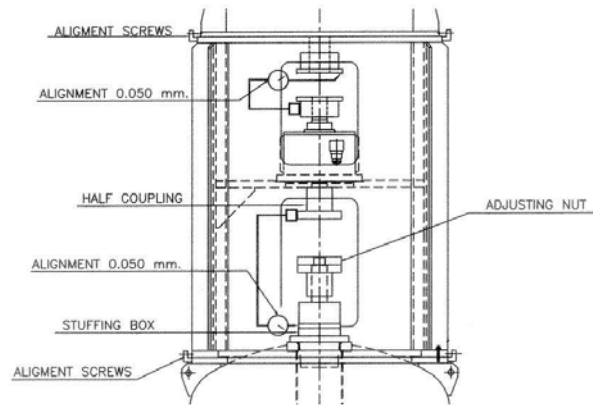


Figure 4.13

Maximum permissible misalignment at working temperature:

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

Note:

- a) Pumps with thick flanged non-spacer couplings can be aligned by using a straight-edge across the outside diameters of the coupling hubs and measuring the gap between the machined faces using feeler gauges, measuring wedge or calipers.
- b) When the electric motor has sleeve bearings, it is necessary to ensure that the motor is aligned to run on its magnetic centerline.
- c) Refer also to section 4.1.6 for alignment of pumps with both mechanical seal and thrust bearing.




Refer to the motor User Instructions for details.


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




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


If the pump is handling hot liquid, the alignment must be rechecked in warm condition of the unit. The alignment of the unit shall be checked again after 200 service hours.

 Complete piping as below and see sections up to and including section 5, “Commissioning, startup, operation and shutdown” before connecting driver and checking actual rotation.

 Once the alignment has been completed, proceed dowelling the motor stand to the discharge head.

4.6 Piping

 **CAUTION** Never use the pump as a support for piping.

 **CAUTION** Protective covers are fitted to the pipe connections to prevent foreign particles or objects entering the pump during transportation and installation. Ensure that these covers are removed from the pump before connecting pipes.

4.6.1 General

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

Discharge and suction (if installed) 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. The maximum allowable values allowed are stated in the

General Arrangement Drawing provided in the Instruction Manual Book.

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.

4.6.2 Suction piping (if applicable)

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

4.6.2.1 Suction strainer

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

The suction system should be thoroughly flushed before installing the suction strainer and making up suction piping to the pump.

The suction strainer should be installed between 5 to 20 pipe diameters upstream from the pump suction flange.

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

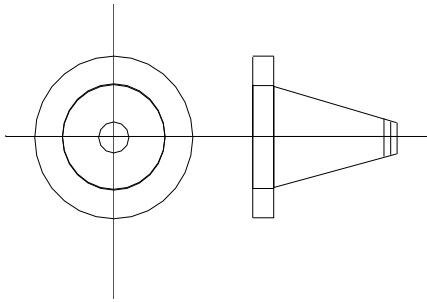


Figure 4.14
Cone Type Strainer

The Flowserve recommendation for suction strainers consists of a conical shaped steel plate. The plate has 1.6 mm (1/16 in.) perforations and is of sufficient size and thickness for the required flow. See Figure above.

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

Pressure gauges should be installed on both sides of the screen so that the pressure drop across the screen can be measured.

When the unit is being started, the gauges on each side of the screen should be carefully watched. An increase in the differential pressure between the two gauges indicates that the screen is becoming clogged with dirt and scale. At this point, the pump should be shut down, and the screen cleaned and/or replaced.

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.*

4.6.3 Discharge piping

- 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.
- Pipework reducers should have a maximum total angle of divergence of 15 degrees.

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

4.6.4 Auxiliary piping

4.6.4.1 Drains

Normal pump leaks and gland leakage are to be drained through a separate piping arrangement or back into the suction/sump.

! Ensure proper drain in case of hazardous, flammable or toxic pumped fluid.

4.6.4.2 Pumps fitted with gland packing

The pump is shipped without packing in the stuffing box. A complete set of packing is shipped in a separate box attached to the pump crate.

Properly packed stuffing box is a must for efficient pump operation. Proceed as follow:

- Clean out the stuffing box.
- Install three rings of packing at the bottom of the stuffing box.
- Insert the lantern ring.
- Continue adding the required number of packing rings, in accordance with cross section drawing

Note:

Install one ring of stuffing box packing in the box at a time, making sure it is properly seated.

- Stagger the joints of succeeding rings. When the last ring is in place, assemble the gland and pull up the nuts evenly until snug. Then back off the nuts and re-tighten finger tight.
The stream of leakage following pump startup can be controlled by taking up the gland nuts. It is suggested that this is done slowly, one flat at a time until satisfactorily leakage or lubrication has been obtained.

! CAUTION

Packing gland must never be tightened to the point where leakage from the packing is stopped. A small amount of leakage is required for lubrication of the packing. Tightening the packing until stopping the leakage flow from the packing will result in burning of the packing, scored shaft sleeve and possible rotor seizure.

4.6.4.3 Pumps fitted with mechanical seals


QLs pumps can be equipped with single or double cartridge mechanical seal.


In relation to the different condition of services, type of fluid and pressures, different seal flushing plans can be provided.

Refer to the dedicated General Arrangement drawing included in the Instruction Manual Book to see the type of flushing plan installed.

Against the dedicated documents, check that the flushing plan is correctly assembled and secured.

Connect all the external connections (external flushing or gas piping,, electrical supply and wiring of instrument (if any) according to what specified in Section 4.8.

 See section 5.4 for *Direction of rotation* before connecting motor to the power supply.

 If external flushing is needed, ensure that the external flushing is open and reach the mechanical seal before starting the pump.


4.6.4.4 Other piping


Refer to the pump general arrangement drawing for location of the auxiliary piping terminal points, such as packing and bearings washing and hypochlorite flushing.


4.6.5 Final checks


After connecting the piping to the pump, rotate the shaft several times by hand to ensure no pipe strain. If pipe strain exists, correct piping.


4.7 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 and installing the 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 in accordance with the motor manufacturer's instructions (normally supplied within the terminal box) including any temperature, ground 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 to the system.

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 sent along with the pump. If no such document is found, please call Flowserve and request for prints.

4.8 Protection systems



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

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

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

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

To prevent excessive surface temperatures at the bearings, it is recommended that temperature and/or vibration monitoring is done on a regular basis.

5 COMMISSIONING, STARTUP, OPERATION AND SHUTDOWN

CAUTION These operations must be carried out by fully qualified personnel. Turn off power supply for safety while pump commissioning is in progress.

5.1 Pre-commissioning procedure

The gland is to be filled with grease and flush supply to be in place. Flush piping to be checked for leaks. Mechanical seals to be checked for leaks, flush flow and pressure.

- a) Pumps with the enclosing tubes and oil-lubed bearings must be filled with the proper lubricant to avoid running dry and to guarantee acceptable performance of the pump. A separate oil tank is attached to the pump (see detail in section 5.2.2).
- b) For can pumps check all vent connections for complete filling of the pump. The venting procedure can take from 10 minutes up to 2 hours, depending on the kind of fluid (except cryogenic service).
- c) Check the direction of rotation of the pump (Coupling spacer dismantled). Should be counter clockwise when viewed from the driver end.
- d) The pump rotor and the shaft seal must be in correct axial position.
- e) Check the readiness of all auxiliary systems (seal sys., lubrication system etc.) for startup.
- f) All pipe work including the internal and the auxiliary pipe work must be connected correctly and must be absolutely tight. Check the tightness of all connections of the auxiliary pipe work. The suction valve must be open, the discharge valve shall be closed or partially open as required.
- g) Turn the pump by hand, if required with the help of a lever, to check the free rotation of the rotor. The rotor must turn uniformly and noiselessly. Some resistance may be felt due to the friction in the bearings and seals.
- h) Check the readiness of the driver for startup. Refer to the manual for the driver to be sure that all precautions are in place to energize the motor.

5.2 Pump Lubricants

Note: Re-checking the motor lubrication should be in accordance with the motor manufacturer's user instructions supplied separately with the pump.

5.2.1 Open lineshaft lubrication

Open lineshaft bearings are lubricated by the pumped fluid on short-coupled units less than 15 m (50 ft.) long and will usually not require pre or post-lubrication. Care is to be taken to ensure that the gland or seal is supplied with the required flush flow.

