



USER INSTRUCTIONS

APKD

Double-Case, Double Suction Vertical Pump

PCN=26999903 07-13 (E) "Original Instructions"

Installation Operation Maintenance



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

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1 INTRODUCTION AND SAFETY

1.1 General

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

Flowserve products are designed, developed and manufactured with state-of-the-art technologies in modern facilities. The unit is produced with great care and commitment to continuous quality control, 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 of the efforts of Flowserve Corporation to provide comprehensive instructions, good engineering and safety practice should always be used.

Flowserve manufactures products to exacting International Quality Management System Standards as certified and audited by external Quality Assurance 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.

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

 **GUARDS MUST NOT BE REMOVED WHILE THE PUMP IS OPERATIONAL**

 **DRAIN THE PUMP AND ISOLATE PIPEWORK BEFORE DISMANTLING THE PUMP**

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

 **FLUORO-ELASTOMERS (When fitted.)**
When a pump has experienced temperatures over 250 °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.

 **APPLYING HEAT TO REMOVE IMPELLER**
There may be occasions when the impeller has either been shrunk fit on to the pump shaft or has become difficult to remove due to products of corrosion.

If you elect to use heat to remove the impeller, it must be applied quickly to the impeller boss. **TAKE GREAT CARE!**

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 vapour. This must be carried out with the shaft in the vertical position. On some pump sizes a cavity exists in the impeller bore so on occasions a significant volume of liquid may drain out.

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



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.



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.



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 start-up, operation and shutdown.*)



CAUTION

NEVER RUN THE PUMP DRY



CAUTION

INLET VALVES TO BE FULLY OPEN WHEN PUMP IS RUNNING

Running the pump at zero flow or below the recommended minimum flow continuously will cause damage to the pump and mechanical seal.



CAUTION

DO NOT RUN THE PUMP AT ABNORMALLY HIGH OR LOW FLOW RATES

Operating at a flow rate higher than normal or at a flow rate with no back pressure on the pump may overload the motor and cause cavitation. Low flow rates may cause a reduction in pump/bearing life, overheating of the pump, instability and cavitation/vibration.

1.6.1 Products used in potentially explosive atmospheres



Measures are required to:

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

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

1.6.1.1 Scope of compliance



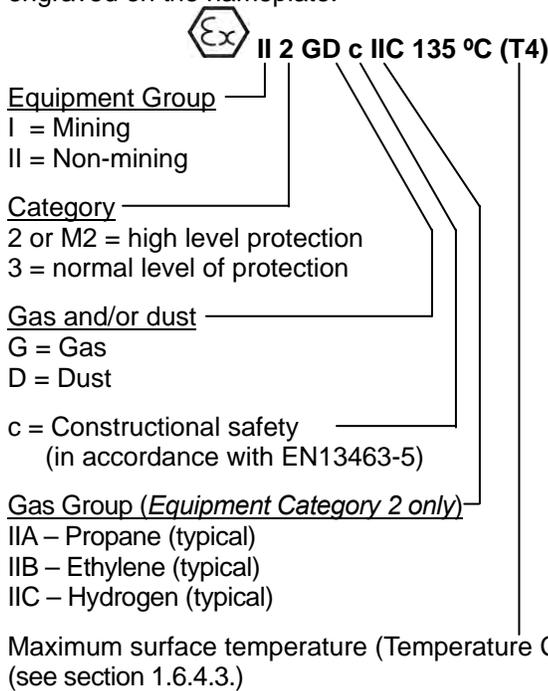
Use equipment only in the zone for which it is appropriate. Always check that the driver, drive coupling assembly, seal and pump equipment are suitably rated and/or certified for the classification of the specific atmosphere in which they are to be installed.

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 so, for pumps sets with a VFD, the ATEX Certification for the motor must state that it covers the situation where electrical supply is from the VFD. This particular requirement still applies even if the VFD is in a safe area.

1.6.1.2 Marking

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



1.6.1.3 Avoiding excessive surface temperatures

ENSURE THE EQUIPMENT TEMPERATURE CLASS IS SUITABLE FOR THE HAZARD ZONE

Pumps have a temperature class as stated in the ATEX Ex rating on the nameplate. These are based on a maximum ambient of 40 °C (104 °F); refer to Flowserve for higher ambient temperatures.

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

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

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

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

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

Temperature classification “Tx” is used when the liquid temperature varies and the pump could be installed in different hazardous atmospheres. In this case the user is responsible for ensuring that the pump surface temperature does not exceed that permitted in the particular hazardous atmosphere.

If an explosive atmosphere exists during the installation, do not attempt to check the direction of rotation by starting the pump 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, fit an external surface temperature protection device.

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

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

1.6.1.4 Preventing the build up of explosive mixtures

ENSURE THE PUMP IS PROPERLY FILLED AND VENTED AND DOES NOT RUN DRY
Ensure the pump and relevant suction and discharge pipeline system is totally filled with liquid at all times during the pump operation, so that an explosive atmosphere is prevented. In addition it is essential to make sure that seal chambers, auxiliary shaft seal systems and any heating and cooling systems are properly filled.

If the operation of the system cannot avoid this condition fit an appropriate dry run protection device (for example liquid detection or a power monitor).

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

1.6.1.5 Preventing sparks



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

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



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

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

Additional requirement for metallic pumps on non-metallic baseplates

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

1.6.1.6 Preventing leakage



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

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

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

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

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

1.6.1.7 Maintenance to avoid the hazard



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

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

To avoid potential explosion hazards during maintenance, the tools, cleaning and painting materials used must not give rise to sparking or adversely affect the ambient conditions. Where there

is a risk from such tools or materials, maintenance must be conducted in a safe area.

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

1.7 Safety labels summary

1.7.1 Nameplate

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

1.7.2 Safety labels

FLOWSERVE		WARNING	J218JZ250
ESSENTIAL PROCEDURES BEFORE STARTING:			
INSTALL AND OPERATE EQUIPMENT IN ACCORDANCE WITH THE INSTRUCTION MANUAL SUPPLIED SEPARATELY. ENSURE GUARDS ARE SECURELY IN PLACE. ENSURE CORRECT DIRECTION OF ROTATION.	ENSURE ALL EXTERNAL CONNECTIONS TO THE PUMP / SHAFT SEALING AND DRIVER ARE CONNECTED AND OPERATIONAL. FULLY PRIME UNIT AND SYSTEM. DO NOT RUN UNIT DRY.	FAILURE TO FOLLOW THESE PROCEDURES MAY RESULT IN PERSONAL INJURY AND / OR EQUIPMENT DAMAGE	

J218/268	
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.	PUMP MUSS AUF FESTEM FUNDAMENT STEHEN. KUPPLUNGSHÄLFTEN KORREKT AXIAL AUSRICHTEN, DANN PUMPE AUF GRUNDPLATTE FESTSPANNEN UND ANSCHLUSSLEITUNGEN BEFESTIGEN. TOLERANZEN S. BEDIENUNGSANLEITUNG.
S'ASSURER QUE LE GROUPE ELECTROPOMPE EST FERMEMENT INSTALLE SUR SON MASSIF. VERIFIER LE LIGNAGE DE L'ACCOUPLLEMENT AVANT ET APRES FIXATION DU SOCLE ET DE LA TUYAUTERIE. VOIR LES TOLERANCES D'ALIGNMENT SUR LA NOTICE	ZORG DAT POMPEENHEID OP EEN STEVIGE ONDERGROND OPGESTELD STAAT EN DAT KOPPELINGS CORRECT UITGELIJNT IS ZOWEL VOOR ALS NADAT DE GRONDPLAAT MET BOUTEN IS VASTGEZET EN DE LEIDINGEN GEINSTALLEERD ZIJN. ZIE HANDLEIDING VOOR TOELAABARE SPELINGEN.
CDC: 603 604 610 612 621 623 624	

Oil lubricated units only:

J218JZ262	
WARNING ATTENTION ACHTUNG WAARSCHUWING	THIS MACHINE MUST BE FILLED WITH OIL BEFORE STARTING CETTE MACHINE DOIT ÊTRE REMPLIE D'HUILE AVANT LA MISE EN MARCHÉ DIESE MASCHINE IST VOR DEM STARTEN MIT ÖL ZÜ FÜLLEN DEZE MACHINE MOET VOOR HET STARTEN MET OLIE GEVULD WORDEN
CDC: 603 604 610 612 621 623 624	

1.8 Noise level

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

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

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

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

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

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

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

For estimating sound power level L_{WA} (re 1pW) then add 17 dBA to the sound pressure value.

1.8.1 Typical vertical motor noise data

Motor Frame Size. NEMA	RPM	Sound Pressure (dBA) (WP- I enclosure)	Sound Power (dBA) (WP- I enclosure)
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
	3600	90.0	103.7
5800	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

Note:

The noise levels shown in table 1.8.1 are extracted from typical motor manufacturer’s data/catalogue to provide the average expected motor noise values at no load for reference only and are not guaranteed. The values could vary depending upon the test and surrounding conditions. The combined noise level of the pump and the motor could exceed the values shown. It is to be noted that adding motors with similar noise levels increases the total noise level. Therefore, the dB correction to the values listed above is required to obtain the combined noise levels of motor and the pump. Actual on-site noise measurement by experts is recommended and safety measures are to be taken accordingly.

1.9 Specific machine performance

For performance parameters see section 1.5, *Duty conditions*. When the contract requirement specifies these to be incorporated into User Instructions these are included here. Where performance data has been supplied separately to the purchaser these should be obtained and retained with these User Instructions if required.

2 TRANSPORT AND STORAGE

2.1 Consignment receipt and unpacking

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

Check any crates, boxes and wrappings for any accessories or spare parts which may be packed

separately with the equipment or attached to side walls of the box or equipment.

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

2.2 Handling

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

2.3 Lifting

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

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

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.

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.

Note: 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.

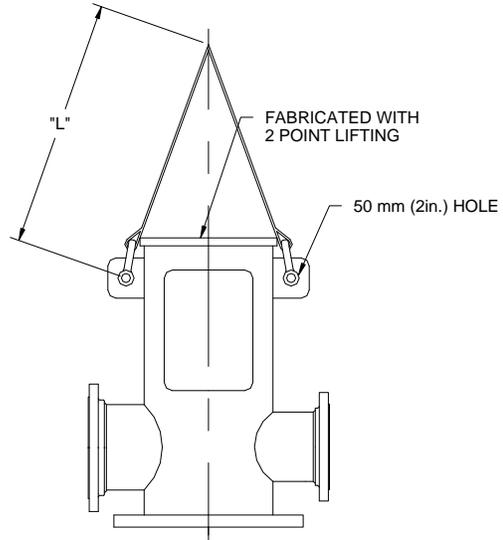
Before lifting the driver alone, refer to the manufacturer's instructions.

2.3.1 Lifting of fabricated discharge heads with or without the pump

If the pump is supplied with a fabricated discharge head use 2 point or 3 point method of lifting as shown in the details provided in 2.3.1.1 & 2.3.1.2. This method is applicable to the lifting of discharge heads with or without the pump.

2.3.1.1 Two point lifting of fabricated discharge head types TF, UF & HFH (with or without pump attached)

Figure 2.1

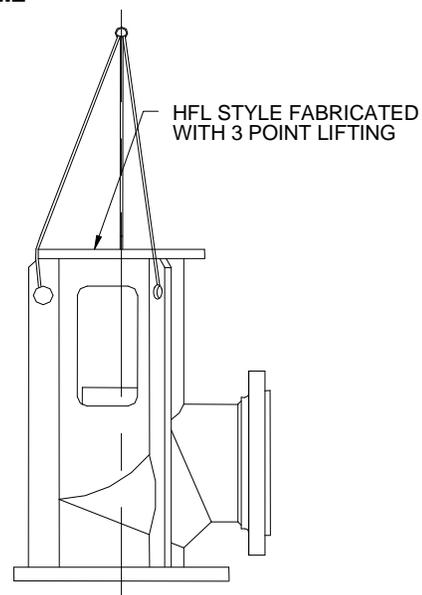


	Fabricated heads with discharge size mm (in.)				
	100 (4)	150 (6)	200 (8)	250 (10)	300 (12)
Pin Dia.	25 (1)	32 (1.25)	32 (1.25)	32 (1.25)	38 (1.5)
L	1070 (42)	1220 (48)	1220 (48)	1370 (54)	1370 (54)

"L" is approximate length

2.3.1.2 Three point lifting of fabricated discharge head of type HFL (with or without pump attached)

Figure 2.2



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

Figure 2.3

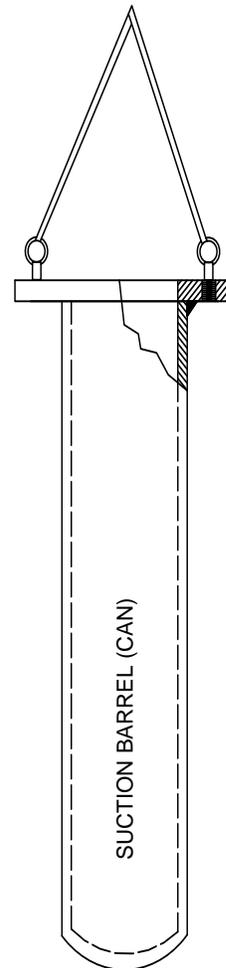


2.3.3 Lifting of suction barrel

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

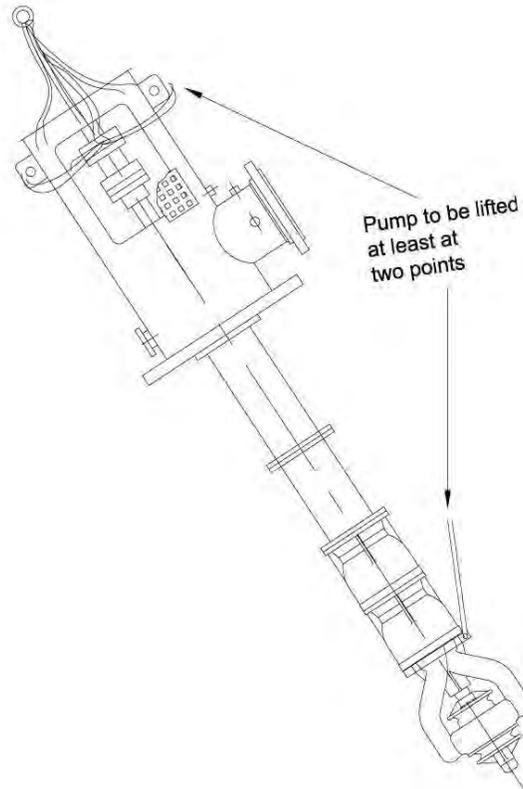
Figure 2.4



2.3.4 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.

