



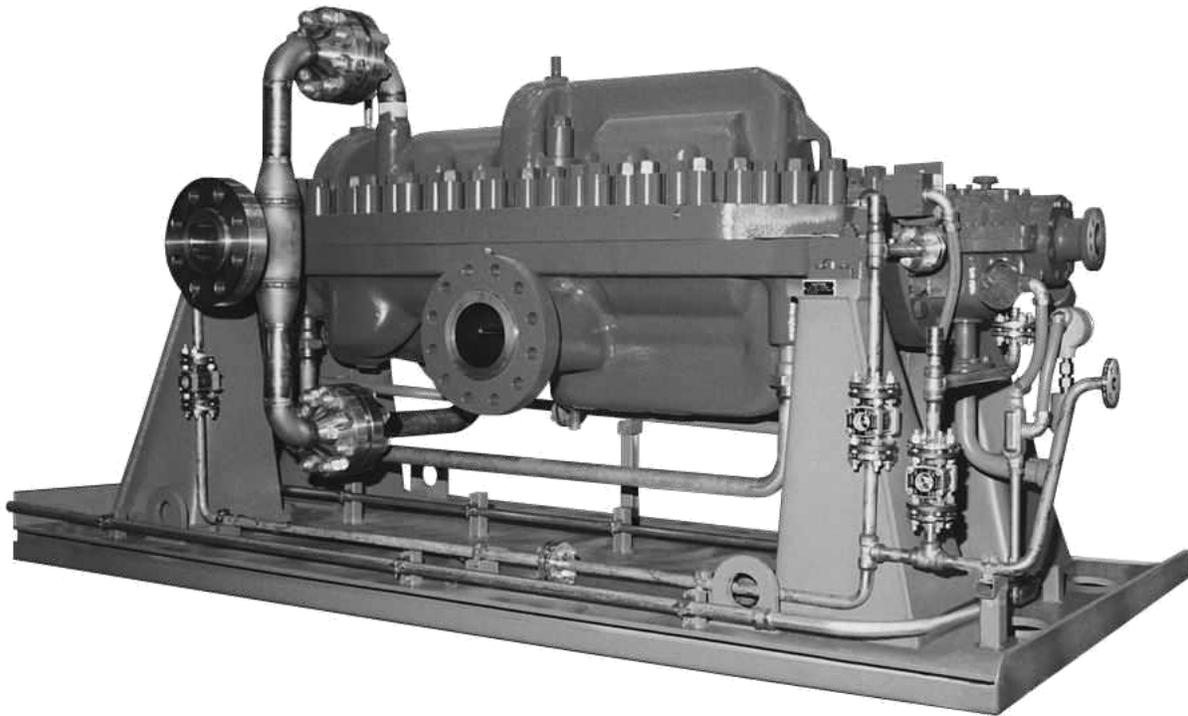
## USER INSTRUCTIONS

### **Flowserve<sup>®</sup> DMX/DMXD/DMXH/DMXDH centrifugal pumps**

Ball-ball configuration multistage, single/double suction,  
horizontally split volute type centrifugal pumps

PCN = 71569282 09-15 (E). Original instructions.

### **Installation Operation Maintenance**



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

***Experience In Motion***

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# 1 INTRODUCTION AND SAFETY

## 1.1 General



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

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

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

These instructions are intended to facilitate familiarization with the product and its permitted use. Operating the product in compliance with these instructions is important to help ensure reliability in service and avoid risks. The instructions may not take into account local regulations; ensure such regulations are observed by all, including those installing the product. Always coordinate repair activity with operations personnel, and follow all plant safety requirements and applicable safety and health laws 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 reliable. In spite of all the efforts of Flowserve to provide sound and all necessary information the content of this manual may appear insufficient and is not guaranteed by Flowserve as to its completeness or accuracy.***

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

## 1.4 Copyright

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

## 1.5 Duty conditions

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



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

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

## 1.6 Safety

### 1.6.1 Summary of safety markings

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



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



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



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

### 1.6.2 Personnel qualification and training

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

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

### 1.6.3 Safety action

**This is a summary of conditions and actions to 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



COUPLING GUARDS MUST NOT BE REMOVED WHILE THE PUMP IS OPERATIONAL.



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 an appropriate crane for the mass and in accordance with current local regulations.



THERMAL SHOCK

Rapid changes in the temperature of the liquid within the pump will 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 68 °C (154 °F) or below -5 °C (23 °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.

**CAUTION** PREVENT EXCESSIVE EXTERNAL PIPE LOAD

Do not use pump as a support for piping. Do not mount expansion joints, unless authorized 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 at full flow and damaging the pump at 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 seals. Low flow rates may cause a reduction in pump/bearing life, overheating of the pump, instability and cavitation/vibration.

**CAUTION** DO NOT RUN THE PUMP AT ABNORMALLY HIGH OR LOW FLOW RATES  
Operating at a flow rate higher than normal or at a flow rate with no backpressure on the pump may overload the motor and cause pump cavitation.

### 1.6.4 Products used in potentially explosive atmospheres

Measures are required to:

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

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

#### 1.6.4.1 Scope of compliance

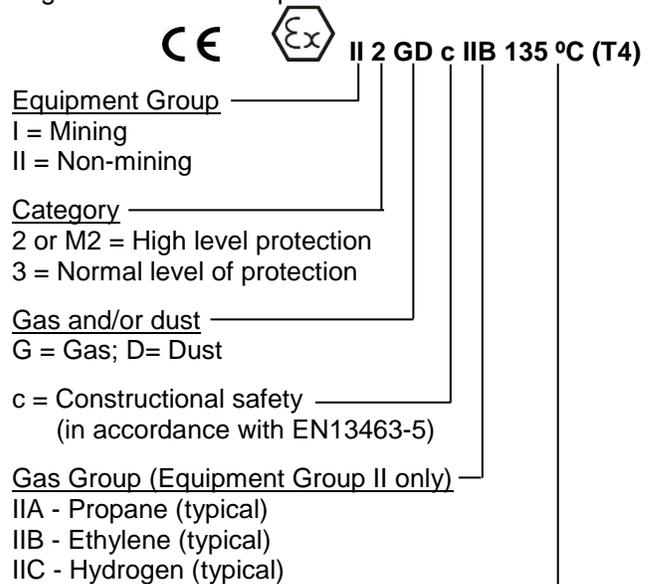
Use equipment only in the zone for which it is appropriate. Always check that the driver, drive coupling assembly, seal and pump equipment are suitably rated and/or certified for the classification of the specific atmosphere in which they are to be installed.

Where Flowserve has supplied only the bare shaft pump, the Ex rating applies only to the pump. The party responsible for assembling the ATEX pump set shall select the coupling, driver and any additional equipment, with the necessary CE Certificate/ Declaration of Conformity establishing it is suitable for the area in which it is to be installed.

The output from a variable frequency drive (VFD) can cause additional heating effects in the motor and so, for 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.

#### 1.6.4.2 Marking

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



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

**1.6.4.3 Avoiding excessive surface temperatures**



ENSURE THE EQUIPMENT TEMPERATURE CLASS IS SUITABLE FOR THE HAZARD ZONE

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

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

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

Temperature class to EN 13463-1	Maximum surface temperature permitted	Temperature limit of liquid
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 responsibility for compliance with the specified maximum liquid temperature is with the plant operator.**

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, the users shall fit an external surface temperature protection device.

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

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

**1.6.4.4 Preventing the build-up of explosive mixtures**



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

Ensure the pump and relevant suction and discharge pipeline system is 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, users shall fit an appropriate dry run protection device (e.g. liquid detection or a power monitor).

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

**1.6.4.5 Preventing sparks**



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

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

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

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

**1.6.4.6 Preventing leakage**



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

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

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

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

If leakage of liquid to atmosphere can result in a hazard, then a liquid detection device shall be installed.

**1.6.4.7 Maintenance to avoid the hazard**



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

**The responsibility for compliance with maintenance instructions is with the plant owner or 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.

A maintenance plan and schedule shall be adopted. (See section 6, *Maintenance*.)

**1.7 Warning labels**

<b>FLOWSERVE</b>		<b>WARNING</b>	J218JZ250
<b>ESSENTIAL PROCEDURES BEFORE STARTING:</b>			
INSTALL AND OPERATE EQUIPMENT IN ACCORDANCE WITH THE INSTRUCTION MANUAL SUPPLIED SEPARATELY.	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.	
ENSURE GUARDS ARE SECURELY IN PLACE.	<b>FAILURE TO FOLLOW THESE PROCEDURES MAY RESULT IN PERSONAL INJURY AND / OR EQUIPMENT DAMAGE</b>		
ENSURE CORRECT DIRECTION OF ROTATION.			

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 KOPPELING CORRECT UITGELIJNT IS ZOWEL VOOR-ALS NADAT DE GRONDPLAAT MET BOUTEN IS VASTGEZET EN DE LEIDINGEN GEINSTALLEERD ZIJN. ZIE HANDLEIDING VOOR TOELAABARE SPELINGEN.

**Oil lubricated units only:**

J218JZ262	
<b>WARNING</b>	<b>THIS MACHINE MUST BE FILLED WITH OIL BEFORE STARTING</b>
<b>ATTENTION</b>	<b>CETTE MACHINE DOIT ÊTRE REMPLIE D'HUILE AVANT LA MISE EN MARCHE</b>
<b>ACHTUNG</b>	<b>DIESE MASCHINE IST VOR DEM STARTEN MIT ÖL ZÜ FÜLLEN</b>
<b>WAARSCHUWING</b>	<b>DEZE MACHINE MOET VOOR HET STARTEN MET OLIE GEVULD WORDEN</b>

**1.8 Specific machine performance**

For performance parameters see 10.4 *Customer Data Sheet*. When the contract requirement specifies these to be incorporated into User Instructions these are included here.

Where performance data has been supplied separately to the purchaser these should be obtained and retained with these User Instructions if required.

**1.9 Noise level**

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

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

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

**1.9.1 Pump noise levels**

The following tables may be used to determine the estimated sound pressure levels (SPL), expressed in dBA (dB), for DMX/DMXD/DMXH/DMXDH pumps.

The values shown have been derived from actual noise test data and are based on the following conditions:

- a) Equipment is located in a free field above a reflecting plane in which the reduction in noise level in all directions is 6 dB in each octave band for each doubling of distance.
- b) Background noise is 10 dB (minimum) below all noise levels in each octave band.
- c) The values shown are at a distance of 1 m (3.3 ft), horizontally from major pump surfaces and 1.5 m (4.78 ft) above the floor using the standard pressure reference of 20 µPa (0.00002 N/m<sup>2</sup>).
- d) Overall noise level, dBA ("A" scale) is determined at points of maximum noise level, and the values of all mid-band frequencies are basis "C" scale readings.

**1.9.2 Overall noise level**

Tables below show dBA levels for two stage and three or more stage pumps, based on the best efficiency point (BEP) at design r/min and required impeller diameter.

For specific gravities less than 1.0, use 1.0 specific gravity. For specific gravities above 1.0, use the actual specific gravity.

When the required condition flow falls outside the range of 75 % to 125 % of BEP, a part load correction (PLC) must be added to the noise levels as follows:

Percent of BEP at required impeller diameter	PLC DB
74 to 62 % or 126 to 136 %	+1
61 to 50 % or 137 to 150 %	+2
49 to 38 %	+3
37 to 25 %	+4

Brake horse power at best efficiency point	dBA
2 stage pump	
250 to 350	87
350 to 500	88
500 to 700	89
700 to 940	90
940 to 1 100	91
1 100 to 1 300	92
1 300 to 1 500	93
Above 1 500, contact Flowserve	94

Brake horse power at best efficiency point	dBA
3 to 14 stages	
90 to 110	79
110 to 140	80
140 to 180	81
180 to 220	82
220 to 280	83
280 to 360	84
360 to 450	85
450 to 560	86
560 to 720	87
720 to 900	88
900 to 1 125	89
1 125 to 1 400	90
1 400 to 1 800	91
1 800 to 2 250	92
2 250 to 2 800	93
2 800 to 3 600	94
3 600 to 4 500	95
4 500 to 5 700	96
5 700 to 7 200	97
7 200 to 9 000	98
9 000 to 11 000	99
11 000 to 14 000	100

### 1.9.3 Combined noise levels for pump and driver components

When two or more sources produce noises that are sufficiently unrelated (so that interference effects do not occur) the total combined noise level may be obtained by a simple addition of dB values according to the table below.

Difference between two levels to be combined, dB	Add to higher level to obtain combined level, dB
0	3
1	2.5
2	2
4	1.5
6	1
9	0.5
10	0

## 2 TRANSPORT AND STORAGE

### 2.1 Consignment receipt and unpacking

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

Any shortage and or damage must be reported immediately to Flowserve and 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.

#### 2.1.1 Receipt inspection

**Note:**

The following information regarding receiving is only offered as a general guideline to the customer. Flowserve requires that all receiving be conducted in accordance with specifications set forth in chapter 3, *Jobsite Receiving and Protection*, from API Recommended Practices 686/PIP REIE 686, First Edition.

***The pump and its associated equipment were carefully inspected at the factory prior to shipment to ensure quality compliance. It is suggested that the pump be inspected upon arrival and that any irregularities or damage be reported to the carrier immediately.***

The condition of the skid and covering is indicative of the way the shipment was handled. Broken skids, torn coverings, bent hold-down bolts, broken straps, etc. indicate rough handling.

The protective covers on the pump nozzles should be in place and undamaged.