All open lineshaft pumps where the static water level is more than 15 m (50 ft.) below the discharge head should be adequately pre-lubricated before starting the pump.

Pre-lubrication shall be provided either by pumped fluid (through a special piping fitted on the discharge head, to be connected to the discharge piping) or by clean external source (water or oil) from auxiliary lines or dedicated tank.

Refer to the specific description on the dedicated documents of the pump.

Note:

It is the responsibility of the User to install a reliable pre-lube system to achieve the pump pre-lubrication. Flowserve will not supply these types of systems or accessories with the pump, unless otherwise agreed.

5.2.2 Enclosed shaft lubrication

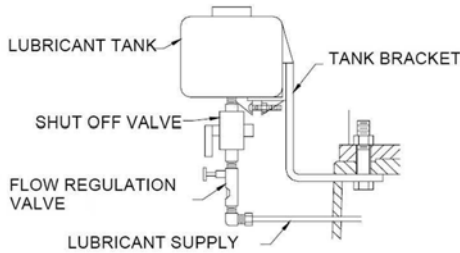
QLs with the enclosed shafting are lubricated by a dedicated oil supply system or injection lubricated by extraneous liquid; usually clean water to meet the application requirements.

On water pumps, the suction bearing on the bowl assembly should be repacked when required. Pumps that pump hydrocarbons or have carbon, rubber, epoxy or Teflon suction bearings do not have the suction bearings packed. If the pump will be started after a longer storage period, the bearings should be first flushed and cleaned by using a suitable cleaning agent. It is not necessary to remove the oil sprayed for short or long-term storage as this will mix up thoroughly with the lubrication oil.

5.2.2.1 Oil lubricated pumps

The lubricating oil must be available and should be allowed to run into the enclosing tube in sufficient quantity to thoroughly lubricate all lineshaft bearings. The gravity flow system is the most commonly utilized system for oil.

The oil reservoir (example shown in detail below) must be kept filled with a good quality light turbine oil (about 30 cSt) at the operating temperature and adjusted to feed a minimum of 3 drops per minute per 30 m (100 ft.) of column length, but not to exceed 5 drops per minute.



5.2.2.1.1 Pre-lubrication of oil lubricated pumps

As a general rule, the oil must be allowed to flow by gravity at least 45 minutes before the pump is started for the first time or in case the pump was turned off for a longer duration. Adequate care should be taken to make sure that the flow is available and is consistent for subsequent startups.

5.2.2.1.2 Enclosed shaft lubricants

The following oils are recommended for enclosed lineshaft bearing lubrication under normal operating conditions. See following tables.

Oil used for enclosed shaft lubrication should only be of high quality turbine grade. The viscosity of the oil at working temperature must be at least 30 cSt (mm²/sec).

The pour point of the oil must be in accordance with the lowest expected temperature of the bearing housing during a stop of the pump.

CAUTION It is recommended that detergent type oils not be used.

Non-food grade lubricant oils

Oil Manufacturer	Trade name of the oil
Conoco Inc.	Conoco Diamond Class Turbine oil ISO -32
Exxon Company	Teresstic- GT 32
Mobil Oil Company	Mobile DTE-797- Grade-32
Shell Oil Company	Tellus-32, Tellus-37 or Turbo Oil T -32
Chevron Lubricants	Chevron Turbine Oil TR-32
BP	Energol HL-C 32
Texaco, Inc.	Texaco Regal (R&O)- 32

Food grade lubricant oils

Oil Manufacturer	Trade name of the oil
Exxon Company	Exxon-DTE-FM32
Mobil Oil Company	Mobile DTE-FM- Grade-32
Shell Oil Company	Cassida HF 32

If none of the above oils are available, equivalent turbine oil (food or non-food grades as required) with the matching properties has to be selected. Oils with a viscosity range of 30 cSt (mm²/sec) to 37 cSt (mm²/sec) at 40 °C (100 °F) with a minimum viscosity index of 90 are recommended.

5.2.2.1.3 Oil level

The correct oil level is in the middle of the oil sight glass and shall be checked when the pump is not in operation. Periodically check if the lubricating oil is mixed with any condensed water. Careful opening of the oil drain during a stop of the pump will show any water.

Note: After the initial start the level will decrease due to circulation of the oil through the bearings.

! If the oil level is higher than specified, it could result in higher bearing temperatures resulting in poor lubrication.

5.2.2.2 Injection lubricated pumps

Enclosed lineshaft bearings are lubricated by extraneous liquid (usually clean water), which is fed to the tension nut either by gravity flow, or by a pressure injection system.

Note: Injection systems are designed for each installation. Injection pressure and quantity of liquid will vary. Normally 0.45-0.90 m³/h (2-4 USgpm) at 0.7-1.4 bar (10-20 psi) over maximum pump discharge pressure of clean liquid is required.

5.2.2.2.1 Pre-lubrication of injection lubricated pumps

As a general rule, the liquid flow is to be started at least 15~20 minutes before the pump is started for the first time or in the event of pump not being in use for longer duration.

The injected lubricant flow is never stopped for short off periods. Adequate care should be taken to make sure that the flow is available and consistent

CAUTION It is recommended that detergent type oils not be used.

5.3 Lubrication of thrust bearing

If the thrust bearing is installed in the pump, it must be supplied properly with lubricant oil.

5.3.1 Grade of Oil

Oil for lubricating ball or roller should be a high quality, well refined mineral oil preferably of the turbine type. Vegetable or animal oils should not be used as they tend to become rancid and will eventually corrode the bearing surface. Oil should conform to specification ISO VG46. The following suppliers grade are suitable.

Oil Manufacturer	Trade name of the oil
AGIP	OTE 46
BP Oil Ltd	Energol THB 46 or CS 46
CASTROL	Perfecto T46
CHEVRON	DC Turbine Oil 46
ESSO	Teresso 46 or Nuto H46
GULF	Harmony 46
MOBIL	DTE Light
SHELL	Turbo T46
TEXACO	Regal Oil R&O 46

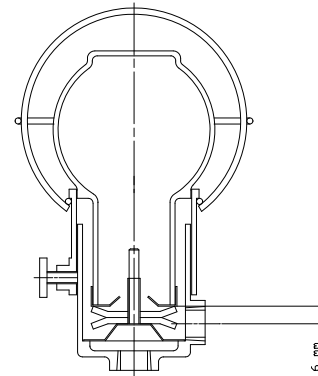
5.3.2 Oil Filling

- Drain the bearing bracket and flush it with a light oil. Install the constant level oiler.
- Make sure the oiler is set at proper level.
- Fill the bottle through the stem, replace and allow oil to flow into reservoir. It may be necessary to fill the bottle several times before the oil ceases to run into the reservoir, indicating that the oil is up to the proper level.
- Refill the bottle to maintain this level.

CAUTION Never fill the reservoir through the air vent opening.

5.3.3 Constant Level Oil Control

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.



Constant level oiler

5.3.4 Bearing Oil Temperature

Circulation of the oil in the reservoir is achieved by centrifugation. It is recommended that the lubricating oil is kept between 38°C and 75°C (100°F-167°F), preferably above 49°C (120 °F). The bearing oil temperature without cooling may rise to 82°C (180 °F).

5.3.5 Oil Change

Operating conditions and severity of service will determine the interval between oil changes. In general higher oil temperature will require more frequent oil change. If the bearings maintain their normal temperature and there has been no contamination of the oil, the interval between changes may be prolonged. Generally the oil should be changed every six months. If the bearing temperature increases, check immediately improper lubrication or a faulty bearing.

5.4 Impeller adjustment

Proper impeller adjustment is needed to place the impeller inside the bowl assembly in the best position to maximize performance. If the impeller position is not fitted, a reduction in performances shall occur, and , in the worst cases, impeller and casing damages by the contact between casing and impeller.

5.4.1 Impeller adjustment of a pump with solid shaft driver

During pump assembly in factory, the pump shaft is axially positioned by the adjusting nut so that the impeller is centered in the correct position.

Check after the installation and regulate the position of the impeller, even if the pump has been installed completely assembled.