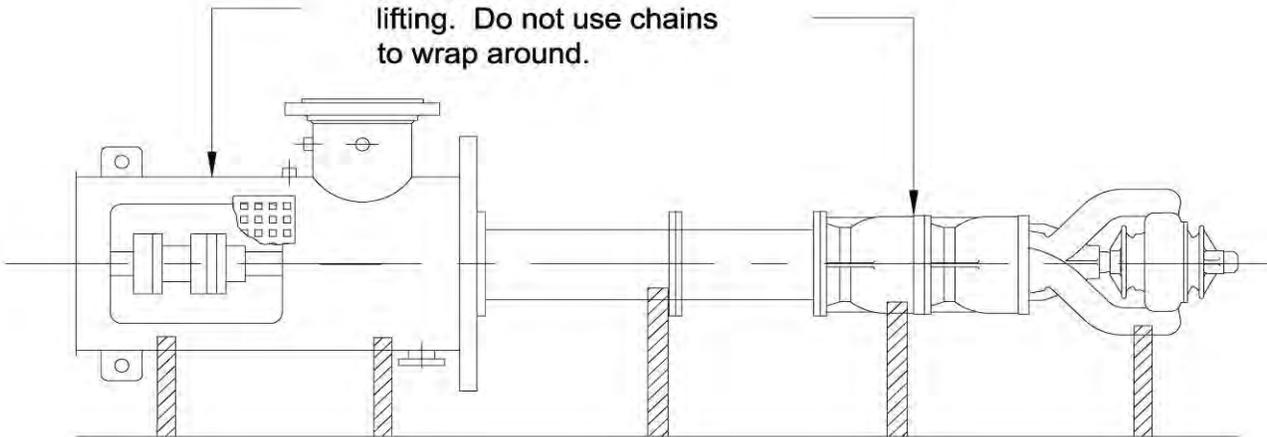
Figure 2.5



Examples shown here are for illustration only. See section 2.3 1 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.

Figure 2.6

Pump to be supported at least two places while lifting. Do not use chains to wrap around.



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 to prevent brinelling of the bearings and the seal faces, if fitted, from sticking.

2.4.1 Inspection before storage

- Inspect the preservative coating/painted surfaces on the various parts. Touch up the areas, if necessary.
- Inspect all covers over pump openings and piping connections. If found damaged, remove the covers and inspect interiors of the opening for any deposits 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. Replace covers and fasten securely.

2.4.2 Short term storage (up to 6 months)

Follow the steps given in section 2.4.1. Select a storage space so that the unit will not be subjected to excess moisture, extreme weather conditions, corrosive fumes, or other harmful conditions.

Driver storage instructions: Check driver manufacturer's User Instructions

2.4.3 Long term or extended storage

If a situation arises for a long-term storage, (more than 6 months) please contact Flowserve for special storage instructions and warranty related information.

2.5 Recycling and end of product life

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



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

3 DESCRIPTION

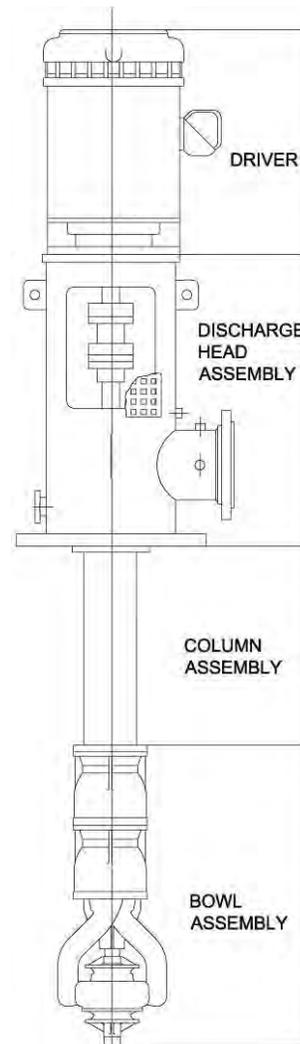
Should questions arise concerning the pump, Flowserve pump division will require the complete serial number to be of assistance. The serial number is stamped on a metal nameplate affixed to the discharge head assembly. The driver will have a separate nameplate attached to it. If you are requesting information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

3.1 Configuration

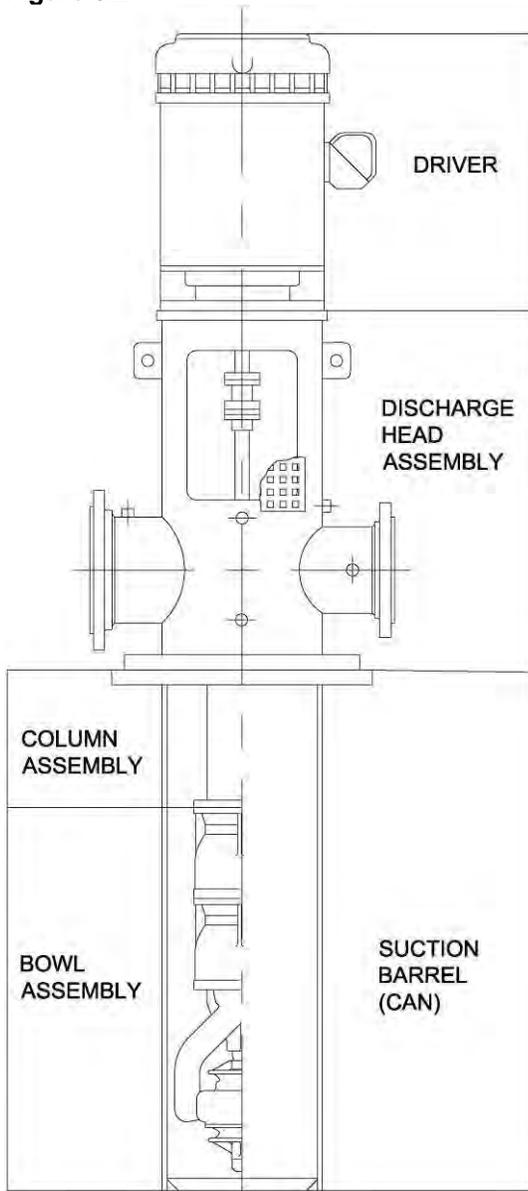
APKD's, are engineered pumps as:(a) Wet pit type and (b) suction barrel (can) type pumps. The pumps vary in size, impeller types and length, and type of discharge head used

3.1.1 Sump and deep well VTP

Figure 3.1



3.1.2 Suction barrel (Can) VTP
Figure 3.2

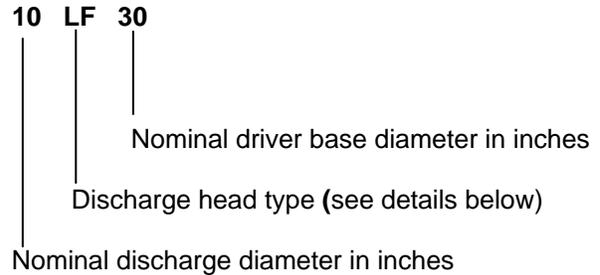


3.2 Nomenclature

The pump size/ serial number will be engraved on the nameplate typically. The nameplate is attached to the discharge head assembly. Identify the actual pump size and serial number from the pump nameplate. The driver will have a separate nameplate attached to it.

3.2.1 Discharge head nomenclature

Consists of alphanumeric code as follows.
 Examples: 10HF20, 6TF16,.....



- HF = Fabricated head for above the ground discharge
- TF & LF = Fabricated heads with base flange
- HFL = Fabricated head for above ground discharge - Low H.P
- HFH = Fabricated head for above the ground discharge -High H.P.

Please see section 3.2.1.1 for discharge head types and identification.

3.1.3 Most common VTP models

The VTP configurations shown in sec 3.1.1 and 3.1.2 are typical.

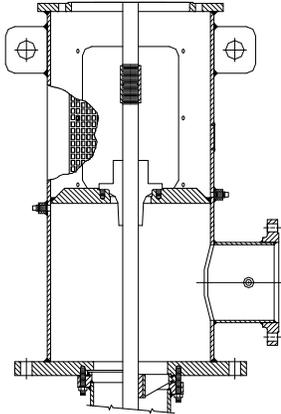
Note: Some units will not require a column assembly. In such cases, the bowl assembly is connected directly to the discharge head. Vertical turbine pumps can have single or multiple stages.

3.2.1.1 Types of discharge heads

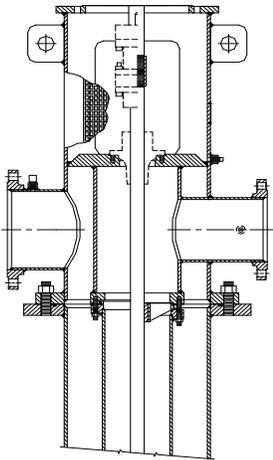
Typical discharge head types. Details (a) thru (e).

a) HF type fabricated discharge head
(Typically with square base plate)

Figure 3.3

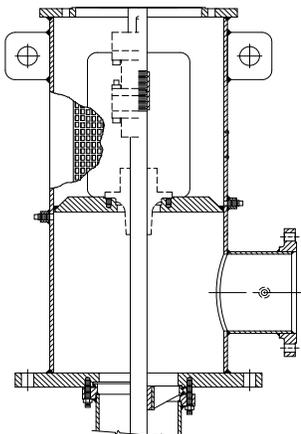


b) TF type fabricated discharge head
Figure 3.4



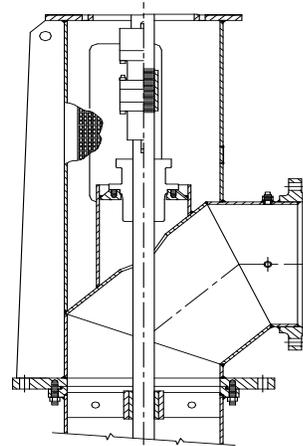
c) LF type fabricated discharge head
(Typically with a circular base plate- ANSI type.
Also available with suction barrel mounting)

Figure 3.5

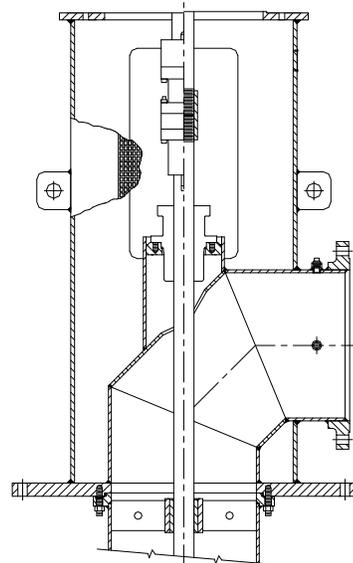


d) HFL type fabricated discharge head

Figure 3.6



e) HFH type fabricated discharge head
Figure 3.7



Note:

The discharge heads shown in section 3.2.1.1 (a) thru (e) are for illustration only. The shaft and coupling arrangements vary. For the actual configuration of the pump that has been purchased, please refer to the drawings supplied with the pump or order specific sectionals from Flowserve.

3.3 Design of major parts

3.3.1 Drivers

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.

3.3.2 Discharge Head Assembly

(See also section 3.2.2.1)

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.

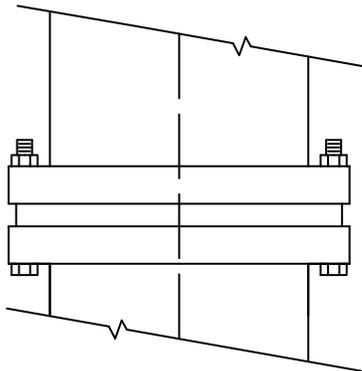
The shaft seal will usually be either a mechanical seal assembly or stuffing box with an open lineshaft or a tube-packing box with an enclosed lineshaft.

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 assembly shown below:

a) flanged column assembly

Figure 3.8



The column supports shaft assemblies, that are of an open lineshaft construction utilizing the fluid being pumped to lubricate the lineshaft bearings. The shafts are key coupled with clamp ring design.

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 Bowl assemblies

The bowl assembly consists of impellers rigidly mounted on the pump shaft coupled to an electric motor. Impellers are cast wheels with multiple diffuser vanes and are generally coated to meet the hydraulic requirements. See section 8.0 for cross sectional and part details.

3.3.5 Suction strainers

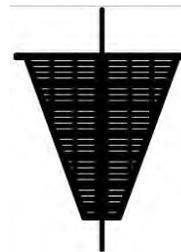
In a new installation, great care should be taken to prevent dirt, scale and welding beads from entering the pump, as it is particularly important to protect the numerous close running fits from abrasive matter present in new piping.

The suction system should be thoroughly flushed before installation the suction and making up suction piping to the pump

The suction strainer should be installed 4 pipe diameters away from suction.

Cone Type Strainer

Figure 3.9



3.3.6 Impellers

The double suction first stage impeller (3A) is keyed and held in position on pump end shaft (10A) by shaft nut. The shaft nut is secured to the shaft with set screws. The remaining single suction intermediate impellers are also keyed. Each impeller is held in position on the upper shaft by use of a split lock collar secured with cap screws. All impellers are of the enclosed type, one piece constructions, and are dynamically balanced.

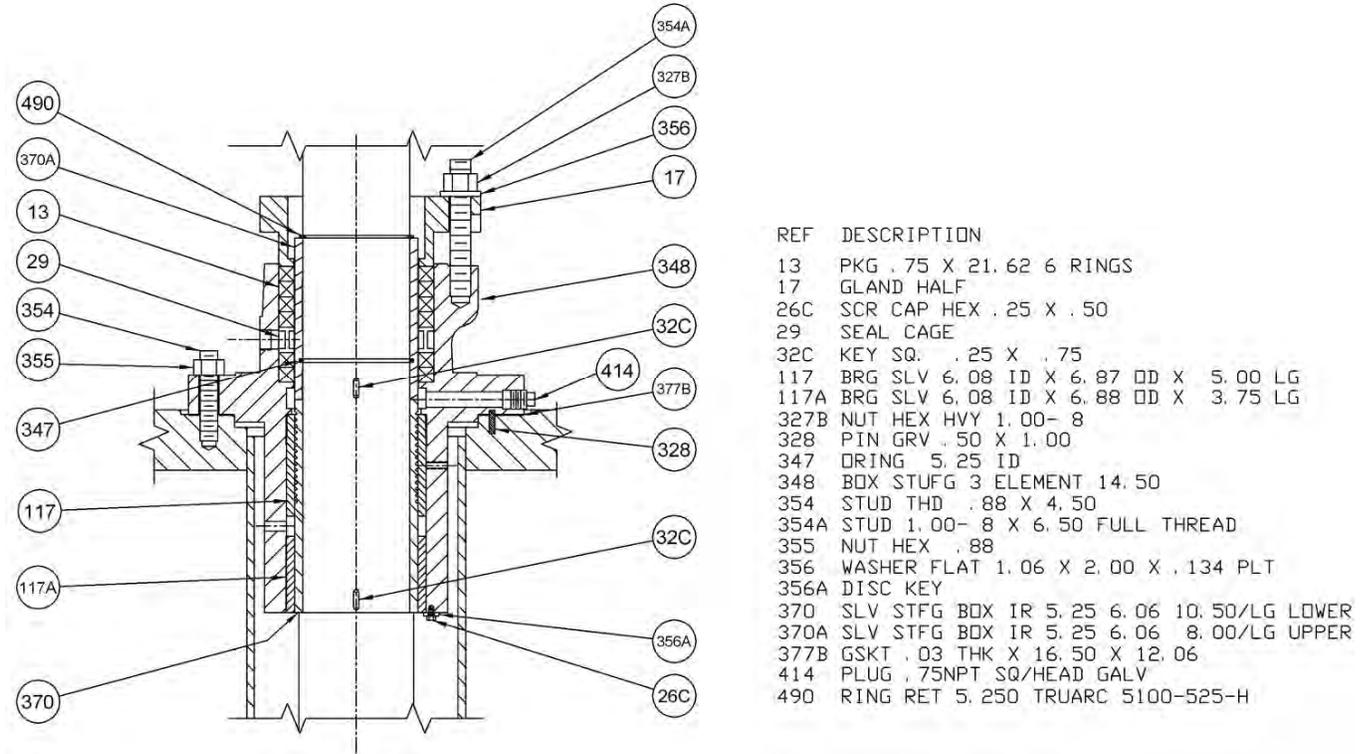
3.3.7 Stuffing box

Some APKD's are fitted with stuffing boxes. In such cases, stuffing boxes are normally adequate for working pressures up to 20.7 bar (300 psi). Refer to stuffing box User Instructions for specifications.