**2.1.2 Unpacking**

The pump should arrive already mounted on the baseplate and it is therefore suggested that the unpacking of the equipment should proceed per instruction as outlined in this manual.

In general, care is to be taken when removing crating, coverings and strapping in order not to damage any auxiliary equipment and or the paint finish.

**2.1.3 Paint/rust preventive**

Internal parts of the pump and bearing housings are protected prior to shipment with a rust preventive such as Dasco guard 2408M. This can be removed with petroleum solvents.

External non-machined surfaces are painted with one of the applicable Flowserve coatings.

Parts ordered separately are protected with a rust preventive such as Dasco guard 2408M. This can be removed with petroleum solvents.

**2.2 Handling**

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

**2.3 Lifting**

**CAUTION** To avoid distortion, the pump unit should be lifted as shown.

**TRAINED PERSONNEL**

**A crane must be used for all pump sets in excess of 25 kg (55 lb). Fully trained personnel must carry out lifting, in accordance with local regulations. The driver and pump weights are recorded on their respective nameplates or mass plates.**

**2.3.1 Lifting equipment**

**Note:** The following information regarding lifting is only offered as a general guideline. Flowserve requires that all lifting and rigging be performed in accordance with specifications set forth in chapter 2, *Lifting and Rigging*, from API Recommended Practices 686/PIP REIE 686, First Edition.

**EQUIPMENT CAPACITY**

**Make sure that any equipment used to lift the pump or any other of its components is capable of supporting the total weight encountered. Make sure that all parts are properly rigged before attempting to lift.**

**2.3.2 To lift unit**

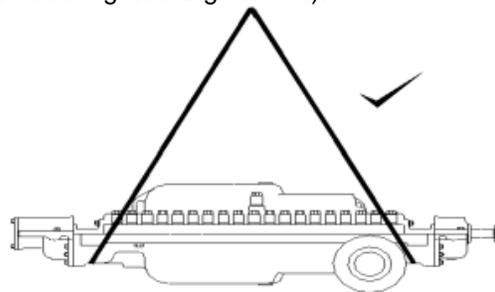
**CAUTION** The complete unit with pump, driver and auxiliary equipment all mounted on the baseplate can NOT be lifted as a unit. Driver must be removed from baseplate before lifting. To lift unit sling baseplate from all lifting eyes. Failure to do this may result in permanent deformation of baseplate. Damage to baseplate caused by mishandling or improper setting prior to grouting is not covered by Flowserve's warranty.

**2.3.3 To lift driver**

Refer to driver manufacturer's instructions.

**2.3.4 To lift pump**

Install sling from overhead hoist and under bearing housing mounting brackets (cast portion of casing where bearing housings attach).



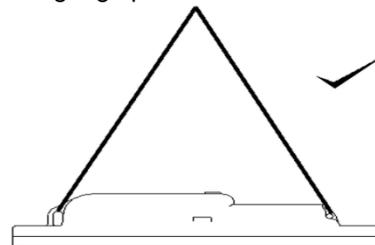
Proper lifting practice for pump

**LIFTING PRACTICE**

**Do not lift entire pump from cast lifting lugs on upper half casings. These lugs are for lifting upper half casing only.**

**2.3.5 To lift half casing**

To lift upper half casing, rig to overhead hoist from cast lifting lugs provided.

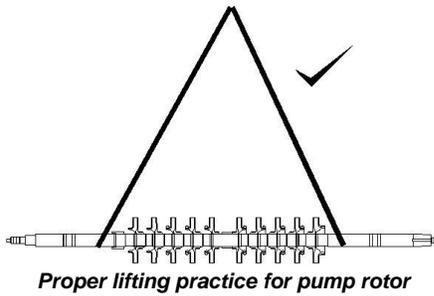


Proper lifting practice for upper case

To lift the pump bottom half casing, slings can be attached to the pump feet, casing boltholes or padded slings can be used around the outer casing.

**2.3.6 To lift pump rotor**

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



## 2.4 Extended storage

**Note:** The following information regarding receiving is only offered as a general guideline. Flowserve requires that all receiving be conducted in accordance with specifications set forth in chapter 3, *Jobsite Receiving and Protection*, from API recommended Practices 686/PIP REIE 686, First Edition.

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

It should be noted, that unless otherwise agreed to, full responsibility and costs associated with the storage and inspection of this equipment rests with the customer.

**CAUTION** If pump is equipped with a mechanical seal and is stored or has not been run for one year or more, the mechanical seal must be removed before start-up and faces re-lapped to guard against the possibility of seal leakage. When reinstalling the seal, new O-rings and gaskets must be used.

### 2.4.1 Pump inspection upon arrival

When the pump is received, it should be inspected for damage or other signs of rough handling. Any damage if found should be reported to the carrier immediately.

Inspect the preservative coating on the various parts. If necessary, renew the preservative in areas where it has rubbed off or scraped.

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

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

### 2.4.2 Storage area

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

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

### 2.4.3 Storage preferred (dry)

If at all possible, the pump and its components should be stored indoors where they will be protected from the elements. If it is not possible to store the pump and its components indoors, precautions must be taken to protect them from the elements. Regardless of whether storage is inside or outside, the storage area should be vibration-free. All boxes that are marked for inside storage must be stored indoors. Coverings of heavy gauge plastic sheets, canvas, waterproof burlap or other suitable coverings should protect the pump and its components from dirt, dust, rain, snow or other unfavorable conditions when stored outdoors.

All equipment must be placed upon skids or blocks to prevent contact with the ground and surface contaminants. Equipment must be adequately supported to prevent distortion and bending.

#### 2.4.3.1 Rotor storage

It is recommended that pump rotor be removed from pump and stored vertically. Rotors may also be stored horizontally in the pump. Rotors that have to be stored horizontally outside the pump must be supported close to the impeller to eliminate sag that may cause the rotor to take a permanent set.

#### 2.4.3.2 Customer inspection

The stored equipment is to be placed on a periodic inspection schedule by the customer.

**Note:** The responsibility for setting up an inspection and maintenance schedule rests with the customer and will be dependent upon the class/type of storage provided.

Initially inspection would occur weekly then, depending upon the inspection reports being favorable or unfavorable, inspection would continue weekly, monthly or quarterly, as may be determined. Inspection reports must be kept on file.

Every inspection should consist of a general surface inspection.

- a) Pump supports are firmly in place.
- b) Pump covers over openings are firmly in place.
- c) Pump coverings, plastics or tarps, are firmly in place. Any holes or tears must be repaired to prevent entrance of dirt or water.
- d) Pump covers are periodically removed from openings and interior accessible areas inspected. If surface rusting has occurred, clean and repaint or re-coat with preservative.
- e) If rusting occurs on exterior surfaces, clean and repaint or re-coat with preservative.
- f) Loosen casing drain plugs to allow seepage of any accumulated moisture.
- g) If the rotor is stored horizontally, rotate pump rotor 1 1/4 revolutions at least once a month to prevent rotor from taking a permanent set.



Make sure bearings have adequate lubrication before turning rotor.



The oil ring inspection plug on top of the bearing housing is to be removed and a small amount of oil poured over the journals before turning.

- h) Periodically remove bearing covers and inspect for accumulation of moisture, rust and foreign material. As required, clean bearings and bearing housing and re-preserve. Install bearing cover and secure to assure maximum protection. Bearings removed for storage should be coated with preservative, wrapped in oil/wax paper, and stored in a warm dry area.
- i) Check individually wrapped parts for signs of deterioration. If necessary, renew preservative and wrapping.



If storage is over one month, instrumentation (controls, electrical devices, temperature switches) should be removed and placed in a climate controlled environment if instrumentation is not powered up.

**2.4.3.3 Prior to installation maintenance**

Six months prior to the scheduled installation date, a Flowserve representative is to be employed to conduct an inspection. All costs involved during inspection, dismantling, restoration, replacement of parts and reassembly will be the responsibility of the customer.

The customer will supply all necessary labor, tools and cranes. This inspection will include (not necessarily in its entirety) but not be limited to the following:

- a) An inspection of all periodic inspection records as kept on file by the customer, and all inspection reports that have been compiled during the storage period.
- b) An inspection of the storage area to determine the "as stored" condition of the equipment prior to any protection being removed.
- c) An inspection of the equipment with protection covers and flange covers removed.
- d) Depending upon the length of time the equipment was stored, the class/type of storage provided, (i.e: indoor, heated, unheated, ground floor, concrete floor, out-of-doors, under roof, no roof, waterproof coverings, on concrete, on ground) and as a result of the inspection of a, b and c above, Flowserve representative may require a partial or complete dismantling of the equipment.
- e) Dismantling may necessitate restoration of painted or preserved surfaces, and or replacement of gaskets, O-rings and mechanical seals and bearings. Use only Flowserve recommended replacement materials.

Upon completion of the inspection, the Flowserve representative shall submit a report to the customer, and to the Manager of Customer Service, stating in detail the result of the inspection.

If there are any discrepancies identified, it is the customer's responsibility for correction before initial startup.

**2.4.4 Storage non-preferred (wet)**

It is not recommended that the rotor be subjected to extended periods of submergence or wetting prior to start-up. However, it is recognized that in some cases, a long period of time may lapse from installation until commercial operation.

If the pump must be stored after being installed and wetted, the following inspection and maintenance should be performed:

- Isolate the pump with valving - tag (seal) all valves
- Preserve the pump internals



If storage is over one month, instrumentation (controls, electrical devices, temperature switches) should be removed and placed in a climate controlled environment if instrumentation is not powered up.



Electric motors (pump driver) should not be stored in damp places without special protection. (Refer to motor manufacturer's instructions).

**2.4.4.1 Corrosive pumpage**

Fill the pump entirely with an approved preservative such as #2004-Chempagard 9 from Chempak. The pump should be filled to highest level possible, affording the greatest protection possible to all internal parts of the pump.

This solution, when drained, will result in a thin residual oil film (less than 0.0127 mm [0.0005 in.]) on all internals after the water has evaporated. This residue provides added corrosion protection until pump is again filled with liquid or put into service.

**Note:** Pump cannot be fully drained. Volutes in the lower half cannot be drained below the bottom of the main casing bore.

**2.4.4.2 Non-corrosive pumpage**

Fill pump with pumpage to the highest level possible. Periodically open drain the connection to drain off any moisture that may have accumulated. Refill to highest level possible. Drain and inspect pump prior to start-up.

- a) Rotate pump rotor 1 1/4 revolutions at least once a month.



Make sure bearings have adequate lubrication before turning rotor.

- b) Periodically remove bearing covers and inspect for accumulation of moisture, rust and foreign material. As required, clean bearings and bearing housing and re-preserve. Install bearing cover and secure to assure maximum protection.

**2.4.4.3 Painting and preservation**

Paints and preservatives used are either Flowserve standard or special as required by the contract specification. Refer to 2.1.3, *Paint/rust preventive*, for the description of paints and preservatives used in this order or contact the branch office through which the order was placed.

**2.5 Recycling and end of product life**

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



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

**3 PUMP DESCRIPTION**

The DMX is a multistage single or double suction, opposed impeller, horizontally split volute pump.

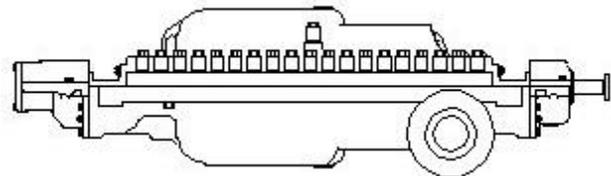
The suction and discharge nozzles are cast integral with the lower half casing. Rotating parts are accessible by removing the upper half casing, which can be removed without breaking suction and discharge piping.

**3.1 Configurations**

The DMX can have the following configurations:

**3.1.1 Single suction**

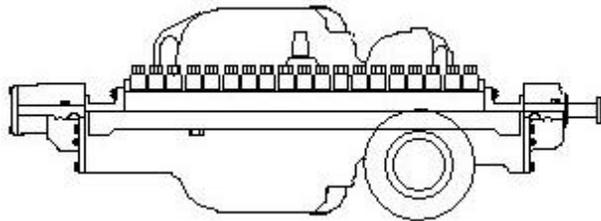
Single suction impeller at first stage (DMX)



Single suction configuration

**3.1.2 Double suction**

Double suction impeller at the first stage (DMXD)



Double suction configuration

**3.2 Name nomenclature**

The pump nomenclature is:

**3X10DMX10**

The 3 is the pump discharge size

The X is the separator

The 10 is the nominal impeller size

The DMX is pump type

The 10 is the number of stages and depending on pump size, they go from 2 to 14 stages

- DMX = single suction standard pressure
- DMXD = double suction standard pressure
- DMXH = single suction high pressure
- DMXDH = double suction high pressure

### 3.3 Design of major parts

#### 3.3.1 Casing

The casing provides for immediate containment of the liquid being pumped, while directing the flow of liquid from the suction nozzle to the impellers and subsequently through the volute to the discharge nozzle.

The casing halves are sealed by the use of a gasket and are joined together by studs, which are installed in the lower half casing and fastened with washers and cap-nuts.

#### 3.3.2 Impellers

The impellers are single suction, enclosed type, and are a one-piece construction and dynamically balanced. They are fitted with renewable impeller rings (front and back), which are held in place by headless set-screws.

The impellers are keyed and have a shrink fit to the pump shaft. They are held in axial position by a split ring.

#### 3.3.3 Casing rings

Casing rings are positioned over the impeller front rings. These rings are tubular and renewable.