- a) With the pump completely installed, proceed installing the hubs of the rigid coupling (thrust bearing side and pump side).
- b) Lift the pump rotor till its upper position and record the vertical distance from a reference point.
- c) Release the rotor to its lower position, and record again the position from the same reference point
- d) The pump rotor shall have an axial run of 5±10mm (0.2±0.4 inches). If the recorded run is different from this range, re- check the installation and pump assembly.
- e) By rotating the screwed collar installed on the pump coupling hub, position the rotor at the middle of the run (half the value from the top and the bottom measured).
- f) Proceed aligning the hubs according to section 5.3.2.

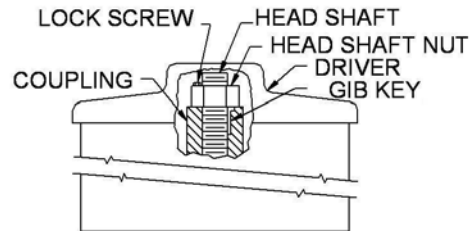
Note: The position of the regulating nut is located on the rigid coupling. If the rigid coupling is not installed, the impeller adjustment shall be done through the regulating nut placed at the top of the bearing house. Refer to the dedicated Cross Sectional drawing supplied with the IOM book to identify where the adjusting impeller nut is located.

5.4.2 Impeller adjustment for a hollow shaft driver

Impeller adjustment when using hollow shaft drivers is as follows. The driver canopy will have to be removed before beginning.

- a) Install headshaft if not already in place.
- b) Install driver clutch in accordance with the driver instruction manual and bolt into place.
- c) Check shaft position. Lower shaft until there is a definite feel of metal contacting metal. This indicates the impellers are "on bottom" and in the correct starting position for impeller adjustment.
- d) Thread headshaft nut down (right hand threads) except 43 mm (1.7 in.) and larger sizes that are having left hand threads, until impellers are just raised off their seat and the shaft will rotate freely.
- e) Check a separate document that is supplied with the pump that provides recommended impeller setting and running clearance information.

Detail showing head shaft and lock screw arrangement



Note: If at any time during the life of this pump the pumping conditions or total pump length changes, contact the factory for recalculation of the impeller setting.


- f) Tighten the adjusting nut to match impeller setting recommended by Flowserve.
- g) Using the cap screw provided, bolt the headshaft nut down & lock using lock screw to the motor coupling. See the details of head shaft and lock screw arrangement under item (h) below.

CAUTION Always lock headshaft nut by tightening the lock screw before starting driver. Failure to do so could result in damage to the pump and driver.

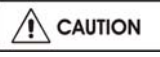
- h) If a mechanical seal is used, adjust the mechanical seal at this time.

Note: Shafts elongate due to the hydraulic thrust of the pump and the impellers must be compensated for this elongation. Shaft elongation varies for each model depending upon the size, shaft length, shaft diameter, impeller weight, number of stages. Please see the documentation supplied along with the pump for exact impeller setting value matched for the specific pump that you have purchased.


5.5 Direction of rotation

 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.


 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.


5.6 Guarding


 Guarding is supplied fitted to the pump set by captive fasteners. 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.

Machinery to be protected at all times by Flowserve provided safety guards or per applicable local or national standard. Compliance is mandatory for some regions of the world and in explosive environments.


5.7 Priming and auxiliary supplies

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

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


 (For Wet Pit application) Ensure that the pump has the required Minimum Submergence according to the value stated on the dedicated General Arrangement Drawing.

5.8 Starting the pump


 Ensure flushing and/or cooling/heating liquid supplies are turned ON before starting the pump.

a) CLOSE the outlet valve (or partially open in some cases).

b) OPEN all inlet valve.
c) For wet pit application check that the liquid levels are correct; for can pumps, ensure that the can is filled with liquid before starting the pump

 d) Ensure all vent connections are closed before starting.

e) Check the motor connections.

 Do not run the pump with the outlet valve closed for a period longer than 30 seconds.

5.8.1 Pre-starting checks

Before starting the pump the following checks should be made.

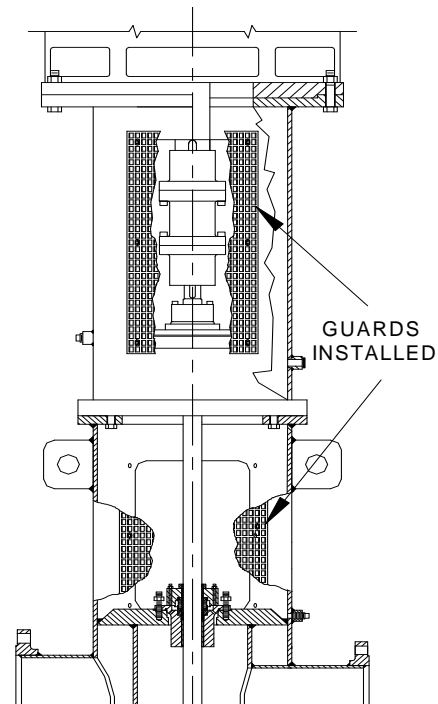
- b) Rotate the pump shaft by hand to make sure the pump rotates freely and the impellers are correctly positioned.
- c) Has the electric motor been properly lubricated in accordance with the instructions furnished with the driver?
- d) Has the electric motor been checked for proper rotation? If not, the pump must be disconnected from the driver at the coupling before checking. The electric motor must rotate counter-clockwise when looking down on the top of the driver.
- e) Check all connections to the driver and control. Do not overfill the grease cavity. Over greasing can lead to failure of the thrust bearing.
- f) Check that all piping connections are tight.
- g) Check all foundation bolts for tightness.
- h) Check all bolting connections for tightness (coupling bolts, mechanical seal gland bolts, driver bolts etc.).
- i) Make sure the mechanical seal is properly adjusted and locked into place. Ensure that all seal spacers are in the running position prior to operation.
- j) All guards must be secured in position prior to pump startup to prevent possible contact with rotating parts.

To ensure proper alignment three items are very important during installation and they are:

- All machined mating surfaces (such as the mating faces of the pump and motor) must be clean and free from burrs and nicks. These surfaces should be cleaned thoroughly with a scraper, wire brush and emery cloth if necessary and all nicks or burrs removed with a fine file.
- Exterior strain must not be transmitted to the pump. The most common cause of trouble in this respect is forcing the piping to mate with the pump. It is recommended that flexible connectors be installed in the piping adjacent to the pump.

- All threads should be checked for damage and repaired if necessary. If filing is necessary, remove the part from the pump if possible, or arrange to catch all the filings so they do not fall onto other parts of the pump. Clean all threads with a wire brush and approved cleaning solvent, ends of shafts must be cleaned and any burrs removed since alignment depends on the shaft ends butting squarely. Lubricate all threaded connections with a suitable approved thread lubricant (an approved anti-galling compound should be used on stainless mating threads).
- k) On pumps equipped with mechanical seals, clean fluid should be put into the seal chamber. With pumps under suction pressure, this can be accomplished by bleeding all air and vapor out of the seal chamber and allowing the fluid to enter. With pumps not under suction pressure, the seal chamber should be flushed liberally with clean fluid to provide initial lubrication. Make sure the mechanical seal is properly adjusted and locked into place. Insure that all seal spacers are removed prior to operation.
- l) On pumps equipped with thrust bearing in the pump, ensure that the thrust bearing support is filled with the correct level of oil, by checking the level through the sight glass. If the thrust bearing has the cooling water installed, check that the flush if cooling water is turned on before starting the pump.
- m) If provided, check that the external flushing of the mechanical seal is turned on.

5.8.1.1 Typical safety guards



Note:

A screen guard is furnished with all pumps having a two-piece headshaft or an adjustable flanged coupling. This screen must be secured in place prior to pump startup to prevent possible contact with rotating parts. Typical arrangement is shown in section 5.8.1.1.

5.8.2 Stuffing box adjustment (if installed)

On the initial starting it is very important that the packing not be tightened excessively. New packing must be run in properly to prevent damage to the shaft and shortening of the packing life.

The stuffing box must be allowed to leak for proper operation. The proper amount of leakage can be determined by checking the temperature of the leakage, this should be cool or just lukewarm - NOT HOT - usually 40 to 60 drops per minute will be adequate.