3.3.7.1 High pressure stuffing box

This type of packing box is fitted on to an open lineshaft for pressures up to 20 bar (300 psi) uses six rings of packing with one seal cage and allows grease lubrication.

Figure 3.10



3.3.8 Mechanical shaft seal

APKD's can also be fitted with a mechanical seal. The requirement to fit the mechanical seal to be provided at the time of contract.

3.3.9 Accessories

Accessories may be fitted when specified by the customer.

3.4 Performance and operation limits

This product has been selected to meet the specifications of the purchase order. See section 1.5.

The following data is included as additional information to help with the installation. It is typical and factors such as temperature, materials and seal type may influence this data. If required, a definitive statement for your particular application can be obtained from Flowserve. Operating limits

Pumped liquid temperature limits*	5 °C (40 °F) to +80 °C (176 °F)
Maximum ambient temperature*	Up to +40 °C (104 °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*.

Inspection prior to installation

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.

Refer to the general arrangement drawing for the pump set.

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:

Be sure to 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 Installation of pumps that are shipped unassembled

4.1.2.1 Lifting

See lifting methods in section 2.3.

4.1.2.2 Equipment and tools required for installation of unassembled pumps

The following list covers the principal tools/items required for installation.

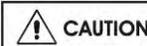
- Mobile crane capable of hoisting and lowering the pump and/or motor.
- Two (2) steel clamps of suitable size.
- Two (2) sets of chain tongs & cable sling for attaching to the pump and motor lifting eyes.
- Pipe clamp for lifting bowl assembly and the column pipe. Approximately 4.57 m (15 ft) of 19 mm (3/4 in.) diameter rope may be required.
- General purpose hand tools, pipe wrenches, end wrenches, socket set, screwdrivers, Allen wrenches, wire brush, scraper and fine emery cloth.
- Thread sealing compound designed for stainless steel and light machinery oil.

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.

4.1.2.3 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.



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

4.1.2.4 Installing the bowl and column assembly

- Sump and piping should be thoroughly cleaned of all loose debris before starting installation.
- Check all bolts for tightness.

- c) Do not lift or handle the bowl assembly by the pump shaft.
- d) If a strainer is to be used, attach it to the bowl assembly using clips and fasteners provided.
- e) Position lifting equipment so it will center over the foundation opening.
- f) If a base plate is used, level the plate to 0.08 mm per m (0.001 in. per ft) and then grout and anchor in place.
- g) Check for axial clearance or endplay and record that number for future reference (while bowls are in a horizontal position you should be able to push or pull the pump shaft indicating axial clearance).
- h) Carefully lift the suction barrel and the bowl assembly with suitable straps or clamps (See *section 2.4 for lifting and safety rules*).
- i) Lower the bowl assembly into the well or sump. Set clamp or holding device that is attached to bowls on a flat surface. This is to stabilize bowl assembly and reduce possibility of cross threading the shaft.
- j) Proceed to install the column assembly (refer to specific column pipe assembly instructions supplied with the pump).
- k) Assemble the discharge head.

4.1.2.5 Installation of discharge head

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

- a) Lift discharge head over shaft and lower carefully into place (See *section 2.3 for recommended lifting methods and safety instructions*). Be sure not to bend the shaft. Fasten the top column flange and bearing retainer, if supplied to bottom of head.
- b) Use shims or wedges between the pump and foundation to level the pump. The shaft must be centered on the discharge head.

See *section 4.1.5 for coupling installation on solid shaft drivers and section 4.3.1~4.3.4 for pump leveling details*

4.1.3 Installation of pumps that are shipped fully assembled

4.1.3.1 Lifting

See lifting methods in section 2.3.

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

- a) Mobile crane capable of hoisting and lowering the entire weight of the pump and motor.
- b) Cable sling for attaching to the pump and motor lifting eyes.
- c) Ordinary hand tools: Pipe wrenches, end wrenches, socket set, screwdrivers, Allen wrenches, wire brush, scraper and fine emery cloth.
- d) 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.

CAUTION 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.

4.1.3.3 Uncrating and cleaning of a fully assembled pump

- a) Clean the parts of all dirt, packing material and other foreign matter.
- b) Flush the pump inside and outside with clean water.
- c) Clean all machined surfaces. Remove any rust spots found on the machined surfaces with fine emery cloth.
- d) Clean all threaded connections and any accessory equipment.

4.1.3.4 Installing the fully assembled pump

If a base plate is used, level the plate to 0.08 mm per m (0.001 in. per ft), grout and anchor in place.

See sections 4.3.1~4.3.4 for pump leveling details.

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



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

Set up installation unit so that the lifting cable will be centered directly over the well or sump. Carefully lift the bowl assembly and suction barrel with a clamp. Lower the bowl assembly into the well or sump. Set the clamps or holding device that is attached to bowls on a flat surface. This is to stabilize bowl assembly and reduce possibility of cross threading the shaft.

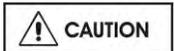
- a) When installing 152 mm (6 in.) or 203 mm (8 in.) pump assembly, leave the pump securely fastened to the wooden skid (as shipped) until the bowl assembly is raised to a vertical position
- b) Lift the pump to a vertical position. If a strainer is used, attach it to the bowl assembly.
- c) Position pump over sump or suction barrel. Align the discharge of the pump with external piping then lower onto the base. Level the entire pump.
- d) If a mechanical seal is included, install the seal at this point per the attached instructions.

4.1.4 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)

- a) Install the suction barrel first and grout the mounting flange and bolts directly to the foundation.
- b) If soleplate is used, mount and grout the soleplate and mount the suction barrel onto the soleplate.
- c) Level the soleplate & the suction barrel flange as required.
- d) Install the pump.

4.1.5 Installation of couplings on solid shaft drivers.



Clean threads on pump shaft and on adjusting nut. Check for burrs and nicks.

All burrs, nicks and rust must be removed from all mating parts of flanged coupling and pump before installation. Failure to remove all burrs, nicks and rust may result in misalignment causing pump to fail.

4.1.5.1 Installation of adjustable flanged coupling WA.

- a) The key [46A] for the driver shaft keyseat should be a snug or tight fit in the shaft keyseat, and a sliding fit in the keyseat of the driver half coupling [42].
- b) The key with pin [46] should be a sliding fit in pump shaft keyseat and a snug or tight fit in pump half coupling [44] keyseat.
- c) Side clearance of keys in keyseats should be checked with a feeler gauge. This clearance should not exceed 0.076 mm (0.003 in.) for a snug fit or 0.127mm (0.005 in) for a sliding fit. These are maximum allowable clearances. Closer fits are preferred, if possible. It may be necessary to file-dress keys to obtain proper fit.
- d) Insert the key [46] with pin into pump half of coupling [44] putting the pin in the hole in keyseat. The key should not extend below coupling.
- e) Lubricate pump coupling half and key assembly with light oil and slide it onto pump shaft [12A] with flange up. Slide it past threads.
- f) Lubricate adjusting nut [66A] with light oil and thread it onto pump shaft [12A] (left hand threads) with male register down. Thread it on until top of shaft and top of nut are even.
- g) Uncrate and lift driver to allow access to drive shaft.



The driver must be set on supports capable of carrying the entire weight of the driver before proceeding to step (h). Failure of supports could cause damage to the motor or loss of life.

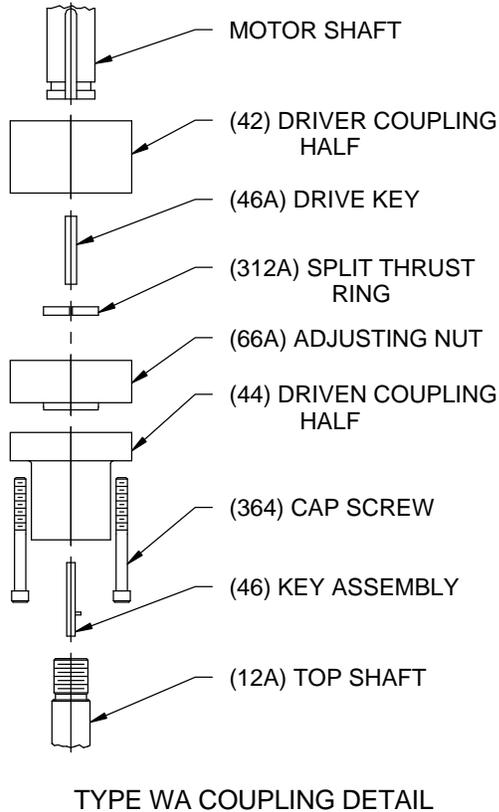
- h) Clean and check driver shaft. Remove any burrs.
 - i) Check the fit of the straight key and split thrust rings [312A] in their respective keyseats. (Refer to paragraph (a) regarding fit of the straight key).
 - j) Install straight key into keyseat. The bottom of the key must be above the top of circular keyseat for the split thrust rings.
- k) Lubricate driver half coupling lightly and slide it onto driver shaft. Slide bottom of coupling above the top of the keyseat for split thrust rings.
- l) Install split thrust rings into circular keyseat and slide the coupling down over them.
- m) Tighten the coupling bolts as follows.

Coupling bolts tightening torques		
Coupling size	Flange diameter mm (in.)	Torque Nm (In·lb)
1 & 2	112 & 137 (4.4 & 5.4)	121.5 (1075)
3, 4 & 5	156, 188, & 213 (6.1, 7.4, & 8.4)	237.0 (2100)
6	251 (9.9)	424.0 (3750)

Torque values are for standard fasteners lubricated with a high stress lubricant (such as, graphite and oil, moly-disulphite, white lead etc.). For stainless steel bolts, multiply listed torques by 0.80.

n) Proceed with driver installation

Figure 4.1

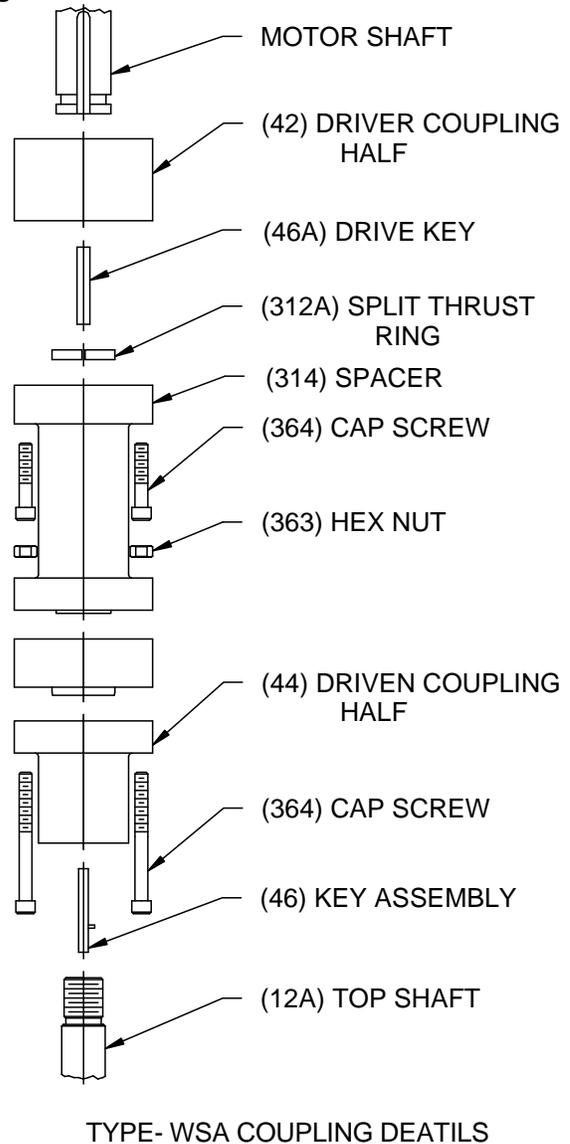


4.1.5.2 Installation of adjustable flanged spacer coupling WSA

Follow procedure from (a) thru (l) as listed in section 4.1.5.1.

- m) Bolt spacer [314] to the driver half coupling [42] using the short set of socket head cap screws [364]. The male register should be pointing down. Tighten all cap screws evenly to the bolt torques as listed in 4.1.5.1 under item (m).
- n) Proceed with the driver installation.

Figure 4.2

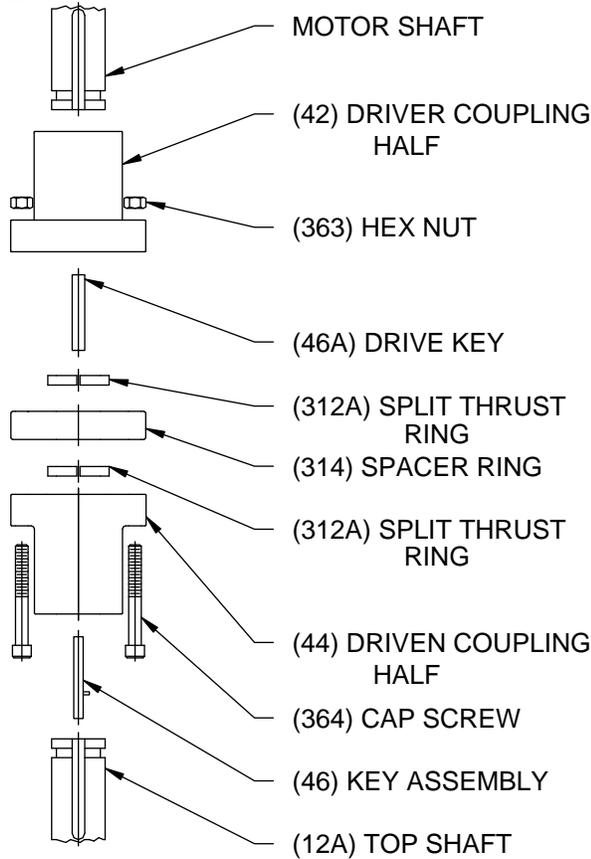


4.1.5.3 Installation of non-adjustable flanged coupling WNA

Follow procedure from (a) thru (e) as listed in section 4.1.5.1.