#### 3.3.4 Channel rings

Renewable cast channel rings are positioned over the impeller back rings. They divide the casing into stages. These rings are horizontally split and are held together by shoulder screws or dowel pins.

#### 3.3.5 Center sleeve

A renewable type center sleeve is used under the center bushing. The center sleeve is tubular and keyed to the shaft (via the impeller key).

#### 3.3.6 Center bushing

The renewable center bushing is horizontally split, and the two halves are held together by socket head cap screws and taper dowel pins. It is held in position by the raised annular ring of the bushing engaging the annular groove in the casing. The center bushing, in conjunction with the center sleeve, divides the casing at the center (back to back) impellers.

#### 3.3.7 Throttling sleeve

A renewable type throttling sleeve is used under the throttling bushing. The throttling sleeve is tubular, keyed, and has a shrink fit to the shaft. It is held in position by a split ring.

#### 3.3.8 Throttling bushing

Renewable type throttling bushing is used. It is held in position by the raised annular ring of the bushing engaging the annular groove in the casing. The throttling bushing, in conjunction with the throttling sleeve, allows pressure to be bled off through the balance line, so that pressure on the seal chambers is balanced. The throttling bushing also balances the axial thrust of the pump rotor.

#### 3.3.9 Crossover sleeve

A renewable type crossover sleeve under crossover bushing is only used on double suction pumps (DMXD/DMXDH). The crossover sleeve is tubular, keyed, has a shrink fit to the shaft, and is held in position by a split ring.

#### 3.3.10 Crossover bushing

A renewable type crossover bushing is only used on double suction pumps (DMXD/DMXDH). The crossover bushing is horizontally split, and the two halves are held together by taper dowel pins. It is held in position by the raised annular ring of the bushing engaging the annular groove in the casing. The crossover bushing, in conjunction with the crossover sleeve, controls the leakage between the first and second stage impellers.

#### 3.3.11 Shaft

The high strength shaft is ground over its entire length to close tolerances. The shaft is designed to transmit the required power without vibration and is stepped at each impeller fit for ease of assembly and disassembly.

#### 3.3.12 Bearings

The plain and thrust ball bearings are lubricated by means of oil rings, which run on journal sleeves and in the oil reservoir of the bearing housings.

The plain ball bearings are a single-row deep-groove type, free to adjust axially in the bearing housing.

The thrust ball bearings are of the double row (mounted back to back) angular contact type, and are of ample size to carry the thrust loads encountered in service.

The pump bearings are renewable.

#### 3.3.13 Seal chambers

The seal chambers are cast integral with the casing. The pump is typically shipped with the mechanical seal already installed.

The mechanical seal is designed to suit each application. This creates the correct seal loading face when seal gland is bolted in place.

Cartridge type mechanical seals are preset at the seal manufacturer’s facility and require no field settings. The seal installation should be checked before start-up.

Refer to the mechanical seal manufacturer’s drawing and instructions found in section 8 of this manual for detailed information.

### 3.4 Performance and operating limits

Refer to section 10.4 *Customer data sheet*.

## 4 INSTALLATION

**Note:** The installation/commissioning of this equipment must be conducted in accordance with API Recommended Practices 686/PIP REIE 686 - First Edition.

Copies of API Recommended ‘Practices’ 686/PIP REIE 686 - First Edition may be obtained from:  
 America Petroleum Institute  
 1220 L Street, N.W.  
 Washington, D.C. 20005.  
 Telephone: (202) 682-8000.

### 4.1 Location

Install the unit close to the source of the liquid to be pumped.



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

When selecting the location, be sure to allow adequate space for operation as well as for maintenance operations involving dismantling and inspections of parts.

Headroom is an important consideration as an overhead lift of some type is required.

### 4.2 Foundation

**Note:** The following information regarding foundation is only offered as a general guideline. Flowserve requires that all foundations be designed and installed in accordance with specifications set forth in chapter 4, *Foundations*, from API Recommended Practices 686/PIP REIE 686, First Edition.

The design of foundation is not the responsibility of Flowserve. It is therefore recommended that the customer consult a competent specialist skilled in the

field of foundations, to ensure proper design/installation of the foundation.

The foundation should be properly prepared according to the planned grouting method. See 4.3, *Grouting*, for details.

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

The most satisfactory foundations are made of reinforced concrete. These should be poured well in advance of the installation to allow proper time for drying and curing.

The General Arrangement Drawing will show required anchor bolt locations and size of bolts.

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

A clean rough-finish top surface is required when applying grout.

#### 4.2.1 Installation check list

- a) Level baseplate.
- b) Preliminary alignment.
- c) Grout baseplate - check foundation bolts.
- d) Alignment shaft/coupling.
- e) Piping installed – correct vent, gauge, valve, suction strainer and pipe support locations?
- f) Check coupling alignment.
- g) Coupling guard correctly installed?

#### 4.2.2 Level the baseplate

**Note:** The following information regarding leveling of equipment is only offered as a general guideline. Flowserve requires that all leveling of equipment be performed in accordance with specifications set forth in chapter 5, *Mounting Plate Grouting*, from API Recommended Practices 686/PIP REIE 686, First Edition.

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

**Note:** When lifting baseplate with pump, sling baseplate from all lifting eyes provided. Failure to do this may result in permanent deformation of the baseplate.

**Note:** Pump, driver auxiliary equipment and piping must be removed from the baseplate before leveling the baseplate.

Locate the baseplate in its proper position on the concrete block together with the leveling screws as shown in the General Arrangement Drawing.

Using a precision level across the machined surfaces of the pump and driver mounting pads, adjust leveling screws as necessary to ensure that baseplate is leveled in all directions.

When the baseplate is leveled, snug the foundation bolts, but do not completely tighten.

#### 4.2.3 Preliminary alignment

Using the previous procedure, adjust baseplate until pump and driver are within 0.076 mm (0.003 in.).

### 4.3 Grouting

**Note:** The following information regarding grouting is only offered as a general guideline. Flowserve requires that all grouting be installed in accordance with specifications set forth in chapter 5, *Mounting Plate Grouting*, from API Recommended Practices 686/PIPR EIE 686, First Edition. Refer to *API 610 - Eighth Edition - Appendix 'L'* for baseplate grouting requirements. It is recommended that the customer consult a competent specialist skilled in the field of grouting, to ensure the proper installation of all grouting.

The following ASTM Specifications are furnished as references for test methods used in conjunction with installation of grouting materials and should be used to obtain proper results:

- ASTM C 78-84, *Test Method for Flexural Strength for Concrete*
- ASTM C 109-90, *Test Method for Compressive Strength of Hydraulic Cement Mortars – Modified*
- ASTM C 469-87a, *Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression*
- ASTM C 496-90, *Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens*
- ASTM C 531-85, *Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical Resistant Grouts and Monolithic Surfacing - Modified*
- ASTM C 666-90, *Test Method for Resistance of Concrete to Rapid Freezing and Thawing*

- ASTM C 939-87, *Test Method for Flow of Grout for Preplaced Aggregate Concrete (Flow Cone Method)*
- ASTM C 942-86, *Test Method for Compressive Strength of Grouts for Preplaced Aggregate Concrete in the Laboratory*
- ASTM C 1090-88, *Test Method for Measuring Changes in Height of Cylindrical Specimens from Hydraulic Cement Grout*
- ASTM C 1107-91, *Standard Specification for Packaged Hydraulic-Cement Grout (Non-Shrink)*
- (CRD-C 621-92), ACI 351, *Grouting for Support of Equipment and Machinery*
- 24-Hour Test, *MBT Test Method for Grout Performance*

**Note:** Minimum requirements for epoxy grout [typical properties at 23 °C (73 °F)]

- ASTM D-635, *Fire Resistant*
- ASTM C-579B, *Minimum Compressive Strength – 12 000 psi*
- ASTM C-827, *Height Change @ 38 °C (100 °F) – Positive – effective bearing area – 95%*
- ASTM C-1181, *maximum creep in 1 year – 1.6X10<sup>-3</sup> in./in. at 140 °F, 400 psi*
- ASTM C-307, *minimum tensile strength – 12.4 Mpa (1 800 psi)*
- ASTM C-580, *minimum flexural strength – 26.2 Mpa (3 800 psi)*
- ASTM C-580, *minimum flexural secant modulus – 1.2X10<sup>4</sup> Mpa (1.8X10<sup>6</sup> psi)*
- ASTM C-531, *maximum coefficient of expansion – 17X10<sup>-6</sup> in./in./°F. Maximum peak exotherm 1 000 g (35.27 oz.) insulated – 35 °C (95 °F). Full aggregate must be used.*

#### 4.3.1 Grouting material

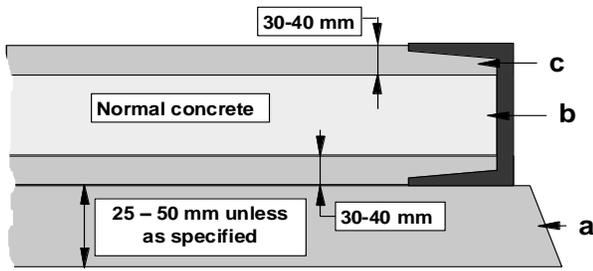
##### 4.3.1.1 Normal grout material

A quality, high strength, non-shrink cementitious grout material shall be used for installation. Epoxy is preferred.

##### 4.3.1.2 Layered grout material

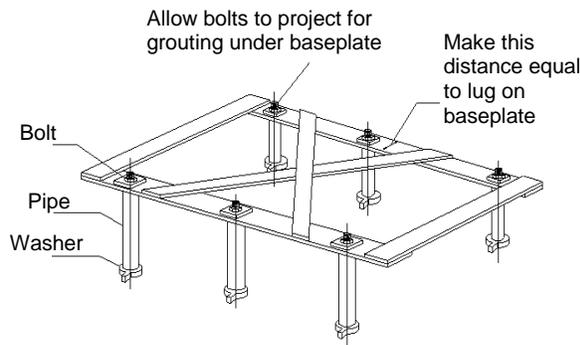
A layered combination of non-shrink cementitious grout and normal industrial concrete can be used. (See sketch below for example.)

- a) The first layer shall be 25-50 mm plus a layer of 30-40 mm of normal grout material as described in 4.3.1.1.
- b) The second layer is normal industrial concrete poured to a level that is approximately 30-40 mm from the top of the baseplate decking.
- c) The top layer is 30-40 mm normal grout material as described in 4.3.1.1.



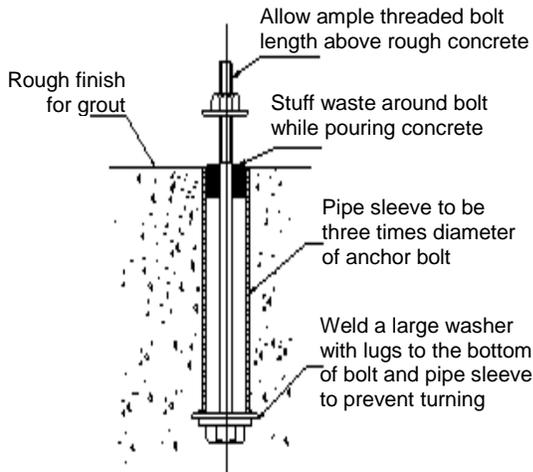
**4.3.2 Grouting method A**

a) Prepare the foundation properly as specified in the sketches below.



*Template for hanging foundation bolts*

The sketch illustrates a recommended foundation bolt arrangement. Notice the large washer with lugs at the bottom. It should be welded to the bolt and pipe sleeve to prevent turning.



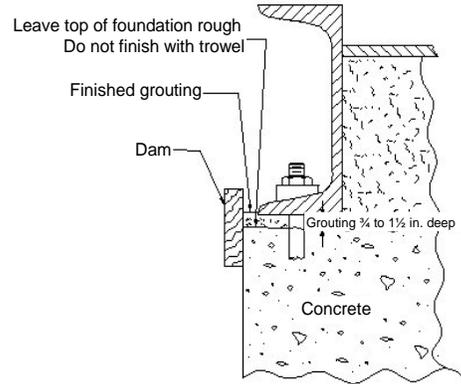
*Foundation complete description*

b) Build a dam around the foundation to contain grout materials.



Before grouting, check level of machined pads of baseplate in both directions and perform a rough shaft/coupling alignment. Alignment after grout has set will not be possible if above is not satisfactorily completed.

c) Grout leveling space and baseplate as per manufacturer's instructions. Holes are provided in the baseplate to permit pouring the grout and distributing. Vent holes are also provided in each compartment. Fill under the baseplate completely, stirring to assure proper distribution of the grout. Check to see that the grout flows under the edges of the baseplate evenly.



*Building dam around the foundation before pouring grout*

**Note:**

Pour grout until level reaches top of dam. Allow drying sufficiently to prevent grout overflowing while completing the remaining grouting.

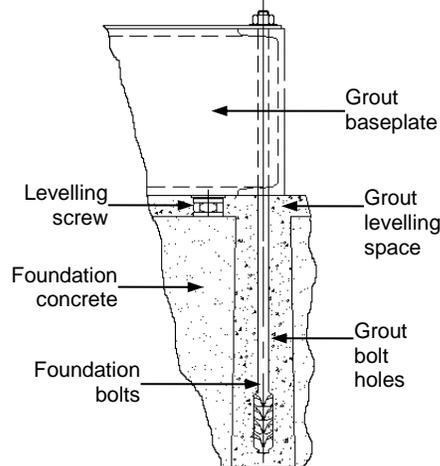
**Note:**

Do not vibrate baseplate when grouting; make sure baseplate is vented properly and all areas indicated on General Arrangement drawing are thoroughly filled to prevent any resonant problems.

d) When grout is thoroughly hardened, remove dam.  
e) Completely tighten the foundation bolts.