When adjusting the packing gland, bring both nuts down evenly and in small steps until the leakage is reduced as required. The nuts should only be tightened about one half turn at a time at 20 to 30 minute intervals to allow the packing to "run-in".

Under proper operation, a packing set will last a long time. Occasionally a new ring of packing will need to be added to keep the box full.

After adding two or three rings of packing, or when proper adjustment cannot be achieved, the stuffing box should be cleaned completely of all old packing and re-packed.

5.8.3 Open shaft lubrication before startup


Open lineshaft bearings are lubricated by the pumped fluid on short-coupled units less than 15 m (50 ft.) long and usually do not require pre- or post-lubrication. All open lineshaft pumps where the static water level is more than 15 m (50 ft.) below the discharge head should be adequately pre-lubricated before startup.

5.8.4 Enclosed shaft lubrication before start up

Enclosed lineshaft bearings are lubricated by an extraneous liquid (usually oil or clean water). The oil reservoir must be kept filled with a good quality of light turbine oil (about 30 cSt (mm²/sec) at operating temperature) and adjusted to feed 3 drops/minute for every 30 m (100 ft.) of column.

Injection systems are designed for each installation. Injection pressure and quantity of lubricating liquid will vary. Usually 0.45 to 0.90 m³/h (2 to 4 gpm) at 0.7 to 0.14 bar (10 to 20 psi) over maximum pump discharge pressure of clean liquid is required.




For recommended oils for enclosed lineshaft bearing lubrication under normal operating conditions, please see tables 5.2.3.1 and 5.2.3.2. If none of the above oils are available, oil with the following specifications should be obtained. Turbine type oil with rust and oxidation inhibitors added, viscosity 30 cSt (mm²/sec) to 37 cSt (mm²/sec) at 37.8 °C (100 °F) with a minimum viscosity index of 90.

 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 startup.

5.8.5 Initial Starting


- a) If the discharge line has a valve in it, it should be partially open for initial starting. The discharge valve is intended to add sufficient system resistance to the pump. Failure to maintain pump flow rates within the limits of the pump and motor could result in severe damage.
- b) Start pre-lubrication liquid flow on pump if required.

- c) Start flushing of mechanical seal through external sources, if required.
- d) Start the pump and observe the operation. If there is any difficulty, excess noise or vibration, stop the pump immediately and refer to the Trouble Shooting Chart (section 7.0) to determine the probable cause.


   Observe extreme caution when venting and or draining hazardous liquids. Wear protective clothing in the presence of caustic, corrosive, volatile, flammable or hot liquids. Do not breath toxic vapors. Do not allow sparking, flames or hot surfaces in the vicinity of the equipment.

- Ensure that the unit is vented of all trapped vapor
- Open the discharge valve as desired to operate the unit at its design conditions
 - Check complete pump and driver for leaks, loose connections, or improper operation

If possible, the pump should be left running for approximately one half hour on the initial startup, this will allow the bearings, packing or seals, and other parts to "run-in" and reduce the possibility of trouble on future starts.

 If abrasives or debris are present, upon startup, the pump should be allowed to run until the pumpage is clean. Stopping the pump when handling large amounts of abrasives (as is sometimes present on initial starting) may lock the pump and cause more damage than the pump is allowed to continue operation.

Every effort should be made to keep abrasives out of lines, sump, etc. so that abrasives will not enter the pump.

 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 startup.

5.8.6 Frequency of lubrication

The characteristics of the installation and severity of service will determine the frequency of lubrication. Lubricant and pump/motor bearing temperature analysis is useful in optimizing lubricant change intervals.

The motor bearing temperature limitations should be considered for its lubrication requirements. Refer to the driver manufacturer's user instructions supplied with the pump. If documents are not found contact Flowserve.

For thrust bearing lubrication, please refer to Section 5.3 of this manual.

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

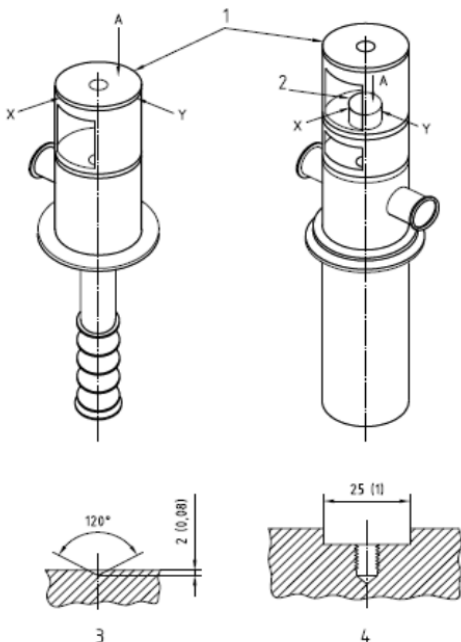
5.8.7 Normal vibration levels, alarm and trip

Pumps generally fall under classification of rigid support machines within the International Rotating Machinery standard and maximum vibration levels are based on those standards.

Vibration shall be recorded placing the accelerometers on the thrust bearing house. If the pump is not equipped with thrust bearing, vibration shall be taken placing the accelerometers on the flange joining the pump head and the driver.

Here below you can find the sketch indicating the measurement points, according to API 610 standard.

Note: To compare the vibration levels during the pump life and with the recorded level during factory acceptance test, the points of measurement shall be kept according to the sketch below. Measuring vibration levels in other points will make the level not comparable.



- Key**
- 1 driver mounting surface
 - 2 pump bearing housing
 - 3 dimple (see 5.10.2.10)
 - 4 optional arrangement for mounting vibration-measuring equipment (see 5.10.2.11)
 - A axial
 - X X axis
 - Y Y axis

CAUTION Alarm and trip values for installed pumps should be based on the actual measurements (N) taken on the pump in a fully commissioned (new) condition. Measuring vibration at regular intervals and recording will help to track any deterioration in pump or operating conditions.

5.8.7.1 Typical allowable field vibration values

According to Flowserve experience, the following values can be taken as a guideline to set the alarm/trip of the pumps.

- Up to 7 mm/s RMS (0.275 in/sec RMS): vibration level acceptable
- Between 11 and 12 mm/s RMS (0.43-0.47 in/sec RMS) the pump must be trip

Note: These values are referred to the measurement taken according to API requirements (see above). Measurement taken on the motor bearings (DE or NDE) will result in higher values.

5.8.8 Motor start/stop frequency

Even though motors are normally suitable for at least two consecutive starts, it is recommended to restart only after coasting to rest between starts (minimum of 15 minutes gap), with the motor initially at ambient temperature. If more frequent starting is necessary, refer to driver manufacturer's instructions or contact Flowserve with details.

CAUTION The number of motor start and stops in any given time affects motor life.

If the motor is expected to experience multi starts in any given time, please refer to the driver's user instructions before the pump is put into operation.

5.9 Running or operation

5.9.1 Venting the pump

CAUTION Make sure that the pump is vented to enable all trapped air to escape, taking due care with the hazardous or hot liquids. Under normal conditions after the pump is fully vented and primed, it should be unnecessary to re-vent the pump.

5.9.2 Pumps fitted with packed glands

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



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 packing gland.

If hot liquids are being pumped it may be necessary to loosen 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 40-60 drops per minute is required.



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 by the pump shaft. Shaft guards must be replaced after the gland adjustment is complete.



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

5.9.3 Pumps fitted with mechanical seal

Mechanical seals require no adjustment. Before pumping dirty liquids, it is advisable, if possible, to run in the pump mechanical seal using clean liquid to safeguard the seal face.



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



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

5.9.4 Pump and motor bearing temperature



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

If pump bearing temperatures (such as thrust bearings) are to be monitored it is essential that a benchmark temperature is recorded at the commissioning stage and after the bearing temperature has stabilized. Typical alarm set:

- set the alarm at 80 °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 95 °C (200 °F) and the trip at 105 °C (220 °F)

It is important, particularly with grease lubrication, to keep a close watch on the bearing temperatures. After startup the temperature rise should be gradual, reaching a maximum after approximately 1.5 to 2 hours. This temperature should then remain constant or marginally reduce with time.

5.10 Stopping and shutdown



- Stop the driver.
- Close the discharge valve.
- Switch off flushing and/or cooling/heating liquid supplies at a time appropriate to the process.