- f) Install one set of split thrust rings [312A] in to the circular keyway in pump shaft. Pull up the pump half of the coupling [44] over the split keys.
- g) Slide driver half coupling [42] onto driver shaft in the same manner as the pump half of the coupling.
- h) Set the spacer ring [314] between the two halves of the coupling together. Tighten all cap screws [364] evenly to the bolt torques as listed in 4.1.5.1 under item (m).
- i) Proceed with the driver installation.

Figure 4.3



TYPE-WNA COUPLING DETAILS

4.1.6 Installation of drivers

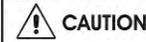
Note:

Drivers will come with solid shaft as specified on the order/contract. Choose the correct installation procedure from the following paragraphs.



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

4.1.6.1 Installation of solid shaft driver



CAUTION 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.

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) Clean driver mounting flange on discharge head and check for burrs or nicks on the register and mounting face. Oil lightly.
- b) Center motor over pump and rotate to align mounting holes. Rotate junction box into desired position.
- c) Lower driver carefully into place making certain that the female register on the driver mates over the male register on the pump.
- d) Bolt driver to discharge head.
- e) Check driver manufacturer's instructions for special instructions including lubrication instructions and follow all "startup" instructions.
- f) 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. To change the direction of rotation on a three-phase motor, interchange any two line leads. To change direction of rotation on a two-phase motor, interchange the leads of either phase.
- g) See impeller adjustment instructions (section 5.3) before bolting the pump and driver half of the coupling together.

4.1.6.2 Installation of solid shaft driver with jacking screws

- a) Clean driver mounting flange on discharge head and check for burrs or nicks on the register and mounting face. Oil lightly.
- b) Center motor over pump and rotate to align mounting holes. Rotate junction box into desired position.
- c) Lower driver carefully into place. Mount the dial indicator base on the O.D. of the motor half coupling. Set the indicator on the pump shaft, position the dial to zero being careful that the indicator is in direct line with one of the jackscrews. Record this reading then rotate the motor shaft and indicator 180 degrees. Record this reading being careful to note plus or minus values. Take the difference of the two readings and using the jackscrews move the motor one-half of the difference. Repeat this step until the T.I.R. reading is a maximum of 0.051mm (0.002in.). Then repeat this step for the set of jack screws located 90 degrees to the first set. Once all readings are within 0.051mm (0.002in.), tighten motor bolts and check for any movement in readings.
- d) Check driver manufacturer's instructions for special instructions including lubrication instructions and follow all "startup" instructions.
- e) Drivers should be checked for rotation at this time. Make electrical connections and "bump" motor (momentarily start, then stop) to check rotation. **DRIVER MUST ROTATE COUNTER-CLOCKWISE** when looking down at top end of motor. To change the direction of rotation on a three-phase motor, interchange any two line leads. To change direction of rotation on a two-phase motor, interchange the leads of either phase.
- f) See impeller adjustment instructions (section 5.3 before bolting the pump and driver half of the coupling together.

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.

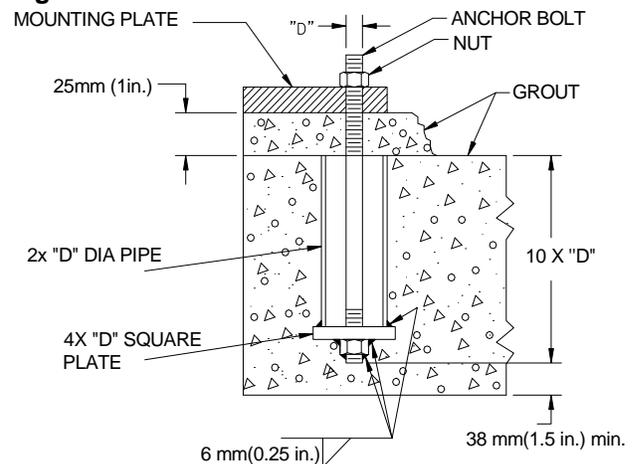
The foundation may consist of material that will afford permanent, rigid support to the discharge head and will absorb expected stresses that may be encountered in service.

Concrete foundations should have anchor bolts installed in sleeves that are twice the diameter of the bolt to allow alignment and has holes in the mounting plate as illustrated in the detail below.

When a suction barrel is supplied as in the case of the type "TF" discharge head, the suction vessel must provide permanent, rigid support for the pump and motor. It should be mounted on a firm foundation.

Detail of a typical foundation bolt, grouted.

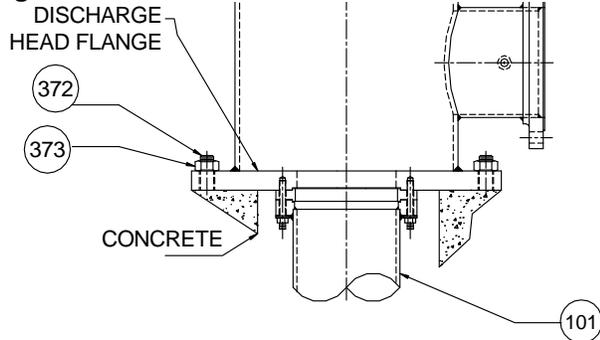
Figure 4.4



4.3.1 Leveling of pumps mounted on the discharge head flange

Example of a typical discharge head with the mounting flange

Figure 4.5



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 [372].

The mounting flange is shimmed to achieve required level by using a precision machinist's level. **The pump is to be leveled to within 0.08 mm/m (0.001 in./ft).** The data to be recorded for future reference. Anchor bolt nuts [373] 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.

4.3.2 Leveling of pumps mounted on a soleplate and the soleplate is grouted

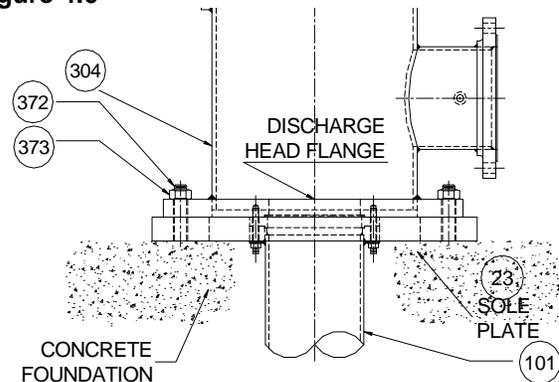
Some pumps are mounted on a separate plate known as soleplate [23]. In such cases, the level shall be set with a master level or a precision machinist's

level. The mounting surface needs to be leveled to within 0.08 mm per m (0.001 in. per one ft).

The level should not exceed 0.125 mm (0.005 in.) elevation difference taken on any two points on the individual soleplate. 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 boltholes with the anchor bolts [372]. **Check and adjust the pump level to within 0.08 mm per m (0.001 in./ft)** with respect to the soleplate and torque the nuts [373] to the required level.

Example of pump mounted on a soleplate

Figure 4.6



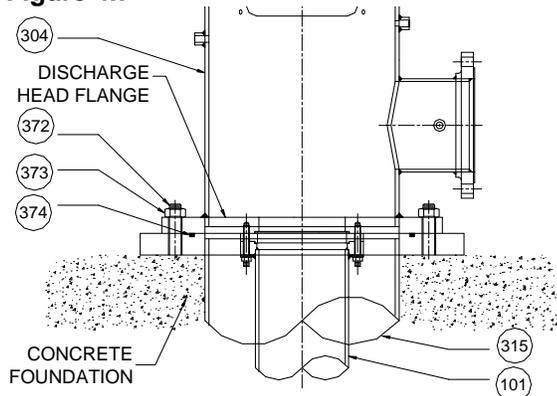
4.3.3 Leveling of pumps with the suction barrel (also referred as "Can" VTPs)

The suction barrel [315] is first lowered into the pit and aligned with the anchor bolts [372]. 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 **0.08 mm per m (0.001 in./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 [372].

Check and adjust the pump level with respect to the barrel flange to within **0.08 mm per m (0.001 in./ft)** and final torque the nuts [373]. The leveling data to be recorded for future reference.

Example of a pump installed with a suction barrel.

Figure 4.7

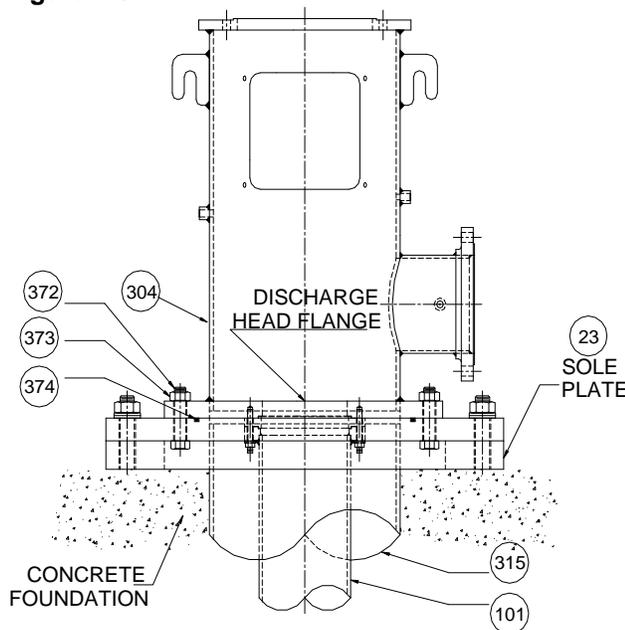


4.3.4 Leveling of pumps with suction barrel mounted on a soleplate

Bolt the soleplate [23] to the bottom of the suction barrel plate. Then proceed to level the barrel mounting surface per paragraph 4.3.3.

Example of pump with a suction barrel mounted on a soleplate

Figure 4.8



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.

- a) All machined mating surfaces (such as the mating flanges of pump and motor) must be clean and free of burrs and nicks.
- b) 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.
- c) All threads should be checked for damage and repaired if necessary. Lubricate all threaded connections with a suitable thread lubricant (an anti-galling compound).

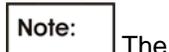
4.5.3 Alignment methods



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 may also have 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.

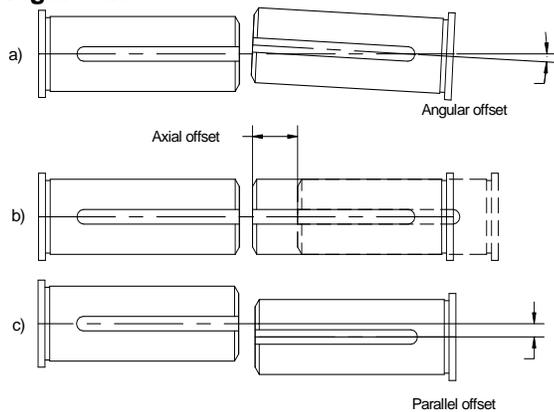
See section 5.3.2.1 for final coupling alignment for solid shaft.

Note: Before bumping motor make sure that the 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.

4.5.4 Angular and parallel misalignment

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.

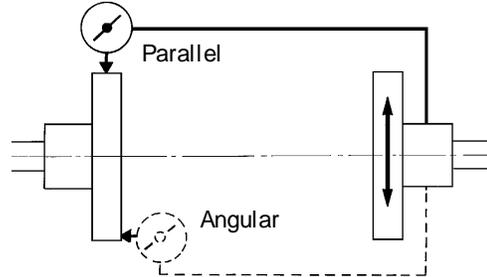
Figure 4.9



- a) **Angular Offset:** The median lines of shaft intersect halfway between the ends of the two shafts.
- b) **Axial Offset:** Another offset is the displacement of one or both of the shafts. A typical example is thermal expansion.
- c) **Parallel Offset:** The median lines run parallel. The maximum allowable parallel offset depends on the size of coupling and is indicated in the instruction manual of manufacturer of coupling.

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

Figure 4.10



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.



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.

4.6 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 Pipe work velocities

In order to minimize friction losses and hydraulic noise in the pipe work it is good practice to choose pipe work that is one or two sizes larger than the pump suction and discharge. Typically, main pipe velocities should not exceed 2 m/s (6 ft/sec) on the suction and 3 m/s (9 ft/sec) on discharge.

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

CAUTION Never use the pump as a support for piping.

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

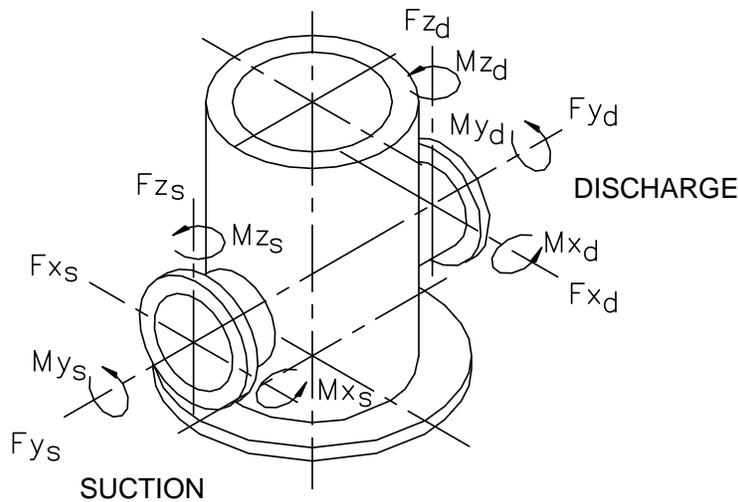
4.6.2 Maximum forces and moments allowed on APKD pump flanges (See table 4.6.2.1)

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

CAUTION Ensure piping and fittings are flushed before use.

! Ensure that the piping arrangement has been provided to flush the pump before removal in cases of hazardous liquid pumps.