**4.3.3 Grouting method B**

a) Prepare foundation properly as shown in the General Arrangement Drawing. The bolt holes must be tapered to the top.



*Foundation and grouting description*

- b) Build a dam around the foundation to contain grout materials.
- c) Grout the foundation bolt holes as per the manufacturer's instructions. Ensure that the grout fills all open space and eliminates all air pockets.



Before grouting levelling space and baseplate, check level of pads of baseplate in both directions and perform a rough shaft/coupling alignment. Alignment after grout has set will not be possible if above is not satisfactorily completed.

- d) Grout leveling space and baseplate as per manufacturer's instructions. Holes are provided in the baseplate to permit pouring the grout and distributing. Vent holes are also provided in each compartment. Fill under the baseplate completely, stirring to assure proper distribution of the grout. Check to see that the grout flows under the edges of the baseplate evenly.

**Note:**

Pour grout until level reaches top of dam. Allow drying sufficiently to prevent grout from overflowing while completing the remaining grouting.

**Note:**

Do not vibrate baseplate when grouting; make sure baseplate is vented properly and all areas indicated on General Arrangement drawing are thoroughly filled to prevent any resonant problems.

- e) When grout is thoroughly hardened, remove dam.
- f) Completely tightened the foundation bolts.

## 4.4 Initial alignment

### 4.4.1 Shaft/coupling alignment

**Note:**

The following information regarding shaft alignment is only offered as a general guideline. Flowserve requires that all shaft alignment be performed in accordance with specifications set forth in chapter 7, *Shaft Alignment*, from API Recommended Practices 686/PIP REIE 686, First Edition.



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

**Note:**

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

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

#### 4.4.1.1 Types of misalignment

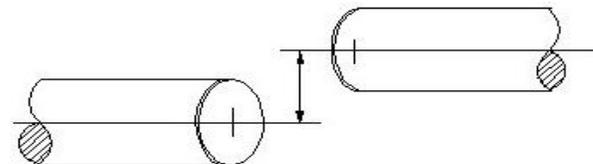
There are two types of shaft misalignment: angular and offset. Both types of misalignment can occur in horizontal and vertical planes and are present in most applications.

In angular misalignment, the centerline of the shafts intersects, but is not on the same axis.

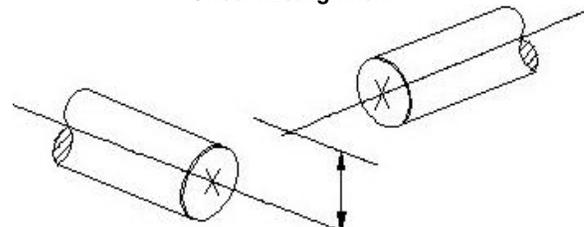


Angular misalignment

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



Offset misalignment

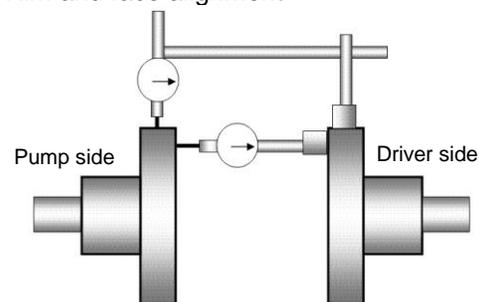


Combined misalignment

#### 4.4.1.2 Alignment methods

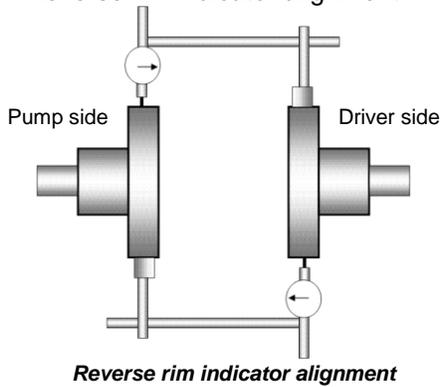
The following methods may be used to align the equipment train. The methods a) and b) are dial indicator based.

- a) Rim and face alignment



Rim and face alignment

b) Reverse rim indicator alignment



c) Laser alignment.

**4.4.2 Dial-indicator-based alignment**

**4.4.2.1 Check soft foot**

Soft foot can affect the alignment readings and should be checked first and eliminated on both pump and driver.

- a) Tighten hold down bolts.
- b) Set a dial indicator on one foot, loosen the bolt and check if there is an indicator reading. If so place a shim with the same thickness as the displacement.
- c) Check and adjust all feet.

**4.4.2.2 Set DBSE**

The shaft gap, or distance between shaft ends (DBSE), must be in accordance with the certified General Arrangement Drawing and must be measured with pump and driver shafts in the center of their axial end float. Motor with sleeve bearings is to be aligned with rotor at magnetic center.

Move driver to ensure proper gap distance.

**Note:** It is recommended that the pump hold-down bolting be torqued before taking any alignment measurements. This makes the pump the fixed machine and the driver the movable machine. In certain cases, however, it may be impractical to move the driver; therefore, the pump may have to be moved.

**4.4.2.3 Determine bracket sag**

Bracket sag must be determined and included in the alignment calculation.

- a) Install clip with extension pieces and dial indicator(s).
- b) Place indicator on top and reset to zero, turn 180° and read indicator and register.
- c) Record sag reading obtained at the bottom.
- d) Side to side readings need not to be corrected as the sag is equal on both sides.

**4.4.2.4 Determine misalignment and correct vertical plane**

Before moving the equipment vertically, it is important that the vertical thermal expansion be taken into consideration. Refer to General Arrangement Drawing notes and or driver instructions for recommended cold vertical setting (if thermal expansion is a factor).

The shims between the motor feet and mounting surface should be clean and dry. This is especially critical for equipment that has been in service for some time and need to be realigned. Water, dirt and rust may change the height of the shim pack over a period of time. Shims should be made large enough to support the weight of the motor on its mounting foot. Do not use many thin shims, as this may result in a spongy mounting.



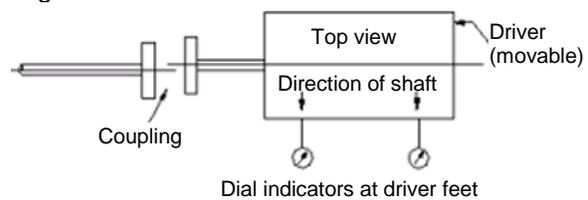
**Recommended shim design**

Move the equipment vertically by adding or removing the calculated thickness of shims. Torque equipment hold-down bolts to required values.

**4.4.2.5 Determine misalignment and correct horizontal plane**

The dial indicators shown below are required to accurately measure the move in the horizontal direction.

Move the driver by bumping with soft hammer/mallet or using jack-screws (if provided). The amount of horizontal relocation required is calculated in the alignment data sheet.



**Dial indicators configuration**

**Note:** It is recommended that the completed alignment document be retained as part of your permanent maintenance file.

**4.4.3 Laser alignment**

The use of laser alignment greatly simplifies the alignment process. Because of equipment and software differences, this will only describe laser alignment in general steps.

- a) Prior to alignment process the baseplate must be leveled.
- b) Check for soft foot condition. Uneven base height, dirty or corroded foot or other irregularities
- c) Rough align the pump and motor shafts with a straight edge.
- d) Mount the laser emitter on the pump shaft, and the laser target on the motor shaft.
- e) Link the shaft ends so they rotate together.
- f) Adjust shim stack heights for vertical parallelism and angular alignment per laser unit's output. Make the necessary corrections by adding or by removing shims at the motor feet.
- g) Adjust the motor position sideways for horizontal and angular alignment per the laser unit's output by using a soft mallet or adjusting screws.
- h) Tighten all pump and motor feet fasteners.
- i) Verify the final alignment

**4.4.4 Check coupling alignment**

The angular and offset coupling alignment must be rechecked.

- a) Coupling faces are to be parallel within 0.0254 mm (0.001 in.) TIR.
- b) Coupling outside diameters is to be aligned within 0.0762 mm (0.003 in.) TIR.
- c) Motor-driven: "bump" the motor and check motor rotation.
- d) Turbine-driven: check turbine rotation. (If wrong, consult turbine manufacturer.)

**4.4.5 Assemble coupling**

- a) Assemble coupling per the manufacturer's instructions included in section 8 of this manual.
- b) Install coupling guard.

**4.4.6 Dowel pump and driver**

**4.4.6.1 Cold pumps - temperature below 93 °C (200 °F)**

Pump hold down bolts are to be torqued to the proper value and dowel pins put in two diagonally opposite feet.

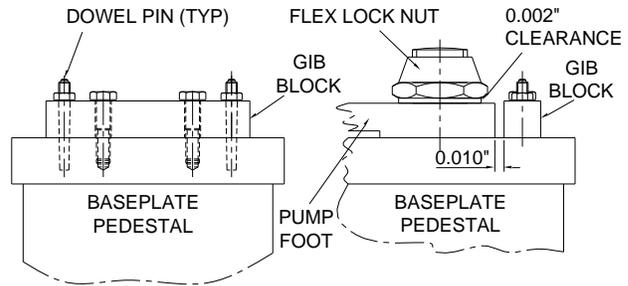
**4.4.6.2 Hot pumps**

Pumps handling liquids at temperatures of 94 °C (200 °F) and over are designed to permit the casing to expand with temperature away from the coupling end of the pump. The units that come under this classification must have the pump support feet dowelled to the pedestal at the coupling end. This maintains the coupling gap at the desired amount.

The pump feet at the opposite end are held from moving vertically by the use of a self-locking nut. The clearance between the base of the nut and the top of the pump foot should be 0.051 mm (0.002 in.).

A gib-block running parallel to the length of the pump foot at each of the outboard feet controls the horizontal movement. The gib-blocks are bolted and doweled to the pedestal. A 0.254 mm (0.010 in.) gap is maintained between the gib-block and pump foot.

**! The self-locking nuts, which hold the pump from moving in a vertical motion, are clamped tight to the pump foot at the time of shipment. The 0.051 mm (0.002 in.) clearance must be established at time of installation.**



*Gib-block installation sketch for hot pump*

**4.4.6.3 Pump driver**

Refer to General Arrangement Drawing and/or driver instructions for doweling information.

**4.4.7 Gib-block installation for hot applications**

Gib-blocks are installed to control the direction of the growth while maintaining pump-driver coupling alignment. They are installed after the baseplate has been leveled and grouted, suction and discharge piping connected, and final shaft coupling alignment is completed.

Gib-blocks are shipped loose and field installed at the site. The following procedure must be followed for correct installation of gib-blocks:

- a) Fully torque the hold-down bolts in the driver end of pumps feet to torque values listed in the instruction manual. (Refer to *Sectional Assembly Drawing* in section 8.)
- b) Install the dowel pins in the pump drive end foot by drilling the foot and the baseplate for the tapered dowel provided.
- c) Position the gib-blocks to obtain a 0.254 mm (0.010 in.) clearance between the gib-block and the side of the non-drive end pump foot as noted on the attached figure. Drill and tap the cap screw holes for the gib-blocks.
- d) Tighten the hold-down bolts for the gib-blocks.
- e) Install the dowel pins in the gib-blocks by reaming the block and baseplate for the tapered dowel provided.
- f) Tighten the hold-down locknuts on the non-drive end pump feet to establish a 0.051 mm (0.002 in.) gap between the locknut and the pump foot.

#### 4.4.8 Hot alignment check

A hot check can only be made after the unit has been in operation a sufficient length of time to assume its NORMAL operating temperature and conditions. If the unit has been correctly cold set, the offset misalignment will be within 0.076 mm (0.003 in.) TIR and the angular misalignment will be within 0.0254 mm (0.001 in.) TIR when in operation. If not, make adjustments.



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



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

#### 4.5 Piping



The following information regarding piping is only offered as a general guideline to the customer. Flowserve requires that all piping and related systems be designed/installed in accordance with specifications set forth in chapter 6, *Piping*, from API recommended practices 686/PIP REIE 686, First Edition.

The design of piping, and related systems, is not the responsibility of Flowserve. It is therefore recommended that the customer consult a competent specialist skilled in the field of piping, to ensure proper design/installation of all piping.

##### 4.5.1 Suction and discharge piping

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

Suction and discharge piping should be of ample size, be installed in direct runs, and have a minimum of bends. Eccentric reducers shall be flat on top (FOT).

It is desirable to have at least seven (7) diameters of straight pipe between the first elbow and the pump suction. Elbows in the piping to the pump suction nozzle should be of the long radius type.

Seven (7) diameters of straight pipe should be used between two elbows in series and the pump suction.

Elbows in more than one plane should not be used without splitters.

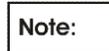
Splitters are placed in the elbow in the mean radius line perpendicular to the plane of the elbow.



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

Install a check valve and a gate valve in the discharge pipe of the pump. When the pump is stopped, the check valve will protect the pump against excessive pressure and will prevent the pump from running backwards. The check valve should be installed between the gate valve and the pump nozzle in order to permit its inspection. The gate valve is also useful in priming and starting the pump.

Keep the suction pipe short and direct. Use a suction pipe equal to or one size larger than the pump suction nozzle. Keep the suction pipe free of all air pockets.



A spool piece should be installed in the suction line so that the suction screen may be installed and removed.



Operation at low flow results in pump power heating the liquid. A bypass may be required to prevent vaporization and subsequent pump damage. Mechanical damage may result from continuous operation at flows less than the minimum flow of design operating point. (See section 10.4, *Customer Data Sheet*.)