For prolonged shutdowns and especially when ambient temperatures are likely to drop below freezing point, the pump and any cooling and flushing arrangements must be drained or otherwise protected.

5.11 Hydraulic, mechanical and electrical duty

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

5.11.1 Changing the pump speed

Changing pump speed effects flow, total head, power absorbed, $NPSH_R$, noise and vibration. Flow varies in direct proportion to pump speed. Head varies as speed ratio squared. Power varies as speed ratio cubed. If increasing speed it is important therefore to ensure the maximum pump working pressure is not exceeded, the driver is not overloaded, $NPSH_A > NPSH_R$, and that noise and vibration are within local requirements and regulations.

5.11.2 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.

5.11.3 Minimum Continuous Stable Flow

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

5.11.4 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.

5.11.5 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).

5.11.6 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.

5.11.7 Operating at Reduced Capacity



Damage to pump may result from prolonged operations at capacities less than MCSF as stated in Data Sheet.

5.11.8 Minimum Submergence (Wet pit applications)

In wet pit (sump) applications, the minimum submergence is the minimum liquid level that shall be granted above the upper suction bell to prevent vortex formation.

The value depends on the pump sizes and the flow, and it's indicated in the General Arrangement drawing provided in the IOM book.

Operating the pump with a liquid level upon the upper suction bell lower than the requirements may cause vortex formation inside the pump, with high vibration, noise, bad performances, mechanical damages to the pump, and in certain cases actual pump failure.

6 MAINTENANCE



It is the plant operator's responsibility to ensure that all maintenance, inspection and assembly work is carried out by authorized and qualified personnel who have adequately familiarized themselves with the subject matter by studying this manual in detail. (See also section 1.6).

Any work on the machine must be performed when it is at a standstill. It is imperative that the procedure for shutting down the machine is followed, as described in section 5.10.

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

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



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

If platforms, stairs and guardrails 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.

6.1 Maintenance schedule



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


- a) Any auxiliary systems installed must be monitored, if necessary, to ensure they function correctly.
- b) Gland packings 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. Proper functioning of the shaft seal must be checked on a regular basis.
- d) Check bearing lubricant level, and ensure oil changes on regular basis, according to section 5.3.5 of this manual.
- 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 that the dirt and dust is removed from areas around close clearances, bearing housings and motors.
- h) Check coupling alignment and re-align if necessary.

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


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

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

A periodic inspection is recommended as the best means of preventing breakdown and keeping maintenance costs to a minimum.

 Variation from initial performance is probably an indication of changing system conditions, wear, or impending breakdown of unit.


6.1.1 Routine inspection (daily/weekly)

 Routine inspection schedule should be developed and inspection log be maintained. The following checks should be made and appropriate action taken to remedy any deviations.


- a) Check discharge pressure for proper operation
- b) Check operating behavior. Ensure that noise, vibration and bearing temperatures are within the allowable limits.
- c) Check motor current /driver power.
- d) Check that there are no abnormal fluid or lubricant leaks (static and dynamic seals) and that any sealant systems (if fitted) are full and operating normally.
- e) Check the shaft seal leaks and make sure that it is within the acceptable limits.
- f) Check the level and condition of oil lubricant. On grease lubricated pumps, check the running hours since last recharge of grease or complete grease change.
- g) Check any auxiliary supplies e.g. heating/cooling, if fitted, are functioning correctly.

6.1.2 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.

6.1.3 Periodic inspection (six monthly)

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



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

6.1.4 Periodic inspections (yearly)

- a) Check foundation fixing, bolting, grouting for looseness, cracking or general distress.
- b) Check unit alignment against previous inspections.
- c) Check calibration of instruments.


6.1.5 Periodic Inspection (3 yearly)

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

6.1.6 Re-lubrication

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

6.1.6.1 Oil lubrication

 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 section 5.3.1 for oil grade recommendations, section 5.3.2 for methods of oil fill, section 5.3.4 for temperature limits.

6.1.6.2 Mechanical seals


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

6.1.6.3 Driver lubrication

 Refer to driver manufacturer's User Instructions supplied with the pump.

6.1.7 Impeller re-adjustment

Ordinarily, impellers will not require re-adjustment if properly set at initial installation.

 All adjustments of the impellers will change the seal setting, therefore, the seal must be loosened from the shaft until the adjustment is completed and then reset.

6.1.8 Maintenance of the stuffing box

6.1.8.1 General

Maintenance of the stuffing box will consist of greasing the box when required, tightening the packing gland occasionally as the leakage becomes excessive, and installing new packing rings or sets as required.

6.1.8.2 Greasing the stuffing box

Under ordinary operation, once-a-month greasing of the stuffing box will be adequate. A high quality industrial grade # 2 grease is recommended; see the table below for typical brands and types.

Manufacturer	Grease types
Exxon	Unirex N2
BP	Energrease LS2
Mobil	Mobilux 2
Shell	Alvania No.2
Texaco	Multitak 20
Esso	Beacon 2

6.2 Spare parts

6.2.1 Ordering of spares

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

- 1) Pump serial number
- 2) Pump size
- 3) Part name – (a)
- 4) Part number – (a)
- 5) Number of parts required

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

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

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

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

6.2.2 Storage of spares

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

6.3 Recommended spares and consumables

A list of spares and consumables are generally included along with this User Instructions and other documents that you have received along with the pump and is made specifically to your order. In the event that the list is not found, please contact Flowserve with pump type and order no.

6.4 Tools required

Standard tools needed to maintain this pump are follows.

- Open ended spanners / wrenches (standard size range)
- Socket spanners / wrenches (standard size range)
- Allen keys/wrenches
- Standard range of screw drivers
- Soft mallet

For drive collet pumps:

- Collet driver
- Sand collar (if not provided on the unit)
- Tie down bolt

Note:

Other tools may be required depending on the accessories/ special parts used per contract. Flowserve in general is not obligated to ship the tools with any pump shipped.

6.5 Fastener torque

Note:

Torque values shown are for standard fasteners lubricated with high stress lubricant such as graphite-oil, moly-disulphite, white lead, etc.

6.5.1 Pump main bolting and general application bolting

Material: A193 Gr B7 Nitronic 50	Thread size (inch)	Torque Nm - (lbf ft.)
	3/8"	23.5 (17.3)
	1/2"	59 (43.5)
	5/8"	118 (87)
	3/4"	225.5 (166)
	7/8"	363 (268)
	1"	520 (383.5)
	1.1/8"	696 (513.5)
	1.1/4"	1049 (774)
	1.3/8"	1304 (962)
1.1/2"	1638 (1208)	
Material: A193 Gr B8M	Thread size (inch)	Torque Nm - (lbf ft.)
	3/8"	17.6 (13)
	1/2"	44.5 (32.5)
	5/8"	88.5 (65.3)
	3/4"	167 (123)
	7/8"	275 (203)
	1"	392 (289)
	1.1/8"	520 (383.5)
	1.1/4"	785 (579)
	1.3/8"	981 (723.5)
1.1/2"	1226 (904)	

6.6 Setting impeller clearance

Please see section 5.4 for specific instructions on impeller adjustment.

6.7 Disassembly



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



- Before dismantling the pump make sure that the power supply is turned off. Pump controls are in off position, locked and tagged.
- Ensure genuine Flowserve replacement parts are available on hand.
- Refer to sectional drawings for part numbers and identification.
- Contact Flowserve for repair/disassembly/ rework instructions as each order is different and are made specific to the requirements.



Please take precaution during disassembly that there is no risk of explosion due to

the nature of the materials/tools/equipment/method used. Wherever chemical and hazardous materials are involved, proper safety rules have to be followed to prevent any dangers to human lives or livestock. Contact Flowserve for guidance, or local regulatory agency for specific safety information.

6.7.1 Pump dismantling instructions


See the dedicated Sectional Drawing referred to the specific pump to identify the components and the codes.

Note:

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 assembly. Protect all machined faces against metal-to-metal contact and corrosion.