Figure 4.11



4.6.2.1 Table of maximum forces and moments allowed on APKD pump flanges

		Discharge Head Size mm(in.)											
Head Type	Forces & Moments	100 (4)	150 (6)	200 (8)	255 (10)	305 (12)	355 (14)	400 (16)	460 (18)	508 (20)	610 (24)	760 (30)	915 (36)
HF LF & TF	Fx	1.05 (240)	1.60 (360)	2.25 (510)	2.95 (660)	3.35 (750)	3.55 (800)	4.20 (950)	4.90 (1 100)	5.34 (1 200)	6.00 (1 350)	7.10 (1 600)	8.45 (1 900)
	Fy	1.35 (300)	2.00 (450)	2.95 (660)	3.65 (820)	4.00 (900)	4.45 (1 000)	5.10 (1 150)	5.80 (1 300)	6.25 (1 400)	7.10 (1 600)	8.45 (1 900)	9.80 (2 200)
	Fz	0.90 (200)	1.35 (300)	1.85 (420)	2.45 (550)	2.65 (600)	2.90 (650)	3.35 (750)	4.00 (900)	4.45 (1 000)	4.90 (1 100)	5.55 (1 250)	6.25 (1 400)
	Mx	1.00 (740)	1.50 (1 100)	2.10 (1 560)	2.75 (2 030)	3.05 (2 250)	3.20 (2 350)	3.65 (2 700)	4.05 (3 000)	4.45 (3 300)	5.40 (4 000)	6.50 (4 800)	7.60 (5 600)
	My	0.50 (380)	0.75 (570)	1.05 (780)	1.35 (990)	1.50 (1 100)	1.55 (1 150)	1.85 (1 350)	2.00 (1 500)	2.50 (1 850)	2.70 (2 000)	3.25 (2 400)	3.80 (2 800)
	Mz	0.75 (550)	1.15 (850)	1.55 (1 140)	2.10 (1 540)	2.30 (1 700)	2.35 (1 750)	2.70 (2 000)	3.05 (2 250)	3.40 (2 500)	4.05 (3 000)	4.90 (3 600)	5.70 (4 200)

Units: Force (F) in kN (lbf); Moments (M) in kNm (lbf-ft)

- Forces and moments shown for TF head are for the discharge flange. For the suction flange, use the values for the next large size head.
- Loads shown are maximum allowable for standard construction. Contact Flowserve if higher values are required or temperatures are higher than ambient

4.6.3 Auxiliary piping

4.6.3.1 Drains

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

4.6.3.2 Pumps fitted with gland packing

The pumped liquid is allowed to flow through the gland packing at discharge pressure and drained out of the pump or re-circulated back into the suction.

4.6.3.3 Pumps fitted with mechanical seals

Auxiliary piping to circulate the flushing liquid back into the suction is required. In case of external clean source requirements for pump applications such as high temperature service, contaminated fluids, oxidizing fluids, a special piping plan to carry the clean liquid into the seal chamber with adequate pressure is required and several piping plans are available to suit the specific pump application.

4.6.3.4 Seal Injection

Seal injection into the condenser pump stuffing box is required for both the packed box and mechanical seal designs the injection is necessary to:

- A) Lubricate either the packing or seal face during operation: and,
- B) Provide a positive liquid seal at the stuffing box when the pump is idle and the condenser is under vacuum to prevent air leakage into the system

Note: The piping plans and flush supply are to be selected based on the application and operating parameters.

4.6.4 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.

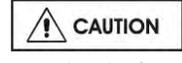
 It is important to be aware of the EUROPEAN DIRECTIVE on electromagnetic compatibility when wiring up and installing equipment on site. Attention must be paid to ensure that the techniques used during wiring/installation do not increase electromagnetic emissions or decrease the electromagnetic immunity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

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

 A device to provide emergency stopping must be fitted.

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

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

 **CAUTION** See section 5.4, *Direction of rotation* before connecting the motor to the electrical supply.

4.8 Final shaft alignment check

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

4.9 Protection systems

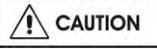
 The following protection systems are recommended particularly if the pump is installed in a potentially explosive area or is handling a hazardous liquid. If in doubt, consult Flowserve.

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, START-UP, 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) 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.
- b) Check the direction of rotation of the pump (Coupling spacer dismantled). Should be counter clockwise when viewed from the driver end.
- c) The pump rotor and the shaft seal must be in correct axial position.
- d) Check the readiness of all auxiliary systems (seal sys., lubrication system etc.) for startup.
- e) 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.
- f) 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.

- g) 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**

Other than the stuffing box lubrication, mechanical seal and/or lineshaft lubrication, the pump will not require further periodic lubrication. On water pumps, the suction bearing on the bowl assembly should be repacked when required. 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.

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.

5.3 **Impeller adjustment**

Proper impeller adjustment positions the impeller inside the bowl assembly for maximum performance. The impellers must be raised slightly to prevent them from dragging on the bowls, but not raised too high so as to adversely affect hydraulic performance.

The impeller must be down against the bowl seat when starting impeller adjustment. When pumps are subjected to suction pressure, the pressure acting against the shaft tends to raise it. Make sure the shaft is down when starting to adjust the impellers.

5.3.1 **Impeller axial clearance setting**

- a) Install indicator bracket on pump stuffing box extension [348] and arrange indicator so that tip is located against lower hub face of the pump half coupling [44]. Determine that the

pump rotor is in the full down position and set the dial indicator at "ZERO".

- b) Determine that the adjusting nut [66A] is in its full down position. With the pump rotor in the full down position, raise the shaft (by jacking) to the upper limit of its travel. Measure the total vertical rotor travel by use of the dial indicator. Divide the total vertical measurement in half and record this number.
- c) With the pump rotor in the full down position again, reset the dial Indicator at "ZERO". Turn the adjusting nut [66A] until its upper face contacts the face of the coupling spacer [314].
- d) Place a scale against the side face of the adjusting nut [66A] to measure the distance that the adjusting nut moves downward as it is backed-off from the coupling spacer [314]. Turn the adjusting nut [66A] until the distance it has moved away from the coupling spacer [314] equals one half of the total vertical rotor travel, computed and recorded in Step 2 above.

Note: If the coupling bolt holes do not line up when the adjusting nut [66A] has been backed-off the desired distance from coupling spacer [314], continue turning the adjusting nut counter-clockwise to reach the nearest bolt hole.

5.3.2 Impeller adjustment for a solid shaft driver

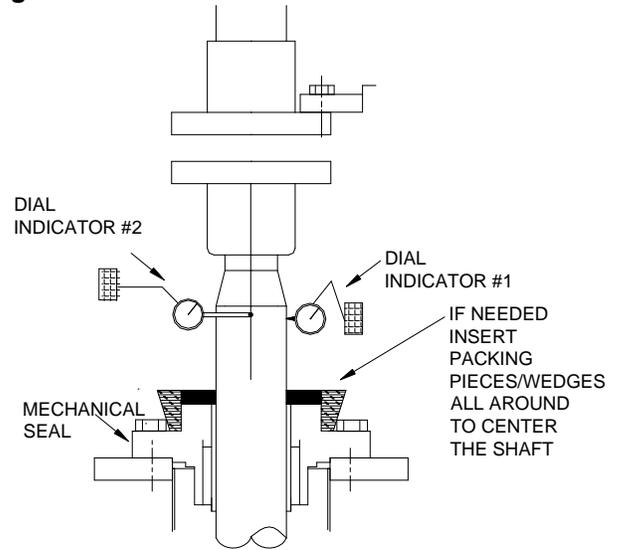
Impeller adjustment when using solid shaft drivers is accomplished in the adjustable flanged coupling located below the driver.

5.3.2.1 Adjusting adjustable flanged coupling

- a) Assemble coupling on pump shaft and driver shaft (if not installed earlier).
- b) Check motor direction of rotation.
- c) Check and write down Flowserve recommended impeller setting for final adjustment.
- d) Pump to motor alignment and final coupling
 - Mount two magnetic indicator bases on the discharge head at 90 degrees to each other
 - Set the indicator tips on the shaft just above the seal and at 90 degrees to each other. (Usually parallel and perpendicular to the discharge nozzle) push the shaft (parallel to discharge) back and forth (without bending shaft)
 - Note and record the minimum and maximum indicator readings. Do the same procedure at 90 degrees to the discharge
 - Set the shaft in the center of the maximum and minimum indicator readings both

directions. If the shaft will not stay in this position, use small wooden wedges between the shaft and seal bolts to hold the shaft. The indicators can now be removed

Figure 5.1

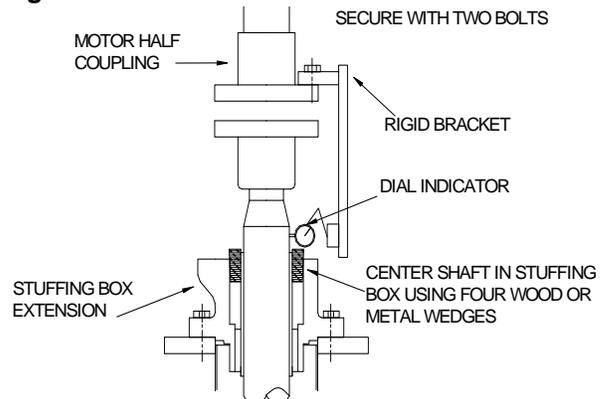


- **Alternate method for pump with packing:** Using an inside micrometer, measure the space between the shaft and the packing box bore. Do this both parallel and perpendicular to the discharge nozzle
- Using the wedges center the shaft so the measurements taken at 180 degrees to each other are within 0.10 mm (0.004 in.) of being equal

(For pumps using jackscrews for motor go to step f).

- e) Mount the magnetic base on the drive half coupling (a band clamp may be necessary to hold base due to limited space). Position the tip of the indicator on the pump shaft just above the seal. Slowly rotate the driver shaft.

Figure 5.2



Note and record the T.I.R. reading. If this reading is more than 0.25 mm (0.010 in.) for WA and WSA couplings or 0.15 mm (0.006 in.) for PA and PSA couplings, unbolt the drive and reposition the driver in the direction required to reduce the T.I.R. to within the allowable limits.

Note:

If a register fit is used for alignment, driver will be able to be moved only a few thousandths of an inch. If enough movement is not obtainable then the male register can be filed to obtain acceptable T.I.R. readings (Go to step g).

- f) On pumps using jackscrews for motor alignment, mount the dial indicator base on the O.D. of the motor half coupling. Set the indicator on the shaft, position the dial to zero being careful that the indicator is in direct line with one of the jackscrews. Record this reading then rotate the motor shaft and indicator 180 degrees.

Record this reading being careful to note plus or minus values. Take the difference of the two readings and using the jackscrews move the motor one half of the difference. Repeat this step until the T.I.R. reading is a maximum of 0.05 mm (0.002 in.).

Then repeat this step for the set of jackscrews located 90 degrees to the first set. Once all readings are within 0.05 mm (0.002 in.) tighten motor bolts and check for any movement in readings.

- g) Set the impeller setting gap between the adjusting nut and the driver portion of the coupling. See impeller setting data supplied along with the pump. If this information is not found, contact Flowserve. Align the match marks on the pump half coupling with the driver half coupling. On pumps with enclosed impellers the match marks can be lined up by increasing the impeller gap until the marks are in line with the driver half coupling marks.
- h) Using 2 bolts of the coupling, at 180 degrees to each other, slowly raise pump half coupling until impellers are just lifted off the seat (This can be gauged by trying to turn shaft by hand. At the point the impellers are lifted the pump will turn). Be sure to lift both sides evenly.
- i) Measure the resultant gap between the motor half coupling and the adjusting nut.

- j) Find the difference between the original gap and the new gap. Add this difference to the original gap and reset the adjusting nut.
- k) Bolt the coupling together and tighten bolts by tightening opposite sides.
- l) Remove wooden wedges, if used. Mount magnetic base on pump and set the tip of indicator on the shaft just above the seal. Slowly rotate the shaft and note the T.I.R. reading.

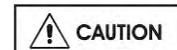
Unless otherwise specified, the allowable T.I.R. readings are:

- WA and WSA couplings 0.10 mm (0.004 in.)
- PA and PSA couplings 0.05 mm (0.002 in.)

If the reading is larger than the allowable values specified above, unbolt the pump and rotate the driver portion of the coupling to different hole and repeat steps (h) and (i) until acceptable readings are obtained.

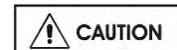
- m) If a mechanical seal is used, adjust the mechanical seal at this time.

5.4 Direction of rotation



Ensure the pump is given the same rotation as specified or as marked on the pump/driver. Please contact Flowserve representative, if you have any questions before the startup.

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

5.5 Guarding



Guarding is supplied fitted to the pump set. Fasteners for guards must remain captive in the guard to comply with the Machinery Directive 2006/42/EC. When releasing guards, the fasteners must be unscrewed in an appropriate way to ensure that the fasteners remain captive. Whenever guarding is removed or disturbed ensure that all the protective guards are securely refitted prior to start-up

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.

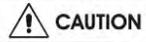
5.6 Priming and auxiliary supplies

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

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

5.7 Starting the pump

 **CAUTION** 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) Prime the pump & check lubrication system in operation (check the liquid level).
- d)  Ensure all vent connections are closed before starting.
- e) Check the motor connections.
- f)  Do not run the pump with the outlet valve closed for a period longer than 30 seconds.

5.7.1 Pre-starting checks

Before starting the pump the following checks should be made.

- a) Rotate the pump shaft by hand to make sure the pump rotates freely and the impellers are correctly positioned.
- b) Has the electric motor been properly lubricated in accordance with the instructions furnished with the driver?
- c) 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.
- d) Check all connections to the driver and control. Do not overfill the grease cavity. Over greasing can lead to failure of the thrust bearing.

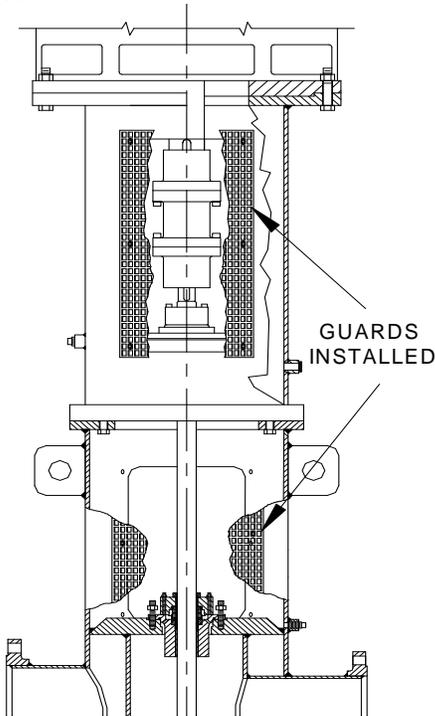
- e) Check that all piping connections are tight.
- f) Check all foundation bolts for tightness.
- g) Check all bolting connections for tightness (coupling bolts, mechanical seal gland bolts, driver bolts etc).
- h) Make sure the mechanical seal is properly adjusted and locked into place. Ensure that all seal spacers are in the running position prior to operation.
- i) 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)
- j) 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.

5.7.1.1 Typical safety guards

Figure 5.3



CAUTION After initial startup, pre-lubrication of the mechanical seal will usually not be required as enough liquid will remain in the seal chamber for subsequent startup lubrication.