**When pump is equipped with manifolded vent and drain lines, each line must be equipped with an individual valve to prevent any liquid from a high pressure line flowing into a low pressure line. These valves must be kept in the closed position during pump operation.**

##### 4.5.2 Suction strainer

In a new installation, great care should be taken to prevent dirt, scale and welding beads from entering the pump. Even when piping has been previously flushed, it is difficult to break loose the oxides and mill scale, which will become free when the pipe heats and cools several times. Numerous close running clearances within the pump are vulnerable to abrasive matter present in new piping. Foreign material may be large enough, or of sufficient volume, to jam a pump, with probable damage to both pump and drive equipment. Smaller size material passing through the pump can cause rapid pump wear and premature pump failure.

This pump is provided with the assumption that it will be pumping clean liquids (unless otherwise stated in the order and addressed in the proposal). Flowserve pumps are provided with running clearances ranging typically from 0.12 mm (0.005 in.) to 0.80 mm (0.030 in.), depending on the service and the pump size. It is impractical to install a suction strainer to remove particulate of this size. Such particles will normally pass through the pump without causing damage, provided the concentrations are minor.

The possibility exists that, on shutdown of the pump, such particles can become trapped in the close running clearances during coast-down, causing binding. Flowserve cannot recommend a procedure that will totally prevent such binding; however we strongly suggest that systems be cleaned and thoroughly flushed prior to connecting the pump to the piping to minimize particles entering the pump. Starting and stopping of the pump should be MINIMIZED, as pumps are most susceptible to dirt during starts and stops.

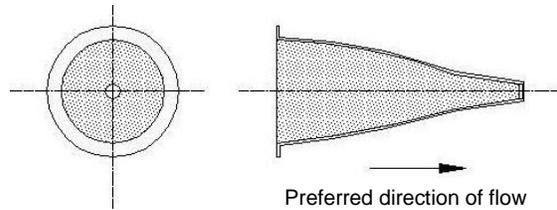
In the event that binding on coast-down occurs, it is unlikely that the binding can be remedied by hand rolling the rotor, and partial disassembly may be required to clean the affected parts. It should be noted that increased particle concentrations increases the probability of coast-down binding and seizures as well as erosion damage.

 Excessive force used to try to free a bound rotor may cause damage beyond minor clean-up and repair of rotor parts.

Generally, a pump should not be installed without start-up strainer protection. The suction piping should be thoroughly flushed before installing the suction strainer and connecting the suction piping to the pump. The strainer should be installed in the inlet piping near the pump, making certain that it is located where it may be readily serviced (cleaned). Be sure, however, that the installed strainer will not distort the flow to the pump suction nozzle.

Do not install the strainer directly on the pump suction nozzle. For a cone-type strainer, the downstream end of the cone should be no closer than four (4) pipe diameters from the pump suction nozzle. Basket-type strainers typically introduce greater flow disturbances and should be installed at least six (6) pipe diameters from the pump suction nozzle.

The Flowserve standard for suction strainers consists of conical-shaped steel plate with  $\frac{1}{8}$  in. perforations see the picture below.



The open area of the strainer should be a minimum of three times the area of the pump suction.

At all times when using suction strainers, it is critical that the pressure drop across the strainer be constantly monitored to ensure that the pump suction pressure does not fall below that required to prevent pump cavitation. Pressure (or vacuum) gauges should be installed on both sides of the strainer so that the pressure drop across the strainer can be monitored. During start-up of the system, the gauges should be monitored continuously. Consult the plant engineer or system designer for the allowable pressure differential across the strainer prior to operating the pump. Pressure differential across the strainer and/or screen is typically no more than 2-3 psig. An increase in the differential pressure between the two gauges indicates that the strainer or screen is becoming clogged with dirt and scale. Before the pressure drop becomes so severe that cavitation occurs, the pump should be shut down and the strainer cleaned. Alarm settings to protect the pump from damaging cavitation and loss of suction need to be supplied by the plant engineer or system designer prior to operating the pump. Typical alarm settings to protect the pump from damaging cavitation and loss of suction would be 5 psig differential pressures across the strainer (screen). The suction piping should be arranged such that the ultimate strainer configuration (location) allows ready access for cleaning.

The strainer may be fitted with a finer screen to filter the inlet flow. When this is done 40 mesh screens are typically used for start-up operation, at reduced flow rates. For final operation in a closed system, the suction strainers are normally removed after the system is cleaned. For critical pump applications, where continuous screening of suction flow is desirable, and in open systems, 20 mesh screening is typically used for permanent strainers. At all times, when using screens and suction strainers, it is critical that pressure drop across the screen and or strainer be constantly monitored to ensure that the pump suction pressure does not fall below that required to prevent cavitation.

When dirt and scale have been removed from the system, as indicated by no further change in pressure drop across the strainer with time, the start-up strainer may be removed or the screen may be replaced with one having larger openings.

If a permanent strainer will be used during normal operation, the pressure differential needs to be monitored on a continuous basis.

If a permanent strainer is not used, the start-up strainer needs to be temporarily reinstalled whenever the system is opened up for repair or routine maintenance. As long as a suction strainer or screen remains in place, the differential pressure should be monitored on a regular basis.

**CAUTION** The pressure drop across the strainer is a direct reduction in the NPSH available to the pump. NPSH available must always exceed the NPSH required by the pump. This requirement may limit the pump flow rate, particularly during start-up operation. Alarms or automatic pump shutdown devices should be installed to minimize the possibility of pump damage. It is the responsibility of the pump operator to obtain the allowable pressure drop across the strainer for safe pump operation from the plant engineer or system designer prior to operation of the pump.

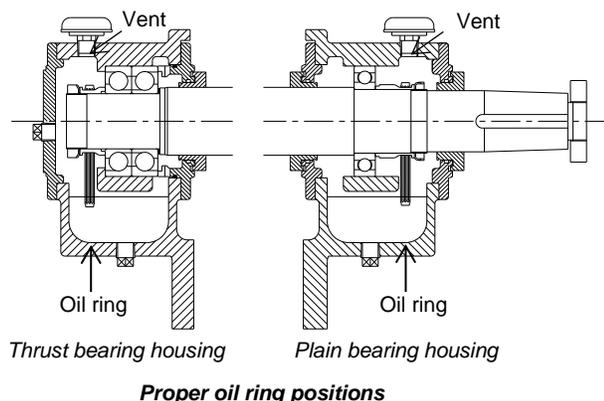
**4.5.3 Coupling alignment check**

Refer to section 4.4.1, *Shaft/coupling alignment*, and perform a coupling alignment check as outlined. This check is recommended to ensure the alignment has not been disturbed during installing suction and discharge piping.

**4.5.4 Inspection of oil rings before start-up**

**CAUTION** A problem can arise when pumps are transported by vehicle or when being lifted by a crane. Jarring or uneven lifting of pumps can cause the oil rings to move out of position. If the oil rings are out of position at start up, the bearings will not get lubrication and will eventually fail.

Before start up takes place remove the 1/2 in. NPT plugs on the top of the housing and confirm that the oil rings are in their proper position. (See figure.)



**4.6 Electrical connections**

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

**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.

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

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

**!** A device to provide emergency stopping must be fitted.

If pre-wired is not supplied 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** Direction of rotation has to be checked with pump uncoupled.

**4.7 Final shaft alignment check**

After connecting piping to the pump, rotate the shaft several times by hand to ensure there is no binding and all parts are free.

Recheck the coupling alignment, as previously described, to ensure no pipe strain. If pipe strain exists, correct piping.

**CAUTION** Refer to section 4.1.1, *Shaft/coupling alignment* and perform a coupling alignment check as outlined. This check is recommended to ensure the alignment has not been disturbed during the grouting of the baseplate or while installing suction and discharge piping.

## 4.8 Protection systems



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

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

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

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

To prevent excessive surface temperatures at bearings it is recommended that temperature or vibration monitoring are carried out.

## 5 COMMISSIONING, START-UP, OPERATION AND SHUTDOWN

**Note:** Commissioning of all equipment must be performed in accordance with specifications set forth in chapter 9, *Commissioning*, from API Recommended Practices 686/PIP REIE 686, First Edition.

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

### 5.1 Precommissioning procedure

- Never operate the pump with suction valve closed.
- Never operate pump unless it is filled with liquid and vented.
- Never operate the pump unless a liquid source is available.
- Never operate the pump without proper lubrication.

#### 5.1.1 Pre-operational checks

At initial start-up and after the equipment has been overhauled:

- Ensure pump and piping are clean. Before putting the pump into operation, it should be thoroughly flushed to remove the rust preventive as well as any foreign matter, which may have accumulated during installation.

Isolate the pump from pipe work, flush out the pipe work then flush the pump. This operation must be carried out thoroughly because the pump contains many close running clearances, which will be damaged by dirt particles. Take all possible care not to contaminate your system.

- Clean and flush bearing housings. Fill reservoir with oil to the proper level. (See section 5.2, *Pump lubricants*.)

**CAUTION** Check that oil rings are properly positioned and not hung-up by looking through vent.

- Turn rotor by hand or with strap to make sure it turns freely.
- Ensure that the mechanical seal is properly assembled and tightened.

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

- Ensure coupling is properly aligned and lubricated; and pump and driver are properly doveled. (Refer to 4.1.1, *Shaft /coupling alignment* procedure).
- Ensure coupling guard is in place.
- Check torque of all bolting and plugs for tightness.

#### 5.1.2 Pump instrumentation set points

The following set points apply to DMX pumps, which use the ball/ball bearing arrangement:

- Bearing metal temperature
  - Normal - 60 to 82 °C (140 to 180 °F)
  - Alarm - 88 °C (190 °F)
  - Shutdown - 93 °C (200 °F)
- Bearing housing vibration
  - Normal - 2.5 to 7.6 mm/s (0.1 to 0.3 in./sec)
  - Alarm - 10.2 mm/s (0.4 in./sec)
  - Shutdown - 12.7 mm/s (0.5 in./sec)

#### 5.1.3 Initial start-up procedure

- Close discharge valve if a bypass system is used. If not, crack open the discharge valve.
- Prepare the driver for start-up in accordance with the manufacturer's instructions.
- Warm-up pump (if required).

Avoid severe thermal shocks to the pump as a result of sudden liquid temperature changes. The pump must be preheated prior to start-up. Unless otherwise specified, the external temperature of the casing must be within 55.6 °C (100 °F) of the temperature of the liquid to be pumped at time of start-up.



Pump temperature stratification could occur. A maximum temperature delta of 28 °C (50 °F) between the upper and lower case must be checked prior to starting the pump.

Due to the heavy metal sections, the casing will lag the liquid temperature during such changes, and severe temperature stresses and subsequent misalignment of machined fits may result. Pre-heating is accomplished by circulating a small amount of hot fluid through the casing by utilizing vents, drains or bypass from discharge and suction. Preheat pump slowly at a rate not to exceed 55.6 °C (100 °F) per hour.

- d) Prime pump and ensure pump suction valve and bypass isolating valve are open.



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

- e) Ensure pump recirculating line (if provided) is open and free of obstructions.
- f) Check that pump is vented by observing leakage from casing vent and seal piping vent. Close vent when liquid is emitted.
- g) Make sure seal piping is turned on.
- h) Prepare the driver for start-up in accordance with the manufacturer's instructions.
- i) Check pump rotation by starting unit momentarily. The direction of rotation is shown on section 10-4, *Pump data sheet*. Note the pump coasts to a gradual stop.



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

- j) Starting the driver (motor driven).
- k) Starting the driver (turbine driven). Start the turbine and bring it up to speed quickly.
- l) As soon as the pump is up to rated speed, open discharge valve. This will avoid abrupt changes in velocity and prevent surging in the suction line.

## 5.2 Pump lubricants

### 5.2.1 Lubricating oil



**Operation of the unit without proper lubrication can result in overheating of the bearings, bearing failure, pump seizures and actual breakup of the equipment, exposing operating personnel to injury.**

Oil requires frequent replenishment at normal operating temperatures and very frequent replenishment at elevated operating temperatures. Oil is always subject to gradual deterioration from use and contamination from dirt and moisture. This deterioration and contamination will, in time, be harmful to the bearing and cause premature wear. For this reason, oil should be checked for contamination and deterioration regularly.

The frequency of oil change depends on the operating conditions and the quality of the lubricant. Oil should be checked for deterioration and contamination weekly during periods of operation.

The following guideline is based on the Cleanliness Code described in ISO 4406-1999.

Oil cleanliness values		
Intervals	ISO 4406 cleanliness code	
	R6µm	R14µm
During factory tests	20	18
First 100 hours of field operation	20	18
Every 2 000 hours of field operation	19	17

**Note:**

The listed oil cleanliness values are for reference only. Deviations from the listed values should be communicated to Flowserve for evaluation.

Mineral oils oxidize and should be replaced at intervals described in the table below.

### 5.2.2 Oil specifications

Straight mineral oils without additives are generally preferred for rolling element bearing lubrication. It should preferably be of the turbine type and not contain free acid, chlorine, sulfur or more than a trace of free alkali. Quality mineral oils with a minimum Viscosity Index (VI) of 95 are recommended.

An ISO Viscosity Grade (VG) number identifies lubricating oils. The VG number is the viscosity of the oil at 40 °C. (104 °F) in centistokes. (See table below.)

In the majority of instances, a turbine oil with a VG number of 46 (nominally equivalent to SAE 20) will meet rolling element bearing lubrication requirements. (See section 5.2.3, *Oil temperature*.)