- Switch off, lock and tag motor circuit breakers. Disconnect all cables/wires and cooling water pipe connections to the driver (if provided).
- Switch off, isolate and tag all instrumentation and monitoring equipment (if installed).
- Close pump suction valve. If discharge valve has not already been closed, this must be done prior to dismantling.
- Close pump suction vent
- Remove pump coupling guards.
- If the pump has a thrust bearing separate from the driver, drain bearing house of oil and remove the oiler.
- Disconnect and remove all auxiliary piping lines.
- Remove the coupling bolts between pump and motor coupling hubs.
- Remove bolts that secure motor to motor stool.
- Attach a sling to motor lifting eyes and lift motor vertically until driver coupling clears motor stool.
- Provide a suitable support and lower the motor on it.
- If the motor stool is not integrated with the discharge head, loosen the bolts fixing the motor stool to the discharge head, and remove it, if there's no thrust bearing on it. If the thrust bearing is placed on the motor stool, remove the motor stool after the removal of the thrust bearing.
- Remove bolts and withdraw coupling spacer.
- Remove pump coupling hub, using a puller and/or applying heat if necessary. Remove the coupling key.
- If the pump is equipped with mechanical seal, loosen mechanical seal drive collar set Screws. Insert first locking tabs into shaft sleeve groove. If the pump is equipped with packing seal, loose seal packing.

- p) If a rigid coupling is installed between the thrust bearing and the sealing device, remove bolting of the coupling spacer. Turn rotor adjusting nut enough to remove rigid coupling spacer. Remove the spacer.
- q) Turn rotor adjusting nut until rotor rest on bottom suction case.
- r) Disconnect suction piping (if present on the pump) and the discharge piping.
- s) Lifting of short set pumps:
Refer back to section 2.3.
 - Remove bolts that secure pumps to support beam or foundation
 - Attach a sling to pump lifting hooks and the lift the pump vertically
 - If present, unbolt and move aside pump support beams
 - Draw the entire pumping unit out of the foundation opening
 - Position pump horizontally on suitable supports for disassembly in a safe and clean area
 - Refer to the following dismantling instruction
- t) Lifting of deep set pumps:
 - Remove bolts that secure pumps to support beam or foundation
 - If installed, remove the rigid coupling spacer
 - If installed, remove the thrust bearing assembly with the motor stool
 - Remove the coupling hubs
 - Remove stuffing box and Mechanical seal (or packing seal) completely. Protect the shaft against damage while lifting the discharge head
 - Lift the pump just enough to access the first column pipe flange connection. Refer back to section 2.3.4
 - Support the entire pump just below the first column pipe joint
 - Disconnect the discharge head and lift. Refer back to section 2.3.1
 - Now lift the pump again by using column pipe flange and disconnect the first section of column piping
 - Remove shaft couplings and repeat the process until all column piping is disassembled
 - Last step is to lift and remove the bowl assembly. Refer back to section 2.3.2
- a) If installed, unbolt and remove complete thrust bearing assembly . At this point if it's desirable to dismantle the bearing assembly, proceed as follow:
 - Remove rotor adjusting nut and key
 - Remove thrust bearing fan security grid and cooling fan
 - Remove thrust bearing cover deflector. Unscrew grub screws first.
 - Unbolt and remove cover form thrust bearing housing
 - Remove spring and shaft guide sleeve complete with line bearing, locking nut and thrust bearing
 - Unscrew locking nut and pull out thrust bearing
 - Pull out line bearing
- b) If not done previously, remove bolts that secure motor stool to pump head. Remove motor stool.
- c) Remove the pump rigid coupling hub from the pump shaft and its key.
If a mechanical seal is installed, remove the mechanical seal cartridge.

 For details on the dismantling of the mechanical seal cartridge refer to the seal manufacturer manual.
If the pump is equipped with packing seal, remove the packing rings.
- d) Remove the stuffing box.
- e) Disconnect pump head from top column pipe.
- f) Slip pump head off top shaft.
- g) Disconnect top column pipe and remove it from top shaft.
- h) Disconnect top shaft from lineshaft proceeding as follow:
 - Remove shaft coupling retaining spirolox ring
 - Slide shaft coupling back and remove split collar
- i) Repeat above steps to disconnect all intermediate column pipes and shafting until case assembly is reached

6.7.3 Hydraulic section dismantling instructions

Disassembly the case assembly as follow:

- a) Disconnect lower suction case
- b) Withdraw form casing pump shaft with impeller.
- c) Remove impeller locking nut
- d) Remove impeller and key

6.7.2 Pump dismantling instructions

If the pump has dismantled fully assembled, proceed as follow:

6.8 Examination of parts

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

Before proceeding with assembly, thoroughly clean all bolts, nuts, threaded connections and mating faces. Clean up any burrs with a file or emery cloth. It should be remembered that when the parts in new or good condition with metal seats are assembled in contact with dirt or worn parts, the new parts are very likely to wear out rapidly.

CAUTION Cleanliness and proper lubrication are required to guarantee ease of re-assembly and proper pump operation.

6.8.1 Maintenance of wear rings

Refer to the dedicated sectional drawing to check if the wear rings are installed or not.

Check the clearances between static and rotating parts and compare them with the value stated in section 6.8.1.3.

When the original clearance has doubled, the new wear rings should be installed to obtain correct tolerances.

6.8.1.1 Impeller wear ring

Impeller wear 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 that the impeller is not damaged during this operation. Preferably remove rings by mechanical turning.

To fit new wearing rings, place rings in an industrial oven and heat to 120°C (250 °F). Slip the heated rings over the impeller seat and press home, ensuring they are firmly seated before cooling.

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.

6.8.1.2 Casing wear ring

New casing wear rings must be shrunk by freezing then installed in casing. Chill rings to -20°C (-4 °F). Fit and secure with a locking pin.

Generally, it's recommended that the rings should be renewed or overhauled when the original clearance has doubled. This will be dependent upon the required pump performance. For operating clearances at wearing rings see following section 6.8.1.3.

On double ring units, renewal of the clearance can be accomplished by re-boring the stationary ring to a slightly larger diameter and replacing the impeller ring with an oversize ring. The next repair should be made by turning down the impeller ring and by replacing the stationary ring with an undersized ring. By alternately renewing or re-machining the two rings, each ring can be used two or more times.

6.8.1.3 Minimum diameter clearances

Wear ring Nominal diameter	Minimum diameter clearance API standard Wear ring	
	Cast Iron / Bronze 12% Cr Steel	316 SS steel Carbon steel
mm	mm	mm
76.2 ÷ 88.8	0.36	0.49
88.9 ÷ 126.9	0.40	0.53
127 ÷ 152.3	0.43	0.56
152.4 ÷ 177.7	0.46	0.59
177.8 ÷ 203.1	0.48	0.60
203.2 ÷ 228.5	0.50	0.63
228.6 ÷ 253.9	0.53	0.66
254 ÷ 279.3	0.56	0.69
279.4 ÷ 304.7	0.59	0.72
304.8 ÷ 330.1	0.61	0.74
330.2 ÷ 355.5	0.64	0.77
355.6 ÷ 380.9	0.66	0.79
381 ÷ 406.3	0.69	0.82
406.4 ÷ 431.7	0.71	0.84
431.8 ÷ 457.1	0.74	0.87
457.2 ÷ 482.5	0.76	0.89

Wear ring Nominal diameter	Minimum diameter clearance API standard Wear ring	
	Cast Iron / Bronze 12% Cr Steel	316 SS steel Carbon steel
in	in	In
3 ÷ 3.49	0.0141	0.0193
3.5 ÷ 4.99	0.0157	0.0209
5 ÷ 5.99	0.0169	0.0220
6 ÷ 6.99	0.0181	0.0232
7 ÷ 7.99	0.0189	0.0236
8 ÷ 8.99	0.0197	0.0248
9 ÷ 9.99	0.0209	0.0260
10 ÷ 10.99	0.0220	0.0279
11 ÷ 11.99	0.0232	0.0283
12 ÷ 12.99	0.0240	0.0291
13 ÷ 13.99	0.0252	0.0303
14 ÷ 14.99	0.0260	0.0311
15 ÷ 15.99	0.0272	0.0323
16 ÷ 16.99	0.0279	0.0331
17 ÷ 17.99	0.0291	0.0342
18 ÷ 18.99	0.0299	0.0350

6.8.2 Maintenance of shaft./s and shaft sleeves

When the pump is dismantled, all shafting should be examined carefully for corrosion, wear and distortion. The impeller hub fit on the lower shaft should be checked for rusting or pitting. All keyways should be checked for tight key fit since a loose fit subjects the shafting to shock loading.