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 5.7.1.1.

5.7.2 Stuffing box adjustment

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.

5.7.3 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.

5.7.4 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 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.

CAUTION 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.

CAUTION 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.

5.7.5 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.

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

5.7.6 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

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.

5.7.6.1 Typical allowable field vibration values for vertical turbines- sump or wet pit types

Motor rating kW (hp)	Vibration velocity-unfiltered	Vibration mm/sec (in./sec) rms
0.75-to 7.5 (1-10)	N	6.1 (0.24)
7.5 to 75 (10 -100)	N	6.1 (0.24)
75 to 750 (100 -1000)	N	6.1 (0.24)-7.1 (0.28)

N = Normal; Alarm = N X 1.25; TRIP = N X 2.0.

5.7.6.2 Typical allowable field vibration values for vertical turbines with suction barrel

	Vibration	Vibration
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Motor rating kW (hp)	velocity-unfiltered	mm/sec (in./sec) rms
0.75-to 7.5 (1-10)	N	5.1 (0.20)
7.5 to 75 (10-100)	N	5.1 (0.20)
75 to 750 (100-1000)	N	5.1 (0.20)-6.1(0.24)
750 to 2238 (1000-3000)	N	6.1 (0.24)-7.1(0.28)

N = Normal; Alarm = N X 1.25; TRIP = N X 2.0.

5.7.7 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.

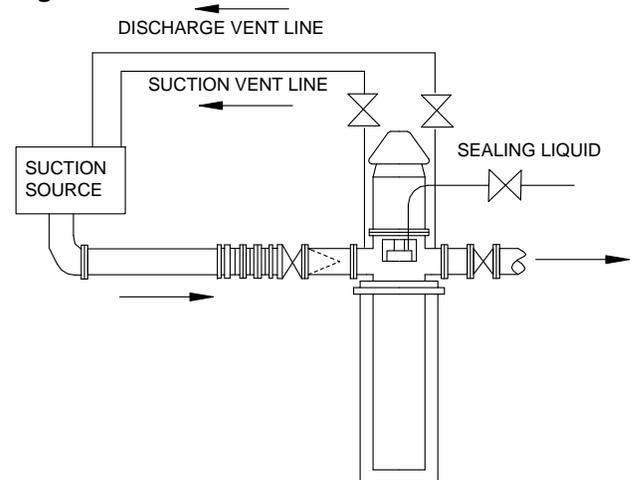
If the motor is expected to experience multi starts in any given time, please refer to the driver’s user instructions before the pump is put into operation.

5.8 Operating the pump

5.8.1 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.

Figure 5.4



5.8.2 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.

5.8.3 Pumps fitted with mechanical seal

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

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



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.

5.8.4 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.

- Record the bearing temperature (t) and the ambient temperature (ta)
- Estimate the likely maximum ambient temperature (tb)
- Set the alarm at $(t+tb-ta+5) \text{ } ^\circ\text{C}$ [$(t+tb-ta+10) \text{ } ^\circ\text{F}$] and the trip at $100 \text{ } ^\circ\text{C}$ ($212 \text{ } ^\circ\text{F}$) for oil lubrication and $105 \text{ } ^\circ\text{C}$ ($220 \text{ } ^\circ\text{F}$) for grease lubrication

It is important, particularly with grease lubrication, to keep a 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 rise should then remain constant or marginally reduce with time.

5.9 Stopping and shutdown



- a) Close the outlet valve, but ensure that the pump runs in this condition for no more than a few seconds.
- b) Stop the pump.
- c) Switch off flushing and/or cooling/heating liquid supplies at a time appropriate to the process.



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.

5.10 Hydraulic mechanical and electrical duty

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

5.10.1 Specific gravity (SG)

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

5.10.2 Viscosity

For a given flow rate the total head reduces with increased viscosity and increases with reduced viscosity. Also for a given flow rate the power absorbed increases with increased viscosity, and reduces with reduced viscosity. It is important that checks are made with your nearest Flowserve office if changes in viscosity are planned.

5.10.3 Pump speed

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

5.10.4 Net positive suction head (NPSH_A)

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

NPSH required (NPSH_R) is a measure of the head required in the pumped liquid, above its vapour pressure, to prevent the pump from cavitating. It is important that NPSH_A > NPSH_R. The margin between NPSH_A > NPSH_R should be as large as possible. If any change in NPSH_A is proposed, ensure these margins are not significantly eroded. Refer to the pump performance curve to determine exact requirements particularly if flow has changed.

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

5.10.5 Pumped flow

Flow must not fall outside the minimum and maximum continuous safe flow shown on the pump performance curve and or data sheet.

6 MAINTENANCE

6.1 General



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

Any work on the machine must be performed when it is at a standstill. It is imperative that the procedure for shutting down the machine is followed, as described in section 5.9.

Guard fasteners must remain captive during dismantling of guards as described in section 5.4

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

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

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

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

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

Do not spray air or compressed inert gas on skin.

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

Never use air or compressed inert gas to clean clothes.

Before working on the pump, take measures to prevent an uncontrolled start. Put a warning board

on the starting device with the words:
"Machine under repair: do not start".

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

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

6.2 Maintenance schedule



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

- a) *Any auxiliary systems installed must be monitored, if necessary, to ensure they function correctly.*
- b) Gland 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. The correct functioning of the shaft seal must be checked regularly.
- d) Check bearing lubricant level, and if the hours run show a lubricant change is required.
- e) Check that the duty condition is in the safe operating range for the pump.
- f) Check vibration, noise level and surface temperature at the bearings to confirm satisfactory operation.
- g) Check dirt and dust is removed from areas around close clearances, bearing housings and motors.
- h) Check coupling alignment and re-align if necessary.

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

6.2.1 Routine Inspection (daily/weekly)



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

- a) Check operating behavior; ensure noise, vibration and bearing temperatures are normal.
- b) 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.
- c) Check that shaft seal leaks are within acceptable limits.
- d) Check the level and condition of lubrication oil. On grease lubricated pumps, check running hours since last recharge of grease or complete grease change.
- e) Check any auxiliary supplies eg. heating/cooling (if fitted) are operating correctly.
- f) Refer to the manuals of any associated equipment if routine checks needed.

6.2.2 Periodic Inspection (every 6 Month)



- a) Check foundation bolts for security of attachment and corrosion.
- b) Check pump operation hours to determine if bearing lubricant shall be changed.
- c) The coupling should be checked for correct alignment and worn driving elements.



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

6.2.3 Re-lubrication

6.2.3.1 Pump lubrication

In general, VTPs that are product lubricated will not require further periodic lubrication. Stuffing box and mechanical seal needs flow of flush. Enclosed line shaft pumps have to be provided with the required oil quantity for an oil lubed system and the injection lube flow at the required pressure for injection lubed systems.

6.2.3.2 Driver lubrication



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

6.2.4 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.

6.2.5 Maintenance of the stuffing box

6.2.5.1 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.

6.2.5.2 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

6.2.5.3 Replacing packing

Remove gland and all old packing. If the box contains a lantern ring, remove this and all packing below it using two long threaded machine screws.

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.

If wear is minor dress down until smooth and concentric. Clean box bore.

Oil inside and outside of replacement rings lightly and install in box, staggering joints 90 degrees. Be sure to replace lantern ring in proper position when used.

Replace gland and tighten nuts finger tight. The packing gland must never be tightened to the point where leakage from the packing is stopped.

A small amount of leakage is required for packing lubrication.

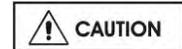
Packing ring sizes vary with the shaft diameter. Packing ring size information are as follows.

PACKING RING SIZES

Packing Dimensions		
Shaft size	Packing ring size	Outside diameter of packing
mm (in.)	mm (in.)	mm (in.)
25 (1.00)	9.65 (0.38)	44.4 (1.75)
32 (1.25)	9.65 (0.38)	50.8 (2.00)
38 (1.50)	11.17 (0.44)	60.4 (2.38)
43 (1.69)	12.70 (0.50)	68.3 (2.68)
49 (1.93)	12.70 (0.50)	74.6 (2.93)
56 (2.20)	12.70 (0.50)	81.0 (3.19)
62 (2.44)	12.70 (0.50)	87.3 (3.43)
68 (2.68)	12.70 (0.50)	93.7 (3.69)
75 (2.95)	12.70 (0.50)	100.0 (3.93)
82 (3.22)	12.70 (0.50)	107.9 (4.24)
89 (3.50)	15.74 (0.62)	120.6 (4.74)
95 (3.75)	15.74 (0.62)	127.0 (5.00)
102 (4.00)	15.74 (0.62)	133.3 (5.24)
114 (4.50)	15.74 (0.62)	146.0 (5.74)

6.2.5.4 Startup with new packing

Check to see that the by-pass line (if used) is connected and the packing gland is loose. Start pump and allow it to run for 20 to 30 minutes. Do not tighten the gland during this "run-in" period even if leakage is excessive. 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.



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.

6.3 Spare parts

6.3.1 Ordering of spares

Flowserve keep records of all pumps that have been supplied. When ordering spare parts we need the following information:



1. pump type and pump size
2. serial number of the pump
3. number of the required spare parts
4. reference number and name of the part as listed in the part list or in the sectional drawing

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

Note: To ensure continued satisfactory operation, replacement parts to the original design specification should be obtained from Flowserve. Any change to the original design specification (modification or use of a non-standard part) will invalidate the pump's safety certification.

Please fill out a spare parts request form and send it to the Flowserve customer service. Contact Flowserve for a copy of the request form or assistance to order spare parts (see back page for contact information).

6.3.2 How to select recommended spares

Generally a list of spare parts supplied along with the pump that shows the parts that are included in each of the following two classes of recommended spares. If you do not find such documentation please contact Flowserve for the list.

6.3.2.1 Class I minimum

Suggested for Domestic Service when pump is handling clean non-corrosive liquids and where interruptions in service are not important.

6.3.2.2 6.2.2.2 Class II average

Suggested for Domestic Service when pump is handling abrasive or corrosive liquids and where some interruptions in continuity of service are not objectionable.

Please contact Flowserve Sales Representative in your area to review the spares best suited to meet your requirements.

6.3.3 Storage of spare parts

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-month intervals.

6.4 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.

6.5 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

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.

6.6 Fastener torques

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

6.6.1 Fastener torques for bowl assembly

Fastener size	Torque
mm (in.)	Nm (lb·ft)
6 (0.25)	7 (5)
8 (0.31)	14 (10)
10 (0.37)	23 (17)
11 (0.43)	37 (27)
12 (0.5)	54 (40)
15 (0.56)	81 (60)
16 (0.62)	114 (84)
19 (0.74)	183 (135)
22 (0.87)	346 (255)
25 (1.00)	502 (370)
28 (1.12)	678 (500)
32 (1.25)	902 (665)
38 (1.50)	1322 (975)

6.6.2 Torques for couplings screws

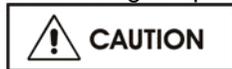
Coupling size #	Flange diameter mm (in.)	Nm (lb·ft)
1 & 2	111 or 137 (4.4 or 5.4)	122 (90)
3-5	156, 187 213 (6.0, 7.4, 8.4)	237 (175)
6	250 (10.0)	424 (313)

6.7 Setting impeller clearance

Please see section 5.3 for specific instructions on impeller adjustment.

6.8 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. See section 8 in this manual
- 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/equipments/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 disassembly instructions

See section 8.0 for sectional drawings.

- Disconnect all cables/wires and cooling water pipe connections to the driver (if provided).
- Carefully remove the flush or lubricant connections and remove any associated piping that would interfere with the dismantling.
- Make sure that all the valves are shut completely to avoid any leaks or spills.
- Disconnect the coupling halves [471] (the driver & pump).
- Disconnect the suction (if used) and discharge pipe connections to the discharge head.
- Rig the motor to a suitable hoist and keep the lifting mechanism in ready state.
- Remove the motor to discharge head [304] bolting and remove the motor from the discharge head and place it on a safe and appropriate location.
- If the pump is of shorter length (with or without can) rig the discharge head along with the entire pump assembly (see section 2.3 for lifting) using a suitable hoist (check the building height clearance before the lifting is attempted)
 - Use eye bolts and hooks as necessary and get the lifting mechanism in ready state.
 - Lifting of short set pumps
 - Remove the fasteners at the discharge head/foundation/soleplate
 - Lift the entire pump assembly by clamping at the discharge head [304] (See section 2.3)
 - Lifting of deep set pumps
 - Remove the fasteners at the foundation plate or soleplate
 - Remove stuffing box/Mechanical seal [349] completely. Protect the shaft against damage while lifting the discharge head [304]
 - Lift the pump just enough to access the first column pipe flange connection
 - Support the entire pump just below the first column pipe joint [101]

- Disconnect the discharge head [304] and lift
- Now lift the pump again by using column pipe flange and disconnect the first section of column piping
- Remove the bearing retainers [307] and shaft couplings [70] and repeat the process until all column piping is disassembled
- Last step is to lift and remove the bowl assembly

See section 2.3, 4.1.2 and 4.1.3 for related information.

6.9 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.

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

Refer to sectional drawings for part numbers and identification.

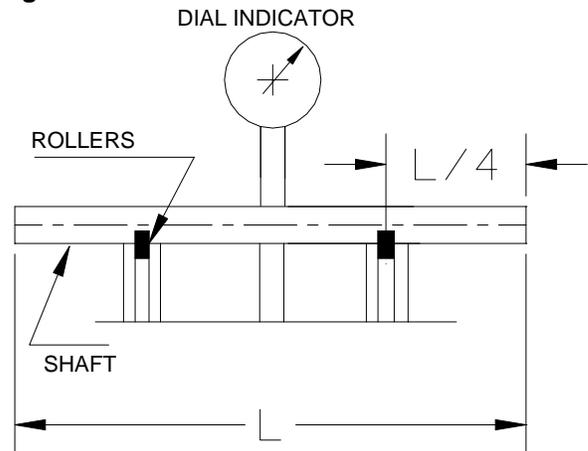
CAUTION Cleanliness and proper lubrication are required to guarantee ease of re-assembly and proper pump operation.

6.9.1 Examination of shaft/s

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

The shaft must be straight to within 0.127 mm (0.005 in.) total indicator reading. The detail below shows the recommended method for checking shaft straightness. If the shaft is not straight, it must be straightened or replaced. If the deflection is gradual over a considerable length, the shaft can usually be straightened by supporting on two blocks straddling the crooked section and applying pressure to the high side to deflect the shaft in the opposite direction. If the shaft has a sharp crook (dog-leg), it is recommended that the shaft be replaced since the shaft will not always remain straight, even if satisfactorily straightened.

Figure 6.1



CAUTION Even if the shaft is new or has been previously straightened, it is recommended that the shaft be re-checked at this point to ensure damage has not occurred in transit or handling.

6.9.2 Examination of bearings

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 (see table 6.8.2.1).