Lubricant must be compatible with all parts requiring lubrication.

Oil replacement interval			
Typical oil operating temperature	Operating cycle	Oil change interval	Notes:
Ambient	Stand by	6 calendar months	
Ambient to 71 °C (Ambient to 160 °F)	Continuous	3 calendar months	Longer intervals between replacements may be possible at these operating temperatures, but 3 month intervals are recommended to protect against normal oxidation, contamination, and deterioration. Regular oil monitoring can inform this decision.
71 °C to 82 °C (160 °F to 180 °F)	Continuous	3 calendar months	3 month intervals are recommended to protect against normal oxidation, contamination, and deterioration.
> 82 °C (> 180 °F)	Continuous	As specified by Flowserve	Continuous operation at oil temperatures above 82 °C (180 °F) requires consultation with Flowserve.

Oil specifications and characteristics		
Oil characteristics	Operating oil temperature	
	16 °C to 38 °C (60 °C to 100 °F)	38 °C to 82 °C (101 °F to 180 °F).
Saybolt viscosity (SSU) 38 °C (100 °F)	158 seconds	215 seconds
Pour point	-7 °C (20 °F)	-7 °C (20 °F)
Flash point	204 °C (400 °F)	204 °C (400 °F)
Recommended ISO viscosity grade (VG) number	32	46

**5.2.3 Oil temperature**

Oil temperature should be maintained between 16 °C (60 °F) and 82 °C (180 °F).

- CAUTION** The minimum bearing oil temperature is 16 °C (60 °F). If necessary, prior to start-up, one of the following procedures should be employed:
- Drain the oil in the bearing housing(s) and replace with warm oil.
  - Heat the bearing housing(s) using heat tape (or other suitable means).
  - Circulate warm liquid through the cooling jacket or immersion cooler (if supplied).
  - Utilize oil with a lower viscosity, or VG number, or consider using a synthetic hydrocarbon oil with a low pour point to give a viscosity similar to that of ISO 46 (for maximum oil operating temperatures of 180 °F) or ISO 32 (for maximum oil operating temperatures of 120 °F).

**Note:** ISO 46 is recommended for continuous operating oil temperatures between 38 °C (100 °F) and 82 °C (180 °F), with a minimum startup temperature of 16 °C (60 °F); ISO 32 may be considered for continuous operating oil temperatures between 16 °C (60 °F) and 49 °C (120 °F), with a minimum start up temperature of 4 °C (40 °F). For startup when oil temperature is below 4 °C (40 °F), oil preheating is recommended.

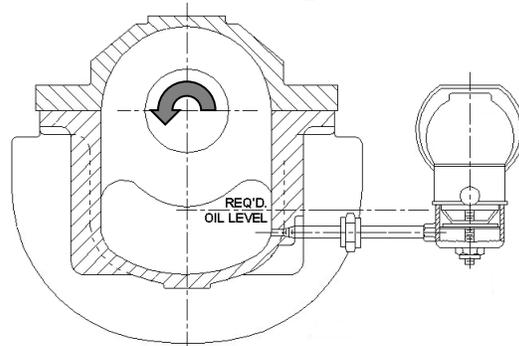
**5.2.4 Cleaning the lubrication system prior to operation**

Before operating the pump, the lubrication system should be thoroughly cleaned to remove any foreign matter that may have accumulated during shipment, storage or installation.

To clean the lubrication system refer to the sectional drawings and proceed as follows:

- Loosen the bearing end covers and flingers and remove drain plugs.
- Flush out the bearing housings with kerosene or other suitable solvent.
- Flush the bearing housing with oil. Oil should be compatible with lubricating oil that will be used.
- After flushing, replace drain plugs. Reassemble bearings and torque end cover bolting. (Refer to section 5, *Maintenance*.)
- Refer to driver instruction book for instructions covering flushing of driver bearings.

**5.2.5 Trico oiler setting**



Assemble oiler to bearing housing. Adjust oiler and fill bearing housing with oil as in the "Trico oil level setting" drawing in section 8.

**CAUTION** Operation of the unit with incorrect oil level setting can result in overheating of the bearings, lack of lubrication to the bearing failures, pump seizures and actual breakup of the equipment, exposing operating personnel to injury.

### 5.3 Impeller wearing clearance

Please refer to the sectional drawings for ring and bushing clearance value.

### 5.4 Direction of rotation

 Check pump rotating by starting momentarily. The direction of rotation is shown in section 1.5, *Duty conditions*. Note that pump coasts to a gradual stop.

### 5.5 Guarding

 **Guarding is supplied and fitted to the pump set.**

 **Fasteners must remain captive in the guard when the guard is removed to comply with Machinery Directive 2006/42/EC.**

 **Whenever guarding is removed or disturbed ensure that all the protective guards around the pump coupling and exposed parts of the shaft are securely fixed.**

### 5.6 Priming and auxiliary supplies

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

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

### 5.7 Starting the pump

#### 5.7.1 Initial start-up

See section 5.1.3, *Initial start-up procedure*.

#### 5.7.2 Normal start up

The starting procedure to be followed for normal start-up is the same as that for initial start-up. When an automatic recycle valve is used, the discharge valve can be opened.

### 5.8 Running or operation

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

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

 **When pump is equipped with manifolded vent and drain lines, each line must be equipped with an individual valve to prevent any liquid from a high pressure line flowing into a low pressure line. These valves must be kept in the closed position during pump operation.**

 **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 breathe toxic vapors. Do not allow sparking, flames, or hot surfacing in vicinity of the equipment.**

 The pump should not be operated outside of the design speed range.

- Never operate the pump with suction valve closed.
- Never operate pump unless it is filled with liquid and vented.
- Never operate the pump unless a liquid source is available.
- Never operate the pump without proper lubrication.

#### 5.8.1 Operating checks

 In the interest of operator safety, the unit must not be operated above or below the nameplate conditions. Such operation could result in unit failure causing injury to operating personnel.

 Operation at low flow results in pump power heating the liquid. A bypass may be required to prevent vaporization and subsequent pump damage. Mechanical damage may result from continuous operation at flows less than the minimum flow specified in section 10.4, *Customer Data Sheet*.

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

- Check suction and discharge pressure gauges.
- Check pressure gauges on each side of suction strainer.
- Check for excessive leakage.
- Check for unusual noises.
- Check oil rings to ensure they are rotating.

 **Eye protection required to perform this action.**

- f) Check oil level in pump bearing housings.
- g) Check for adequate flow of cooling liquids.
- h) After unit has been operated a sufficient length of time to reach normal operating temperature and condition, the unit is to be shut down and a "HOT" coupling alignment check must be made. (Refer to section 4.1.1, *Shaft/coupling alignment procedure*).



**Operation of the unit without appropriate lubrication can result in overheating of the bearings, bearing failures, pump seizures and actual breakdown of the equipment, exposing operating personnel to injury.**

## 5.9 Stopping and shutdown

If motor driven, de-energize driver circuit. If turbine driven, stop the pump by manually tripping the over-speed trip.

**Note:**

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



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

- a) Close the pump suction and discharge valve.
- b) Close valve in bypass line.
- c) Drain the pump.

## 5.10 Hydraulic, mechanical and electrical duty

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

### 5.10.1 Specific gravity (SG)

The capacity and total head in m (ft) of liquid developed by a centrifugal pump are fixed for every point on the curve and are always at the same speed. Neither capacity nor total head will be affected by a change in the specific gravity of the liquid pumped. However, since the developed pressure in bar (psi) and the power to drive the pump are a function of the specific gravity of the liquid, both will be affected in direct proportion by any change in specific gravity. Therefore, a change in specific gravity will affect the discharge gauge pressure and power. Any changes should be noted, in that they may overload the pump driver.

### 5.10.2 Viscosity

The pump is designed to deliver rated capacity at rated head for a liquid with a particular viscosity.

When contemplating operation at some viscosity other than that for which the pump was originally designed and or applied, the changed conditions should be referred to Flowserve for recommendations.

### 5.10.3 Changing the pump speed

Changing the speed of a centrifugal pump changes the capacity, total head and brake horse power. The capacity will vary in a direct ratio with the speed, whereas the total head will vary as the ratio of the speed squared. The brake horse power will vary as the ratio of the speed cubed except in cases where the speed change also affects the efficiency of the pump.

When contemplating speeds other than of the original condition, refer to Flowserve for recommendations.

### 5.10.4 Net positive suction head (NPSH)

Any liquid, hot or cold, must be forced into the impeller of the pump without vaporization by the pressure of the vessel from which the pump takes its suction.

The head of liquid necessary to force the required flow into the pump is called the Net Positive Suction Head. This value, more commonly called NPSH, is the head above the vapor pressure of the liquid at the pumping temperature.

There are two kinds of NPSH: the  $NPSH_R$  by the pump, as shown on the pump curve, is the head needed to cover the losses in the pump suction. The second NPSH is that available in the system, taking into account the friction loss in suction piping, valves, fittings etc. In all cases the  $NPSH_A$  (measured above vapor pressure) must exceed the  $NPSH_R$  in order to push the liquid into the pump.

Failure to have an adequate margin of  $NPSH_A$  over  $NPSH_R$  will cause a reduction of pump performance and internal damage to the pump.

## 6 MAINTENANCE

This pump is a precision machine. Take every precaution to avoid damage or slight burrs to the shaft bearing areas, as well as any other ground, finished surface when dismantling the pump.

It should be understood that the information contained in this manual does not relieve operating and maintenance personnel of the responsibility of exercising normal good judgment in operation and care of the pump and its components.

Before performing any disassembly, maintenance and or inspection on the unit, the following steps should be taken and warnings observed.

- a) Tag driver controls in the "off" position.



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

- b) Isolating pump.



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

- c) Draining pump.

**Note:**

Pump cannot be fully drained.

*If handling hot liquids:*



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

*If handling caustic liquids:*



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

*If on vacuum service:*



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

## 6.1 Maintenance schedule

Although your Flowserve pump has been designed for extended, trouble-free service, certain preventive maintenance measures should be performed on a regular basis to ensure optimum performance. A well-planned program of routine maintenance is the best assurance of dependable operation. The following preventive maintenance (PM) inspections are suggested as a minimum, and may be supplemented by the experience of the operating personnel.

## 6.2 Spare parts

### 6.2.1 Ordering of spares

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

- Pump serial number
- Pump size/type
- Order number
- Part name – taken from section 8 or pump sectional drawing
- Part number – taken from section 8 or pump sectional drawing
- Number of parts required – taken from section 8 or pump sectional drawing

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

Order number should be taken from section 10.4, *Customer Data sheet*.

For 24-hour part ordering service, call the Flowserve Distribution Center on +1 800 526 3569.

To place an order, contact the nearest Flowserve office found at [www.flowserve.com](http://www.flowserve.com).

Preventive maintenance item	Instructions	Frequency
Suction strainer when used	Check pressure differential between the gauges located on each side of the strainer.	Daily
Pump suction and discharge pressure/flow rate	Check suction and discharge pressure/flow rates for proper pump operation.	Daily
Mechanical seal	Inspect visually.	Daily
Instrumentation	Check all related pressure gauges, temperature and detectors etc. to detect any abnormalities.	Daily
Shaft rotation (down periods only)	During extended down periods rotate the shaft by hand 1 <sup>1</sup> / <sub>4</sub> times to ensure bearing lubrication and to prevent shaft binding.	Monthly
Auxiliary piping	Check for leakage around connections etc.	Weekly
Bearing housing vibration	Review all vibration data for any abnormalities and/or sudden changes in levels.	Weekly
Bolting tightness	Check all external bolting for proper torque.	Monthly
Cleanliness	General clean-up soiled areas.	Quarterly
Oil system	Refer to lubrication system section of instruction manual.	Periodically



**The use of parts other than Flowserve approved parts may create hazardous conditions over which Flowserve has no control. Such hazardous conditions can lead to injury, or result in damage to the equipment. Flowserve does not support nor will be responsible for the use of non-Flowserve furnished parts nor the use of materials that are not as originally furnished without the expressed written approval of Flowserve.**

**6.2.2 Service instructions**

For 24-hour emergency repair service, contact the Flowserve Service Department on +1 800 547 8671 or +1 908 859 7372 or contact the nearest Flowserve Service Center.

**6.2.3 Storage of spares**

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

**6.3 Recommended spares and consumable items**

A recommended spare parts classification is offered for Flowserve parts furnished on this unit. The classification of a required part can be identified by referring to the appropriate assembly drawing and parts list included in section 8 of this manual.

The recommended spare parts are divided into three classifications, which are defined below.

- a) Class 1 (minimum): covers recommended spare parts for a single unit where additional spare parts are ordinarily available from branch or dealer stock. Suggested for domestic service handling non-corrosive liquids where interruptions in service are not objectionable. This include gaskets and bearings that are not reusable.
- b) Class 2 (average): covers recommended spare parts for a single unit where additional spare parts are not readily available. Suggested for domestic service handling abrasive or corrosive liquids where some interruptions in service are permissible. This includes Class 1 spares plus all renewable wear parts.
- c) Class 3 (maximum): covers recommended spare parts for a single unit where maximum protection from major shutdown must be considered. Suggested for export service or domestic service where minimum loss of service is essential. This includes Class 1 and 2 spares plus a spare rotating assembly.

The Flowserve Sales Representative in your area will gladly review the class of spares best suited to your requirement.

**6.4 Tools required**

**Note:**

No special tools are required to assemble or disassemble the pump. Common mechanical tools are sufficient. However we recommend a torque wrench to tighten and remove all fasteners.