Replace a shaft that is bent or distorted. If the shaft shows wear at the impeller hub or a sleeve location, it may be possible to rebuilt it by metal spraying or plating and regrinding. This repair should only be carried out by trained and competent personnel. After a shaft has been repaired, check it for possible run-out. Recheck it after complete assembly of the rotor.

All shaft sleeves should be checked for wear prior to reassemble of the pump. Any sleeve indicating wear should be replaced.

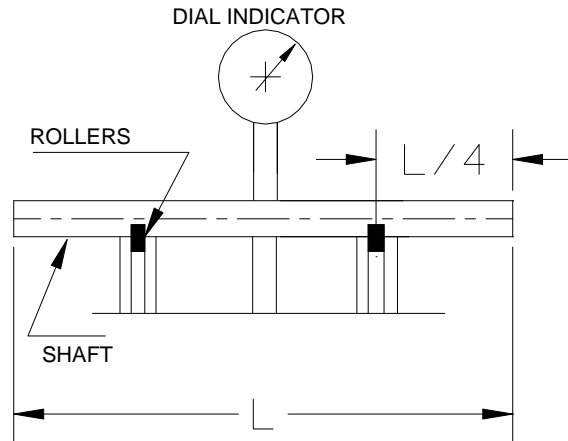
Shaft sleeve on intermediate shafting are shrunk in position to match the bearing bushings.

Remove worn sleeves by mechanical turning.

To fit new sleeves, place sleeves in an industrial oven and heat at 120°C (250°F). Slide the heated sleeves onto the shaft in position.

Check the shafts for straightness, pitting and wear. Remove all burrs or nicks. Shaft damage is usually best corrected by replacing the shaft.

The detail below shows the recommended method for checking shaft straightness.



6.8.3 Maintenance of shaft guide bushings

Check all bearings for total clearance over the shaft. It is recommended that all bearings indicating visual wear be replaced. In addition, any bearings whose running clearance exceeds "As New" tolerances by more than 50% should be replaced.

"As new " diametrical clearance are 0.2 ÷ 0.3 mm (0.008÷0.012 in).

Worn bearings can cause pump vibration and can result in damage to the wearing rings and mechanical seal.

Bearing bushings are pressed in their seats. Remove worn bushings by mechanical turning. To fit the new bushings use a suitable press.

Note:

Rubber bearings should always be replaced when servicing a pump.

6.8.4 Maintenance of thrust bearing (if provided)

Anti- friction bearings are shrunk on the shaft guide sleeve. 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 and therefore no longer usable.

Check always the bearing immediately after removal for any imperfections or any play between the races. It is recommended that new bearings are used for replacement of removed bearings since it happens

very often that the damages caused by removal cannot be detected until the pump is put into operation.

When mounting anti-friction bearings on the pump shaft guide sleeve it has to be remembered that the satisfactory operation of anti-friction bearings requires that the inner is firmly held on the sleeve so that it cannot turn on the sleeve.

Heat the bearing to expand the inner race and shrink it on the sleeve.

Place the bearing on a shelf in a temperature controlled oven, A temperature of 80°C (175°F) 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 sleeve with a feeler gage to make sure it is pressing firmly against the shoulder.


Note: In case the pump is equipped with tilting pads bearings, please refer to dedicated instruction provided with the specific pump documentation or refer to the nearest Flowserve center for advice.

6.8.5 Maintenance of the bearing house (if provided)

Thoroughly flush and clean the oil passages. Remove all scale and deposit in the water circulation coil (if installed) by chemical treatment when necessary.

6.8.6 Maintenance of bowl assembly

 When repairing a bowl assembly that has been in service for several years, the physical condition or strength of all parts such as cap screws, bowls and bowl threads must be carefully checked.

 **CAUTION** When attempting to rework any part, extreme care must be taken to maintain alignment of mating parts and ensure “as new” tolerances.

The inspection, disassembly of bowl assembly requires expertise and tools to perform the job correctly. It is recommended to seek the services of Flowserve trained technicians to inspect and repair bowl assemblies.

6.8.6.1 Maintenance of casing

The casing waterways should be kept clean and clear of rust.

New O-rings shall be installed whenever the pump is disassembled.

6.8.6.2 Maintenance of impeller

Clear all passageways and check for signs of damage from abrasion or corrosion. Replace an impeller that shows signs of excessive wear.

Slightly eroded parts can be repaired by welding. Dynamically balance impellers after any machine or repair work

6.8.7 Maintenance of seals

6.8.7.1 Replacing packing (when provided)


A good grade of graphite braided asbestos free packing shall be used. Do not under any circumstances use flax packing in the pump, as rapid wear of the sleeve may result.


Inspect shaft or sleeve for score marks or rough spots. Be sure by-pass holes (if supplied) are not plugged. Repair or replace badly worn shaft or sleeve.


The following procedure shall be followed in repacking the stuffing box.

1. Loosen the stuffing box gland.
2. Remove the old packing with a packing puller and clean the stuffing box.
3. Make sure the packing to be used is of correct type and size. Measure stuffing box to determine proper length of packing. Packing should be cut long enough (approximately 1.5 mm longer than measured) to endure that the OD of the packing rings hugs the stuffing box rather than the sleeve.
4. Oil inside and outside of replacement rings lightly and Insert each ring of packing separately, pushing it as far as possible into the stuffing box and seating it firmly. Stagger the rings so that the joints are 90° or 180° apart.
5. After inserting the required number of rings of packing, the seal cage can be inserted. It is important to make sure it is located directly under the sealing connection and that the insertion of successive rings will not displace it.
6. Continue adding more rings of packing. When the required number of packing rings has been inserted, install the gland and tighten the gland nuts by hand; then back off the nuts until the gland is loose. In tightening the gland the nuts should be brought up uniformly so that the gland will not be cocked and so that the packing is subject to uniform pressure.

7. New packing has to be run-in. It is good practice to start the pump with the stuffing box gland quite loose. After the pump has been running for approximately 10 to 15 minutes, gradually tighten the stuffing box gland until leakage is reduced to a constant drip. Package that is too tight in the box will cause undue friction, creating heat which will glaze the packing and possibly score the shaft sleeves. Packing must remain soft and pliable.

 **CAUTION** It may be impossible to add the last ring of packing in the stuffing box and still insert the gland. When this occasion arises, omit the last ring of packing and tighten the gland. Continue to tighten the gland at periodic intervals (daily), allowing for proper leakage, until the packing has seated itself well enough to allow the final ring to be inserted.


 **CAUTION** Should the new packing cause excessive heating during "run-in", flush the shaft and packing box area with cold water or shut the pump down and allow to cool.

 **CAUTION** For all repair instructions please call Flowserve representative or customer service with the order no. and unit details for specific repair instruction literature.


All repair work to be carried out by trained and authorized personnel only. Flowserve's written permission may be required for any disassembly/repair of the pump that is still under warranty.

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


6.8.7.2 Maintenance of mechanical seals (when installed)

 Refer to the seal manufacturer manual for specific instructions.


6.8.8 Maintenance of driver

 Refer to the driver manufacturer manual for specific instructions.

6.8.9 Maintenance of coupling and gearbox

 Refer to the coupling or gear manufacturer manual for specific instructions.

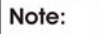
6.8.10 Maintenance of flushing systems, accessories and instruments (if provided)

 Refer to the specific manufacturer manual for instructions.


6.9 Reassemble procedure



To assemble the pump, reverse the dismantling procedure previously described.

Refer to the dedicated cross sectional drawing to identify the different parts.

 **Note:** The pump that has been purchased may have order specific assembly and parts configurations. Refer to the dedicated documentation or to Flowserve personnel for information.

It is recommended to call for trained Flowserve technicians for all your assembly needs.

 Refer to seal manufacturer's instructions for disassembly and re-assembly of mechanical seals.

  Please take precaution during assembly process such that there is no risk of explosion due to the nature of the materials/tools/equipment/methods used. Wherever chemicals and hazardous materials are involved, proper safety rules must be followed to prevent any dangers to human lives or livestock. Refer to applicable local regulatory agency requirements for specific safety information.

If headroom permits, it is recommended that the pump be assembled in a horizontal position and be lowered as one complete unit into the foundation opening.