Note: Rubber bearings should always be replaced when servicing a pump.

6.9.2.1 Shaft/bearing clearance

Shaft Size mm (in.)	Shaft Diameter/Tolerance Min Dia- Max Dia mm (in.)		Bearing Clearance (Max/Min) mm (in.)
25.40 (1.000)	25.35 (0.998)	25.40 (1.000)	0.28/0.13 (0.011/0.005)
31.75 (1.250)	31.70 (1.248)	31.75 (1.250)	0.35/0.15 (0.012/0.006)
38.10 (1.500)	38.05 (1.498)	38.10 (1.500)	0.33/0.18 (0.013/0.007)
42.86 (1.690)	42.81 (1.685)	42.86 (1.687)	0.36/0.18 (0.014/0.007)
49.21 (1.940)	49.16 (1.935)	49.21 (1.937)	0.38/0.23 (0.015/0.008)
55.56 (2.190)	55.51 (2.185)	55.56 (2.187)	0.41/0.23 (0.016/0.009)
61.91 (2.440)	61.86 (2.435)	61.91 (2.437)	0.41/0.23 (0.016/0.009)
68.26 (2.690)	68.21 (2.685)	68.26 (2.687)	0.43/0.23 (0.017/0.009)
74.61 (2.940)	74.56 (2.935)	74.61 (2.937)	0.43/0.23 (0.017/0.009)
82.55 (3.250)	82.47 (3.247)	82.55 (3.250)	0.46/0.25 (0.018/0.010)
88.90 (3.500)	88.82 (3.497)	88.90 (3.500)	0.48/0.28 (0.019/0.011)
95.25 (3.750)	95.17 (3.747)	95.25 (3.750)	0.53/0.35 (0.021/0.012)
101.60 (4.000)	101.58 (3.997)	101.60 (4.000)	0.56/0.33 (0.022/0.013)
114.30 (4.500)	114.22 (4.497)	114.30 (4.500)	0.58/0.35 (0.023/0.014)
127.00 (5.000)	126.92 (4.997)	127.00 (5.000)	0.61/0.38 (0.024/0.015)

Bronze, epoxy, carbon and hard-backed rubber bearings are pressed into their respective bores. They can either be pressed out or machined on the inside diameter until the wall is thin enough to collapse.

Some rubber bearings are the snap-in or glue-in type. These can be removed by prying inward on the outside of the bearing to collapse it.

If the bearing bore of the housing is heavily scarred or corroded, the part should be replaced or reworked to provide a true bore for the bearing.

Replacement bearings are designed to be pressed into housings so bores will shrink to "as new" tolerances. Measure the bore of bearings after pressing and ream as necessary to assure "as new" tolerances.

6.9.3 Inspection 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.



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.

6.9.3.1 Inspection of enclosed impellers

- a) Clear all passageways and check for signs of damage from abrasion or corrosion. Replace an impeller that shows signs of excessive wear.
- b) Check impeller running clearances against "as new" tolerances listed in the section 6.8.4. If the clearances exceed the maximum tolerances shown by more than 50%, the new wear rings should be installed to obtain correct tolerances.
- c) If the original unit was furnished with bowl and impeller wear rings, they may be pressed or machined off.

Please note that certain repairs may require special skills and it is recommended to contact Flowserve authorized service center before attempting any such repairs.

See wear ring tolerance chart in section 6.8.4.

If the impeller has a balance ring on the topside (side opposite pumping vanes) running clearances must be checked.

Please see section 6.9.4 for wearing ring tolerance chart for enclosed impellers.



6.9.4 Wearing ring tolerance chart for enclosed impellers

Bowl ring internal diameter. Nominal mm (in.)	Clearance between bowl and impeller wear rings		Bowl ring interference fit	Impeller ring interference fit
	Standard	Galled		
	mm (in.)			
50-75 (2-3)	0.330/0.229 (0.013/0.009)	0.533/0.432 (0.021/0.017)	0.101/0.050 (0.004/0.002)	0.076/0.025 (0.003/0.001)
75-100 (3-4)	0.356/0.229 (0.014/0.009)	0.635/0.483 (0.025/0.019)	0.127/0.050 (0.005/0.002)	0.101/0.025 (0.004/0.001)
100-125 (4-5)	0.381/0.279 (0.015/0.011)	0.635/0.533 (0.025/0.021)	0.152/0.076 (0.006/0.003)	0.127/0.038 (0.005/0.002)
125-150 (5-6)	0.406/0.305 (0.016/0.012)	0.660/0.559 (0.026/0.022)	0.178/0.076 (0.007/0.003)	
150-180 (6-7)		0.686/0.584 (0.027/0.023)		
180-200 (7-8)	0.432/0.330 (0.017/0.013)	0.711/0.610 (0.028/0.024)	0.203/0.076 (0.008/0.003)	0.152/0.051 (0.006/0.002)
200-230 (8-9)	0.457/0.356 (0.018/0.014)	0.737/0.635 (0.029/0.025)	0.254/0.102 (0.010/0.004)	0.178/0.051 (0.007/0.002)
230-255 (9-10)		0.762/0.660 (0.030/0.026)		0.229/0.051 (0.009/0.002)
255-280 (10-11)		0.788/0.686 (0.031/0.027)		0.229/0.076 (0.009/0.003)
280-305 (11-12)		0.813/0.711 (0.032/0.028)		
305-330 (12-13)	0.508/0.356 (0.020/0.014)	0.890/0.737 (0.035/0.029)	0.280/0.102 (0.011/0.004)	0.254/0.102 (0.010/0.004)
330-355 (13-14)		0.914/0.762 (0.036/0.030)	0.305/0.102 (0.012/0.004)	
355-380 (14-15)		0.940/0.788 (0.037/0.031)	0.305/0.127 (0.012/0.005)	
380-405 (15-16)		0.965/0.813 (0.038/0.032)		
405-430 (16-17)	0.559/0.406 (0.022/0.016)	0.990/0.838 (0.039/0.033)	0.330/0.406 (0.013/0.016)	0.279/0.127 (0.011/0.005)
430-455 (17-18)		1.010/0.864 (0.040/0.034)		
455-485 (18-19)	0.610/0.457 (0.024/0.018)	1.041/0.889 (0.041/0.035)	0.356/0.152 (0.014/0.006)	0.305/0.127 (0.012/0.005)
485-510 (19-20)		1.070/0.914 (0.042/0.036)		
510-535 (20-21)		1.092/0.934 (0.043/0.037)		
535-560 (21-22)	0.660/0.508 (0.026/0.020)	1.118/0.965 (0.044/0.038)	0.381/0.179 (0.015/0.007)	0.330/0.152 (0.013/0.006)
560-585 (22-23)		1.143/0.990 (0.045/0.039)		
585-610 (23-24)		1.168/1.020 (0.046/0.040)	0.406/0.179 (0.016/0.007)	0.356/0.179 (0.014/0.007)
610-635 (24-25)		1.194/1.041 (0.047/0.041)		
635-660 (25-26)		1.220/1.066 (0.048/0.042)	0.406/0.203 (0.016/0.008)	0.356/0.179 (0.014/0.007)
660-685 (26-27)		1.244/1.092 (0.049/0.043)		

6.10 Assembly

To assemble the pump, consult the sectional drawings provided in section 8.0 and some specific assembly drawings may be necessary.

Note: The pump that has been purchased may have order specific assembly and parts configurations. Specific cross sectional drawings that reflect the exact pump/parts details can be purchased from Flowserve. Contact Flowserve for drawings purchase and cost 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/equipments/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. To assemble the pump consult the sectional drawings.



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.	Check impeller adjustment. See Section 5.3 for details.
		●				●	●					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.	
						●	●	●				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 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.
					●	●	●					Wearing ring surfaces worn.	Replace worn wear ring/surfaces.
		●				●	●					Impeller damaged or eroded.	Replace. or consult Flowserve for an upgrade.



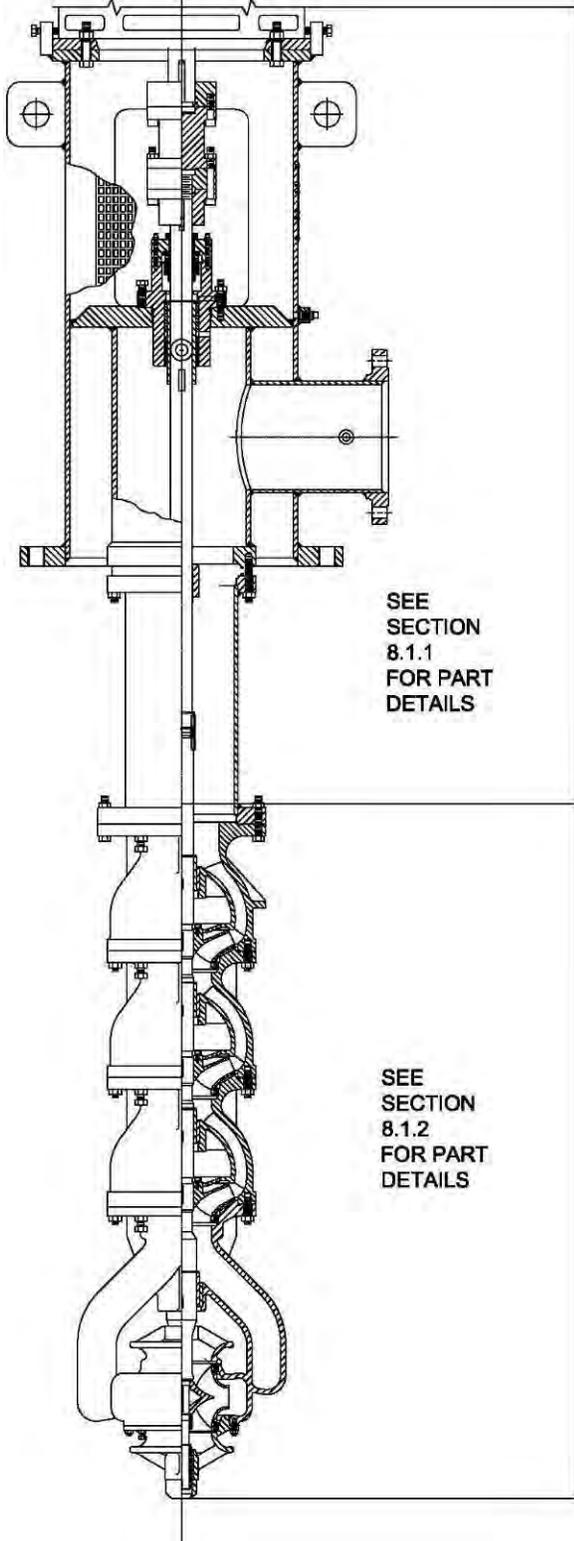
FAULT SYMPTOM

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														
													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 DRAWINGS AND PARTS LISTS

8.1 Cross section: Product lubricated APKD

Typical wet pit pump



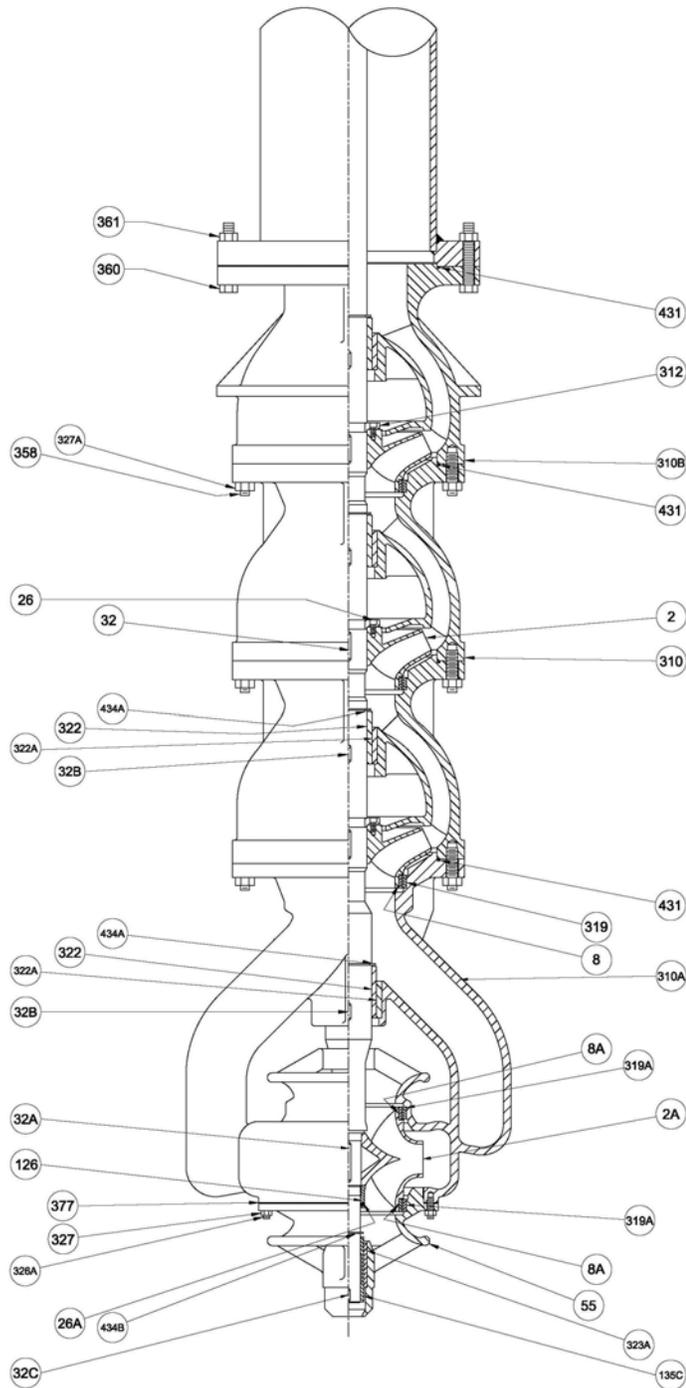
See sections 8.1.1 and 8.1.2 for parts details

Note:

All the sectional drawings provided in this section are typical representations of the most common pump types and are provided for the purposes of basic understanding of the equipment. The details shown may not reflect the specifics of the pump that has been purchased. Order-specific cross sectional drawings and parts list can be purchased from Flowserve separately. Contact Flowserve for ordering and pricing information on such drawings and documentation.