**6.5 Fastener torques**

**6.5.1 Torque values**

The torque values are given for each stud size for both standard casings and high pressure casings with a cross reference to hydro-pressures.

Stud size	DMX/DMXD pump		DMXH/DMXDH pump	
	in. (UN 8)	Nm	lbf-ft	Nm
1.125	750	550	930	685
1.250	1 050	775	1 310	965
1.375	1 425	1 050	1 775	1 310
1.500	1 700	1 250	2 100	1 550
1.625	2 300	1 700	2 875	2 120
1.750	3 150	2 320	3 930	2 900
1.875	4 200	3 100	5 220	3 850
2.000	4 600	3 400	5 760	4 250
2.250	6 670	4 920	8 340	6 150
2.500	9 220	6 800	11 525	8 500
2.750	12 420	9 160	15 525	11 450
3.000	16 160	11 920	20 200	14 900

**Note:**

The above torque values will be applied only when the casing hydro test pressure is equal to or less than the values showing in the following table. Any hydro test pressure exceeding these values must have torque values cleared by Flowserve.

Pump type	Max. hydro pressure	
	bar	psi
3x8DMX	207	3 000
3x10DMX	276	4 000
3x10DMXH	414	6 000
4x10DMX/DMXD	276	4 000
4x10DMXH/DMXDH	414	6 000
4x11DMX/DMXD	276	4 000
4x11DMXH/DMXDH	414	6 000
6x11DMX/DMXD	276	4 000
6x11DMXH/DMXDH	379	5 500
6x13DMX/DMXD	224	3 250
6x13DMXH/DMXDH	345	5 000
8x13DMX/DMXD	224	3 250
8x13DMXH/DMXDH	248	3 600
8x14DMX/DMXD	224	3 250
8x14DMXH/DMXDH	248	3 600
8x15DMX/DMXD	207	3 000
8x15DMXH/DMXDH	248	3 600
10x16DMXD	186	2 700

**Note:**

The above torque values apply only to standard stud material, i.e. ASTM A193 GrB7. Any other material must have torque values cleared by Flowserve.

**Note:**

The above torque values assume good threads that are well greased.



**When reassembling the pump, all fasteners must be tightened to the correct torque value. Failure to observe this warning could result in injury to operating personnel.**

## 6.6 Disassembly

For a better understanding of this section please refer to the exploded views drawings in section 8.

### 6.6.1 Dismantling procedure

- a) Remove all auxiliary piping and instrumentation that will interfere with disassembly, and drain oil from bearing housings.



**Use extreme caution not to expose maintenance personnel to hot liquids when removing auxiliary piping or draining bearing housings.**

- b) Remove temperature detectors (if supplied) and all other instruments from bearing housings.
- c) When mechanical seals are used, loosen piping and seal gland bolting.

### 6.6.2 Removal of seal chamber parts

To remove mechanical seal from pump:

- a) Install setting plates/eccentric washer in place.
- b) Loosen drive collar.
- c) Remove gland bolting.
- d) Slide mechanical seal from shaft after bearing housings are removed as described in section 6.6.4 and 6.6.5.

The seal may be disassembled/inspected/reassembled as in the seal manufacturer's drawing and instructions in the appendix of this manual.

**Note:**

After reassembly of seal, setting plates/eccentric washers must be removed before start-up.

### 6.6.3 Coupling removal

Remove coupling guard. Remove coupling bolting and remove the spacer piece (if used). Loosen setscrews in coupling nut and remove nut. (The use of a puller will be required to remove it from the shaft.)

### 6.6.4 Thrust bearing removal

- a) Remove cap-screws [6570] and outboard bearing end cover [3266].
- b) Loosen set-screw [6570] in pump side flinger [2540] and slide it back on the shaft towards the seal chamber.
- c) Remove cap-screws [6570] and lock-washers [6541] from pump side end cover [3260].
- d) Remove the dowel pins [6810] and cap-screws [6570], which secure bearing housing [3200] to the casing.
- e) Carefully slide bearing housing [3200] from thrust ball bearing [3013]. Use a crane with the eyebolts.
- f) Release the locking tabs of bearing lock-washer [6541].
- g) Loosen and remove bearing lock nut [3712] and lock-washer.
- h) Remove journal sleeve [2400].
- i) Remove thrust ball bearing [3013] using a puller that will bring pressure against inner bearing race only.
- j) Remove thrust bearing shims [3126], measure and record thickness and tie together, as they are needed for reassembly purposes.
- k) Remove pump side bearing end cover [3260].

### 6.6.5 Plain bearing removal

- a) Loosen Allen set-screw [6570] from coupling side flinger [2540] and remove flinger from end of shaft.
- b) Loosen Allen set-screw [6570] from pump-side flinger [2540] and slide flinger back on shaft towards the mechanical seal.
- c) Remove cap-screws [6570] from coupling-side end cover [3260]. Remove coupling-side end cover from shaft.
- d) Remove cap-screws [6570] from pump-side end cover [3260] and slide end cover back on shaft towards the mechanical seal.
- e) Remove cap-screws [6570] and dowel pins [6810] which secure bearing housing to the casing.
- f) Carefully slide bearing housing [3200] from plain ball bearing [3011]. Use a crane with the eyebolts.
- g) Release the locking tabs of bearing lock-washer [6541]. Loosen and remove bearing lock nut [3712] and lock-washer [6541]. Remove journal sleeve [2400].
- h) Remove ball bearing [3011] using a puller that will bring pressure against the inner bearing race only.
- i) Remove pump-side bearing end cover [3260] and flinger [2540] from shaft.

### 6.6.6 Rotor removal

- a) Remove cap-nuts [6580] and washers [2905] holding the upper half casing to the lower half. Remove dowel pins [6810]. Using jack-screws [6570] in lower half casing, break the seal between the upper half and lower half casing. Rig upper half casing to an overhead hoist using the two cast lifting lugs.



**The cast lifting lugs provided on the upper half casing are for lifting the upper half casing only. Do not lift the pump from these lugs.**

- b) Carefully lift upper half casing and place on boards to protect machined surfaces.
- c) Rig slings around shaft close to the impellers. Rig the slings to an overhead hoist. Carefully lift rotor [2000] from lower casing and place on horses for further dismantling.

**Note:**

Casing wearing rings [1500], channel rings [1500], throttle bushing [1630], center bushing [1600], seal chamber bushings [4132] (and crossover bushing [1600] if double suction design - DMXD and DMXDH) will be removed with the rotor.



Block to prevent rolling.

- d) Remove seal chamber bushings [4132] and throttle bushing [1630] from shaft ends.
- e) Remove casing rings [1500] from the two outer impellers at each end of the rotor.

**Note:**

In case of double suction pumps (DMXD and DMXDH), remove crossover bushing [1600]. Crossover bushing is horizontally split and held together by dowel pins [6810].

- f) Remove channel rings [1500] from impeller back ring at each impeller. Channel rings are horizontally split and are held together by shoulder screws or dowel pins.

**Note:**

Channel rings are precision machined as a set, after being dowelled. They should be match marked and numbered for reassembly purposes. It is suggested that the two halves be placed back together immediately.

- g) Remove center bushing [1600] from center (back to back) impellers. Center bushing is horizontally split and held together by socket head cap-screws [6570] and dowel pins [6810].

### 6.6.7 Dismantling the rotor

- a) Remove throttling sleeve [2430]. The throttling sleeve has a shrunk fit to the shaft and will have to be heated to remove. Heat throttling sleeves O.D. evenly throughout their length to approximately 149 °C (300 °F) using a torch with a fine tip.
  - Push throttling sleeve inboard (towards impeller)
  - Remove split ring [2531]
  - Throttling sleeve can now be removed from end of shaft
  - Remove throttling sleeve key [6700]
- b) Heat (as described in section 6.6.8) and remove the first outboard impeller [2200], split ring [2531] and impeller key [6700].



**When heating parts, gloves or other suitable protection must be worn.**

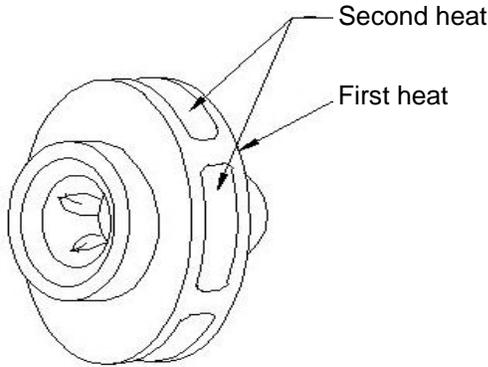
After impeller is heated, it will have to be pushed towards the center of the pump, the split rings [2531] removed and quickly pulled from the end of the shaft.

**Note:**

The shaft is step machined at each impeller fit to ease the disassembly process. It is recommended that each impeller be marked with its stage number to ensure proper reassembly.

### 6.6.8 Heating impellers for removal

- a) Apply heat (torch with fine tip) to periphery [outer 38 mm (1.5 in.)] of impeller until temperature reaches 191 °C (375 °F) (minimum) to 204 °C (400 °F) (maximum). Use "tempilstick" to determine temperature.
- b) Maintaining temperature between (191 °C to 204 °C (375 °F to 400 °F) at the periphery, apply heat down through the vane passages, thus heating the hub.
- c) Do not apply heat directly to the shaft; this will cause it to expand.
- d) With periphery, shroud and hub at temperature, remove impeller.
- e) If the impeller does not move freely off the shaft, additional heat may be necessary. This heating should be started at the periphery of the impeller, not the hub. (Additional heating of the hub area at this time will tighten the impeller on the shaft, not loosen it). If the impeller still fails to come free, the impeller and shaft should be allowed to cool completely and the heating process repeated, starting at step a).



**Heating impeller for removal**

- f) Remove casing ring [1500] from the next impeller on the outboard impellers.
  - g) Repeat steps c) and d) until all impellers are removed on the outboard impellers.
- Note:** Let entire rotor cool after removing several components with heat as there may be a build-up of heat in the rotor.
- h) Heat must be applied to remove the center sleeve [2450].
  - i) Continue to disassemble the impellers by repeating steps c) and d) until all impellers [2200] have been removed from the shaft.

**Note:** In case of double suction pumps (DMXD and DMXDH), remove crossover sleeve [2450] after the first stage impeller is removed by applying heat.

**6.6.9 Impeller ring removal**

Remove impeller rings by removing the set-screws [6570] and machine off.

**6.6.10 Parting flange gasket**

Remove all traces of old gasket [4590] material. When using any tool on surfaces to remove gasket material, do not gouge machined surfaces. Do not reuse the gasket once the casing is opened. Use only Flowserve recommended replacement materials.

**6.7 Examination of parts**

**6.7.1 Inspection and renewal of parts**

- a) Having completely dismantled the rotor, check the shaft for runout using V-blocks or rollers placed under the normal running areas. Runout not to exceed 0.050 mm (0.002 in.) TIR.
- b) Wire-brush the pump parts thoroughly. Clean off all scale, carbon etc. Examine parts for wearing corrosion and erosion.
- c) Check throttling sleeve, center sleeve and crossover sleeve (if supplied) for wear. Replace if required.

- d) The casing/impeller rings are renewable and should be replaced when badly grooved, and or when the pump performance does not meet the system requirements. Whenever it becomes necessary to replace either wearing ring, both rings involved (casing ring and impeller ring) must be ordered and replaced as they are furnished standard size only.
- e) If new casing rings are used, make sure that they seat in both the upper and lower half casing and that the anti-rotation device is properly located in its respective lower half casing fit. The use of a scraper on the ring to casing fit will help to fit the ring to the casing.
- f) Using a torch could change the metallurgy of the rings if too much heat is applied. Removing impellers with a torch is acceptable but putting on new impeller rings must be done with an oven instead of a torch.

**6.7.2 Dynamic-balance impeller**

Whenever an impeller is tampered with (i.e. new impeller, wear rings installed etc.) the impeller must be dynamically balanced before being reassembled to the shaft.

Dynamic balancing should be performed on a suitable balancing machine by trained personnel.

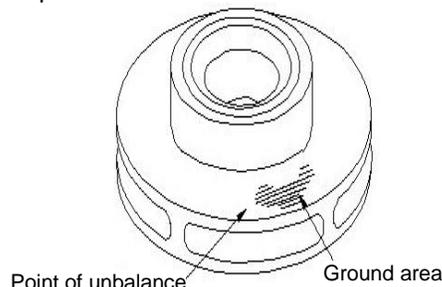
Two balance planes should be used and located equidistant as possible from the center of gravity of the impeller.

The maximum allowable unbalance at each of the two planes shall be calculated as follows:

$$U = 4 W / N \text{ or } 0.01 \text{ oz-in whichever is greater.}$$

U = unbalance per plane oz-in  
W = impeller weight per plane lb.  
Usually 1/2 the total impeller weight.  
N = Operational rotational speed r/min

Metal should be removed from the impeller shrouds during the balancing operation in accordance with the attached sketches until the impeller is within acceptable tolerance limit of unbalance.



**Grinding impeller for dynamic-balance**

Grinding must not be performed in the area within 19 mm (¾ in.) of the final diameter of the impeller. Ground areas must have a smooth transition to the non-ground areas and must be polished. Minimum thickness of the impeller shrouds after balancing must not be less than 80 % of the nominal thickness as in the detail drawing.

## 6.8 Assembly of pump and seal

When reassembling pump, all fasteners must be tightened to the proper torque values. (Refer to the sectional drawing in section 8.)