6.9.1 Casing assembly

- a) Install key and impeller on pump shaft.
- b) Install impeller locking nut.
- c) If pump casing is split in two parts , assembly the upper part of the casing and the upper suction bell.
- d) Install rotor into casing.
- e) Install lower suction case.

6.9.2 Shafting and columns

- a) Slide coupling on column shaft, displacing it far enough to permit insertion of the key and the slit collars.
- b) Bring column shaft end in contact with lower shaft end face and align them provisionally.
- c) Install the key and the split collars.

- d) Slide back coupling and install the retaining ring.
- e) Fit the O-ring in place, install and bolt column to its correspondent flange.
- f) Repeat above steps to install the complete shafting and all columns.

6.9.3 Pump completion

- a) Fit O-ring in place, install and bolt discharge head to top column.
- b) Fit O-ring in place, install and bolt stuffing box to discharge head.
- c) If the pump is provided with packing seal, assemble packing. If the pump is provided with mechanical seal, install mechanical seal cartridge and bolt seal end plate in position.



At this stage do not lock mechanical seal sleeve to pump shaft and do not remove locking tabs.

- d) If rigid coupling is provided, install rigid coupling key, half coupling, coupling nut and coupling nut screws. Align the coupling hubs with a max tolerance of 0.025 mm (0.001 in).
- e) If provided, install rigid coupling spacer.
- f) Push pump shaft until rotor rests on lower suction case.
- g) Install motor stool.
- h) If provided, install complete thrust bearing assembly with rigid half coupling in place. Bolt rigid coupling spacer. If no rigid coupling is provided, install the bearing house directly on the shaft.
- i) If flexible coupling is provided, install flexible coupling key and pump half coupling. Pre-heat coupling hub to approx. 150 °C (300°F).

6.9.4 Pump re-installation

- a) Lift pump vertically and lower it down into foundation opening. Refer back to section 2.3.
- b) Secure pumps discharge head to foundation plate or discharge beams, whichever is provided.
- c) For pump in can, secure pump discharge head to can flange.
- d) Bolt pump nozzle(s) to discharge (and suction- in case of pump in can) piping.
- e) Set the driver as described under Chapter 4 of this manual.
- f) Check driver/driven shaft alignment and assemble the coupling between the two shafts.
- g) Position pump shaft axially acting on adjusting nut so that space between coupling halves is as specified on pump elevation drawing.
- h) Screw adjusting nut locking screws.
- i) If the pump is provided with mechanical seal, lock mechanical seal sleeve to pump shaft and remove locking tabs.
- j) Replace all auxiliary piping, systems, instrumentation and pipe plugs.
- k) If the pump has a thrust bearing in the pump, install oilier and fill thrust bearing house to correct oil level (refer to section 5.3).
- l) Install coupling guards.
- m) Refer to Chapter 5 for commissioning and starting procedure.



7 FAULTS; CAUSES AND REMEDIES

FAULT SYMPTOM

Pump overheats and seizes									
↓	Pump will not run								
↓	↓	Pump vibrates or is noisy							
↓	↓	↓	Mechanical seal has short life						
↓	↓	↓	↓	Mechanical seal leaks excessively					
↓	↓	↓	↓	↓	Pump requires excessive power				
↓	↓	↓	↓	↓	↓	Motor Overloaded			
↓	↓	↓	↓	↓	↓	Insufficient pressure developed			
↓	↓	↓	↓	↓	↓	Insufficient capacity delivered			
↓	↓	↓	↓	↓	↓	Pump runs but does not deliver liquid			
						POSSIBLE CAUSES		POSSIBLE REMEDIES	
						A. SYSTEM PROBLEMS			
●					●	Pump not submerged.		Check requirements/liquid level. Vent and/or prime.	
	●				●	Impeller not adjusted or loose on shaft.		See PART/2-Section A7 for proper impeller adjustment.	
		●			●	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.	
					●	Line check valve backward/stuck.		Reverse chuck valve /free the valve.	
					●	Unit running backwards.		See start up instruction. Check motor phase/wiring	
	●				●	Air or vapor pocket in suction line.		Check suction line design for vapor pockets.	
					●	Air leaks into suction line.		Check suction pipe is airtight.	
	●				●	Intake strainer or impeller plugged or pump in mud or sand.		Start and stop several times or use line pressure if available to back flush or pull pump to clean.	
	●				●	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 or consult Flowserve.	
					●	Total system head is lower than pump design head.			
					●	Specific gravity of liquid different from design.		Check and consult Flowserve. Check the pump design for the type of liquid to be handled. Consult Flowserve.	
					●	Viscosity of liquid differs from the designed.			
●	●					Operation at very low capacity.		Measure. Check minimum permitted. Consult Flowserve.	
●	●					Operation at high capacity.		Measure value and check maximum permitted. Consult Flowserve.	
						B. MECHANICAL PROBLEMS			
●	●	●	●	●		Misalignment due to pipe strain.		Check the flange connections and eliminate strains using elastic couplings or a method permitted.	
	●					Improperly designed foundation./Loose fasteners.		Check setting of base plate. Tighten, adjust, grout base as required. Check fasteners and torque.	
	●	●	●	●		Shaft bent.		Check shaft run outs. Consult Flowserve.	
●	●	●		●	●	Rotating part rubbing on stationary part.		Check. Consult Flowserve, if necessary.	
●	●	●	●	●		Bearings worn.		Replace bearings.	

FAULT SYMPTOM

Pump overheats and seizes								
⇓ Pump will not run								
⇓ Pump vibrates or is noisy								
⇓ Mechanical seal has short life								
⇓ Mechanical seal leaks excessively								
⇓ Pump requires excessive power								
⇓ Motor Overloaded								
⇓ Insufficient pressure developed								
⇓ Insufficient capacity delivered								
⇓ Pump runs but does not deliver liquid								
						POSSIBLE CAUSES	POSSIBLE REMEDIES	
		●	●	●		Wearing ring surfaces worn.	Replace worn wear ring/surfaces.	
	●			●	●	Impeller damaged or eroded.	Replace. or consult Flowserve for an upgrade.	
		●				Leakage under sleeve due to joint failure.	Replace joint and check for damage.	
		●	●			Shaft sleeve worn, scored, or running off center.	Check and renew defective parts.	
		●	●			Mechanical seal improperly installed.	Check alignment of faces/damaged parts/assembly	
		●	●			Incorrect type of mechanical seal.	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. Consult Flowserve for problem resolution ideas.	
		●	●	●		Solids/Abrasive particles in liquid pumped.		
			●	●		Internal misalignment of parts preventing seal ring and seat from mating properly.		
			●	●		Mechanical seal was run dry.	Check mechanical seal/flush supply/pump and repair.	
		●	●	●		Internal misalignment due to improper repairs causing impeller to rub.	Check method of assembly, possible damage or state of cleanliness during assembly. Check and consult Flowserve, if necessary.	
●	●	●				Excessive thrust caused by a mechanical failure inside the pump.	Check wear condition of impeller, its clearances and liquid passages.	
●	●					Excessive grease in ball bearings.	Check method of re-greasing.	
	●	●				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 and consult Flowserve, if necessary.	
	●	●				Damaged bearings due to contamination.	Check contamination source and replace bearings.	
C. MOTOR/ELECTRICAL PROBLEMS								
	●			●	●	●	Wrong direction of rotation.	Reverse 2 phases at motor terminal box.
	●						Motor Protector open.	Check nameplate for voltage and current rating. Replace faulty motor protectors.
					●		Line voltage not correct/faulty control box/wiring/low voltage.	Check wiring diagram.
	●						Blown fuse/breaker open/dead motor/short or loose connection.	Check/repair or replace fuses/breakers.
				●		●	Motor running on 2 phases only.	Check supply and fuses.
	●	●				●	Motor running too slow.	Check motor terminal box connections and voltage.

8 PARTS LIST AND DRAWINGS

8.1 Cross section:

Please refer to the dedicated Cross sectional drawing issued with the P.O., as to identify the different parts and features of the pump bought.

The construction features of the pump vary depending on the specific pumped fluid, specifications applied.



NOTES:

A series of 25 horizontal dashed lines provided for taking notes.



NOTES:

A series of horizontal dashed lines providing space for handwritten notes.



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