8.1.2 Parts identification: Bowl assembly

Typical wet pit/sump type design-product lubricated APKD



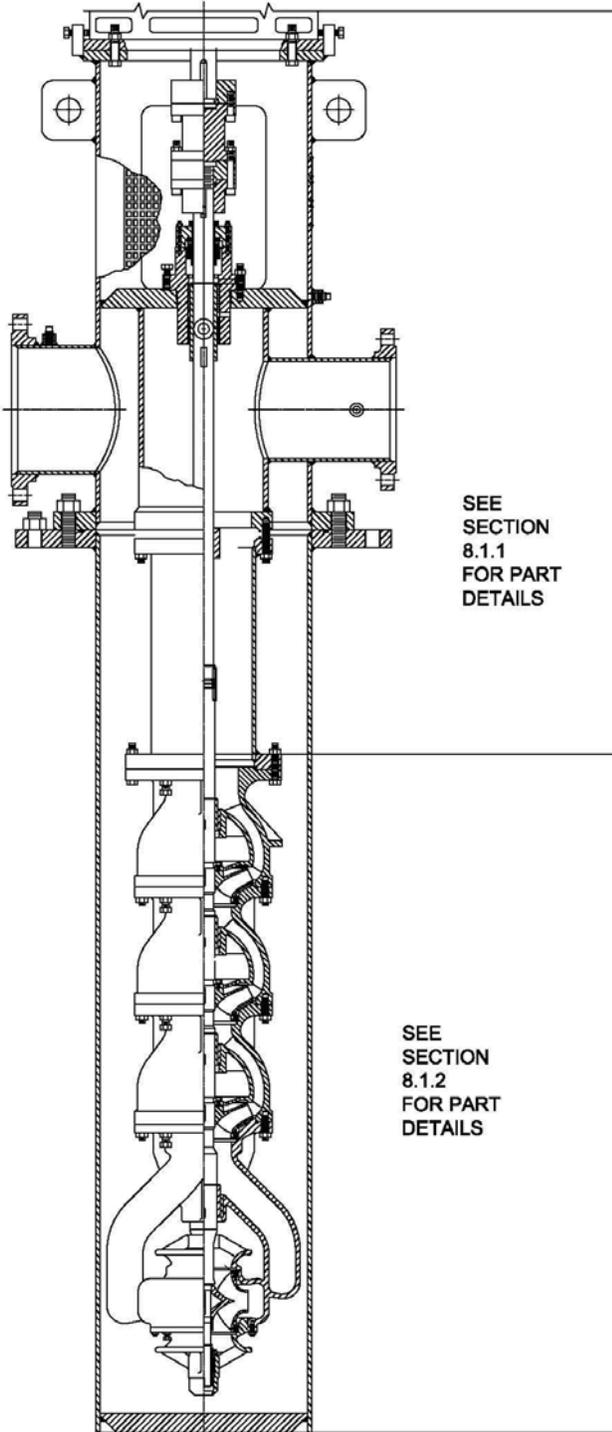
8.1.2.1 Parts list-Bowl assembly

Ref no.	Description
2	1 ST STAGE IMPELLER
2A	INTERMEDIATE IMPELLER
8	WRG RING – INT. IMPELLER
8A	WRG RING – 1 ST STAGE IMPELLER
26	SCREW CAP-SOCKET
26A	SCREW CAP-SOCKET
32	KEY-INT. IMPELLER
32A	KEY-1 ST STAGE IMPELLER
32B	KEY-JOURNAL SLEEVE-BOWLS
32C	KEY-JOURNALSLEEVE-SUCTION HEAD
55	SUCTION HEAD
126	SHAFT NUT
135C	JOURNAL SLEEVE-SUCTION HEAD
310	APKD BOWL
310A	APKD BOWL 1 ST STAGE
312	IMP. SPLIT RING
319	BOWL WRG RING
319A	BOWL WRG RING
322	JOURNAL SLEEVE-BOWLS
322A	BEARING SLEEVE – SUCTION HEAD
323A	BEARING SLEEVE – BOWLS
326A	STUD
327	NUT-HEX
327A	NUT-HEX
358	STUD
377	GASKET
426	SCREW CAP-HEX
431	O-RING
434	RETAINING RING
434A	RETAINING RING

8.2 Cross section: Suction barrel APKD
Typical

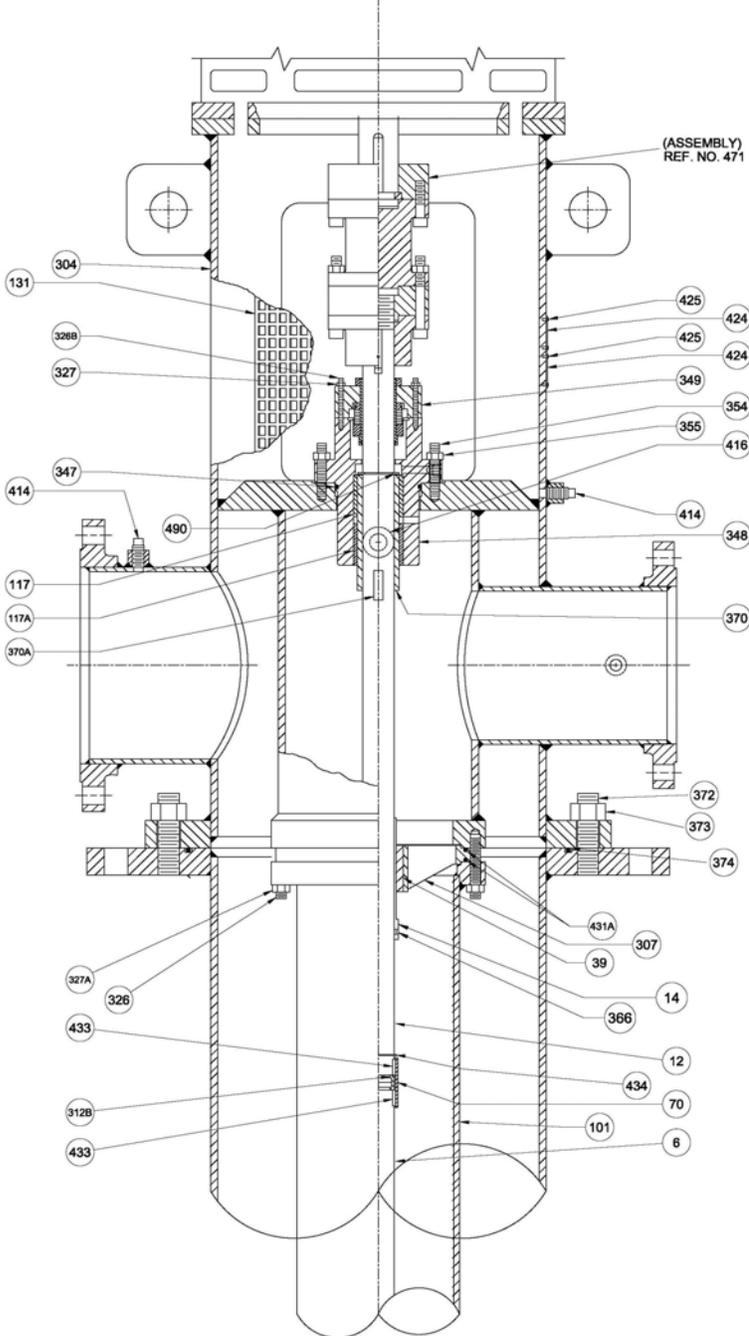
See sections 8.2.1 and 8.2.2 for parts details

Note: *All the sectional drawings provided in this section are typical representations of the most common pump types and are provided for the purposes of basic understanding of the equipment. The details shown may not reflect the specifics of the pump that has been purchased. Order-specific cross sectional drawings and parts list can be purchased from Flowserve separately. Contact Flowserve for ordering and pricing information on such drawings and documentation.*



8.2.1 Parts identification: Discharge head/column/suction barrel

Typical product lubricated APKD with a suction barrel

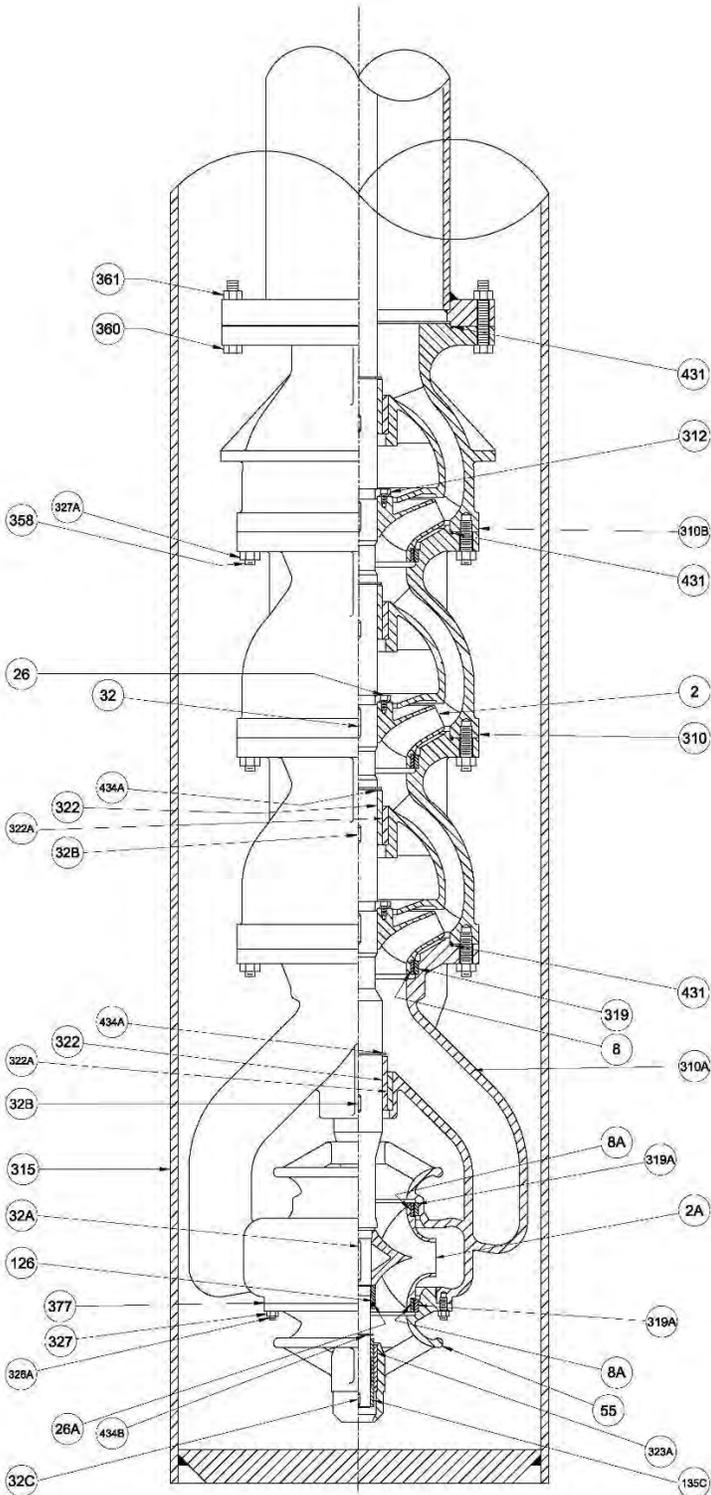


8.2.1.1 Parts list-Disch. head and column Assy.

Ref no.	Description
6	PUMP SHAFT
12	TOP SHAFT
14	SLEEVE-TOPSHAFT
39	BEARING SLEEVE
70	KEYED SHAFT SLEEVED
101	COLUMN PIPE
117	BEARING SLEEVE
117A	BEARING SLEEVE
131	COUPLING GUARD
304	DISCHARGE HEAD
307	BEARING RETAINER
312B	CLAMP RING
326	STUD
326B	STUD
327	NUT-HEX
327A	NUT-HEX
347	O-RING
348	STUFFING BOX
349	MECHANICAL SEAL
354	STUD
355	NUT-HEX
366	SET SCREW
370	STUFFING BOX-SLEEVE
370A	KEY-SLEEVE
372	STUD
373	NUT-HEX
374	O-RING BARREL
414	PLUG
416	PLUG
424	FLOWSERVE DISPLAY NAMEPLATE
424	FLOWSERVE SERIAL PLATE
425	DRIVE SCREW
425	DRIVE SCREW
431A	O-RING
433	KEY-COUPLING
434	RETAINING RING
471	FLANGED COUPLING ASSEMBLY
490	RETAINING RING

8.2.2 Parts identification: Column and bowl assembly

Typical product lubricated APKD with the suction barrel



8.2.2.1 Parts list- Column and bowl assembly

Ref no.	Description
2	1 ST STAGE IMPELLER
2A	INTERMEDIATE IMPELLER
8	WRG RING – INT. IMPELLER
8A	WRG RING – 1 ST STAGE IMPELLER
26	SCREW CAP-SOCKET
26A	SCREW CAP-SOCKET
32	KEY-INT. IMPELLER
32A	KEY-1 ST STAGE IMPELLER
32B	KEY-JOURNAL SLEEVE-BOWLS
32C	KEY-JOURNALSLEEVE-SUCTION HEAD
55	SUCTION HEAD
126	SHAFT NUT
135C	JOURNAL SLEEVE-SUCTION HEAD
310	APKD BOWL
310A	APKD BOWL 1 ST STAGE
312	IMP. SPLIT RING
315	SUCTION CAN
319	BOWL WRG RING
319A	BOWL WRG RING
322	JOURNAL SLEEVE-BOWLS
322A	BEARING SLEEVE – SUCTION HEAD
323A	BEARING SLEEVE – BOWLS
326A	STUD
327	NUT-HEX
327A	NUT-HEX
358	STUD
377	GASKET
426	SCREW CAP-HEX
431	O-RING
434	RETAINING RING
434A	RETAINING RING

8.3 General arrangement drawing

The typical general arrangement drawing and any specific drawings required by the contract will be sent to the Purchaser separately unless the contract specifically calls for these to be included into the User Instructions. If these drawings are supplied separately, the purchaser should retain those with the User Instructions.

9 CERTIFICATION

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

10 OTHER RELEVANT DOCUMENTATION AND MANUALS

10.1 Supplementary user instructions

Supplementary instructions determined from the contract requirements for inclusion into user Instructions such as for a driver, instrumentation, controller, sub-driver, seals, sealant system, mounting

component etc are included in the Data Book. If further copies of these are required they should be obtained from the supplier for retention with these user instructions.

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

10.2 Change notes

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

10.3 Additional sources of information

Reference 1:

NPSH for Rotodynamic Pumps: a reference guide, Europump Guide No. 1, Europump & World Pumps, Elsevier Science, United Kingdom, 1999.

Reference 2:

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

Reference 3:

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

Reference 4:

ANSI B31.3 - Process Piping.



NOTES:



NOTES:



Your Flowserve factory contacts:

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5310 Taneytown Pike, PO Box 91
Taneytown, MD 21787-0091, USA

Telephone: +1 (410) 756 2602
Customer Service FAX: +1 (410) 756 2615
Parts inquiry/Order PH: +1 (800) 526 3569

Your local Flowserve representative:

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

**FLOWSERVE REGIONAL
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Flowserve Corporation
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Telephone 39 0362 6121
Fax 39 0362 303396

Latin America and Caribbean

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