### 6.8.1 Bearing handling information

Ball bearings require proper handling and installation to ensure optimum performance. The following information is intended as a minimum to ensure that the bearings are handled and installed properly.

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

**Note:**

Under no circumstances are the bearings to be left exposed; they should be protected by wrapping or be covered.

### 6.8.2 Bearing installation

- a) There is one simple method of providing a heat source for expanding the inner race of the bearings to facilitate mounting. Bearings still wrapped in their original intimate wrap are placed on a shelf in a temperature-controlled oven. A temperature of 66 °C (150 °F) for half an hour should be sufficient.
- b) When bearings are installed on a shaft or journal sleeve, make sure bearing is installed squarely and firmly seated. Hold bearing in place until it has cooled sufficiently so that it will not move from position. Cover bearings to protect them from dirt.

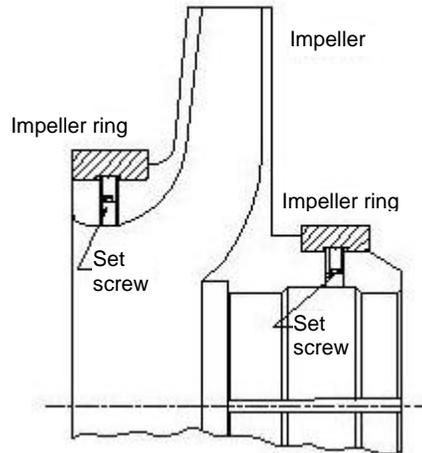
**Note:**

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

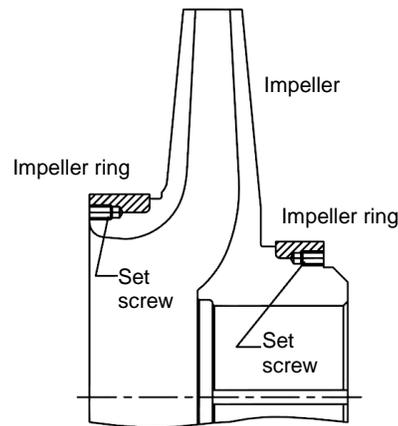
- c) When installing the bearing housing onto the bearing and shaft, the bearing housing bores and bearing outside diameter should be coated with grease or lubricating oil to facilitate assembly.

### 6.8.3 Impeller ring installation

Impellers ring setscrews can be either axial or radial through the hub.



*Typical radial screw installation for impeller rings*



*Typical axial screw installation for impeller rings.*

- a) Make sure ring fit on impeller is free of nicks and burrs. Install the set-screws in the tapered holes on the ring fits. The radial set screw must be installed in such a way that the socket end is accessible from the inside of the impeller and the point end is just slightly below the ring fit land. It may be easier to install the radial set screw from the outside of the impeller.

- b) Heat the new ring to 148 °C (300 °F) in a convection oven to allow for uniform heating. Do not use a torch as this may cause local re-tempering of the material.
- c) After the rings are thoroughly heated, they can be assembled on the impeller hubs. Only one of the internal edges has been machined with a lead in chamfer. Radial location is unimportant as there is a uniform cross-section around the circumference. The ring must fit up against the shoulder provided on the hubs for proper assembly.
- d) After cooling tighten all the set-screws with an Allen wrench.
- e) Rings are machined to final size. They do not have to be turned after assembly.

**6.8.4 Rebuilding rotor**

**CAUTION** Before up-staging or de-staging a pump (adding or removing impellers), contact Flowserve Customer Service department for instructions, to avoid permanent damage to the pump rotor.

**Note:** Split rings and keys should be pre-fitted and marked for proper location before assembling the rotor. Impellers should be marked for proper location prior to heating for assembling on the rotor.

- a) Install center stage impeller key [6700], into key way in shaft and pre-fit split rings [2531] to shaft. Split rings to fit snug in groove.
- b) All impeller bores and shaft outside diameters are to be dimensionally inspected.

**CAUTION** Impeller-to-shaft fit must be a minimum of 0.0254 mm (0.001 in.) to 0.0762 mm (0.003 in.) interference fit.

- c) Heat the center impeller [2200] in the suction side in an oven, and assemble to the shaft, moving the impeller past the split ring groove in the shaft. Quickly install split ring [2531] and pull impeller back to seat against the split ring. A constant heat source is preferred to a torch; a torch is not recommended.

**Note:** Make sure impellers are installed for proper rotation and location.

- d) Install center sleeve [2450] from the opposite end of the shaft. The center sleeve is to be seated against the impeller hub installed in step c).
- e) Place casing ring [1500] on impeller front ring.

**Put the case ring on the previous impeller before assembling the next impeller. Failure to do so will require complete dismantling of the rotor.**

- f) Continue to assemble remaining inboard impellers [2200] as in steps a), c) and e).

**Note:** In case of double suction pumps (DMXD and DMXDH), install crossover sleeve [2450] before assembling the first stage impeller.

**Note:** Let entire rotor cool after removing several components with heat as there may be a build-up of heat in the rotor. It is recommended that shaft runout is checked.

- g) Assemble outboard impellers [2200] as in steps a), c) and e).
- h) Install throttling sleeve key [6700] to shaft and pre-fit split rings [2531] in shaft to fit snug in groove. Heat the throttling sleeve and slide onto shaft far enough to expose split ring groove. Install split ring and pull sleeve back to seat against the split ring.

**6.8.5 Dynamically balance rotor**

- a) Place the rotor assembly on V-blocks or rollers. The runout of all impeller wear rings and bushings is not to exceed 0.05 mm (0.002 in.) TIR.
- b) All pump rotors are to be dynamically balanced.

Refer to section 6.7.2 for grinding for balance information.

**6.8.6 Installing rotor in casing**

- a) The seal chamber bushing [4132], throttle bushing [1630], channel rings [1500] and center bushing [1600] should be checked to make sure they seat in both the upper and lower half casing and that the anti-rotating pins [2923] can be properly located in the slot on the lower half casing parting flange.
- b) Install main parting flange gasket [4590]. (Refer to section 6.6.10, *Parting flange gasket*.)
- c) Place lower half of the center bushing [1600] into the lower half casing [1210], making sure the anti-rotation pins are properly located in the slot on the lower half casing parting flange.

**Note:** In case of double suction pumps (DMXD and DMXDH), place lower half of the crossover bushing [1600] into the lower half casing [1210], making sure the anti-rotation pins are properly located in the slot on the lower half casing parting flange.

- d) Place the lower half of all channel rings [1500] in lower half casing, in the same sequence as they were removed, making sure the anti-rotation pins are properly located in the slot on the lower half casing parting flange.

**Note:**

Channel rings are precision machined as a set, after being dowelled. Be sure they are reassembled as a set.

- e) Place casing rings [1500], throttle bushing [1630] and seal chamber bushings [4132] in their proper positions on pump rotor.
- f) Rig rotor [2000] to an overhead hoist. (Refer to section 2.3.1, *Lifting equipment*.)
- g) Position rotor over lower half casing and position bushings and casing rings such that the anti-rotation pins are facing in the up position such that they can be easily rotated in the slot on the lower half casing parting flange.



All anti-rotation pins must be located in the slot on the lower half casing parting flange. Failure to do so could cause the pins to be bent or crushed.

- h) Lower rotor into casing slowly, making sure it is seated properly.
- i) After the rotor is in pump, rotate the rings and bushings on the rotor so that the anti-rotation pins are properly located in the slot on the lower half casing parting flange.
- j) Install the upper half of center bushing [1600] and seat taper dowel pins [6810]. Install cap-screws [6570] and tighten.

**Note:**

In case of double suction pumps (DMXD and DMXDH), install the upper half of crossover bushing [1600] and seat taper dowel pins [6810].

- k) Install upper half of channel rings [1500] and seat shoulder screws or dowel pins.
- l) Check rotor axial float as described in section 6.8.8.
- m) Rig upper half casing [1210] to an overhead hoist. (Refer to section 2.3.1, *Lifting equipment*.)
- n) Position upper half casing over lower half and lower carefully, making sure all rings and bushings enter their proper fit.
- o) Install main parting flange dowel pins [6810] and seat.
- p) Check rotor axial float and vertical lift as described in sections 6.8.8 and 6.8.7.
- q) Install main parting flange washers [2905] and nuts [6580] and torque to the recommended value.

**Note:**

Make sure parting flange jack-screws [6570] in lower half casing are backed out far enough so as not to protrude above parting flange machined surface.

**6.8.7 Check rotor vertical lift**

It is necessary to check and record the vertical lift of the rotor within the casing.

- a) Place a dial indicator on the upper half casing with the indicator tip resting on the top of the shaft. Zero the indicator.
- b) Using a bar and a block of wood under the shaft, lift the shaft and record the movement. Take measurements at both ends of the pump.
- c) The minimum acceptable vertical movement is the minimum back ring clearance on the suction end of the pump and the minimum throttling bushing clearance on the discharge end of the pump. (For clearances, refer to the sectional drawings included in section 8 of this manual.)
- d) If this minimum movement is not obtained, the cause must be investigated and corrected.

**6.8.8 Check rotor axial float**

- a) Push the rotor toward the coupling end as far as it will go.



Do not force rotor.

**Note:**

Some of the rotor weight may have to be supported externally. The impeller rings contacting the channel rings are now supporting the rotor.

- b) Place a piece of masking tape on the shaft (if seal is used) or shaft sleeve (if seal chamber is used), in the seal chamber area, at the thrust end of the pump. Place a scale across the face of the seal chamber and make a line on the masking tape.
- c) Push the rotor toward outboard end as far as it will go. Using scale, mark another line on the masking tape.
- d) Measure and record the total rotor end float between the two lines. The acceptable minimum end float is given on the pump sectional drawing (included in section 8). If this minimum end float is not obtained, the cause must be investigated and corrected. Two of the most likely causes could be:
  - impellers not properly seated against the split ring
  - improperly machined part i.e. impeller ring or channel ring
- e) Mark another line midway between the first two lines. This centerline represents the centering of the impellers within their volutes. Masking tape is to be left on shaft for use in step 6.8.10, *Centralize rotor axially*.

### 6.8.9 Horizontal and vertical shaft alignment

**Note:**

The rotor must be initially aligned using “dummy bearings”. Do not put on mechanical seals at this time, as the seal chamber bore must be exposed to centralize the rotor. Dummy bearings (not furnished) will ease the assembly process of adding shims and the mechanical seals. Dummy bearings can be made by taking a used set of ball bearings and opening up the bore so it has a 0.0127 mm (0.0005 in.) to 0.0254 mm (0.001 in.) loose fit to the shaft.

a) Assemble plain bearing:

- Assemble dummy bearing to shaft. Install journal sleeve [2400], bearing lock-washer [6541] and bearing nut [3712] and tighten.

**Note:**

Do not set locking tab of lock-washer at this time. Dummy bearings will have to be removed.

- Assemble bearing housing [3200] into position over the plain ball bearing. Install dowel pins [6810] and snug down cap-screws [6570]. Install both the horizontal and vertical adjusting screws [6570] in the bearing housing mounting flange. Remove dowel pins [6810].

b) Assemble thrust bearing:

- Slide pump side end cover [3260] with 0.051 mm (0.002 in.) shims [3126] onto shaft.
- Install shims [3126] against shaft shoulder if amount was recorded at disassembly. If shim thickness was not recorded at disassembly, or if rotor was rebuilt completely, do not install any shims at this time.
- Assemble “dummy bearing” to shaft. Compare width of outside bearing races with new bearing races. Differences must be compensated when adjusting for 0.127 mm (0.005 in.) to 0.254 mm (0.010 in.) end-play.
- Install journal sleeve [2400], bearing lock-washer [6541] and bearing nut [3712] and tighten.

**Note:**

Do not set locking tab of lock-washer at this time; the dummy bearing will have to be removed.

- Carefully install bearing housing [3200] into position over the thrust ball bearing.

**Note:**

Bearing housings have been preset at factory and dowelled to the casing. Rotor vertical and horizontal alignment should be checked. Rotor should turn with no indication of binding. Should rotor require further adjustment, remove dowel pins [6810] and proceed with steps c), d) and e).

- Install dowel pins [6810] and bearing housing to casing cap-screws [6570] and snug down cap-screws. Install both the vertical and horizontal adjusting screws [6570] in the bearing housing mounting flange. Remove dowel pins [6810].
- c) Using a dial indicator and the adjusting screws [6570], adjust the horizontal and vertical position of the shaft inside the seal chamber to within 0.0254 mm (0.001 in.) radially.
- d) Repeat step c) on thrust end, then recheck plain end. Pump shaft should turn freely with no indication of binding or rubbing. This should be taken into account when making adjustments.
- e) If rubs occur, adjust the rotor upwards in 0.025 mm (0.001 in.) increments. Check alignment at both ends after each movement. After adjustment, check for rubs.
- f) When vertical and horizontal alignment is obtained, tighten bearing housing bolting (except the two top bolts at the adjusting screws). Ream the dowel holes and install dowel pins [6810]. Loosen adjusting screws and tighten the two top bearing housing bolts.

### 6.8.10 Centralize rotor axially

- a) Make sure center mark on masking tape is in line with seal chamber face as in step e) of section 6.8.8, *Check rotor axial float*.
- b) Install dial indicator on thrust bearing housing [3200] so indicator contacts end of shaft. Set indicator at zero.
- c) Push rotor outboard to ensure contact between thrust ball bearing [3013] and bearing housing [3200].
- d) Read the distance the shaft moved on the dial indicator. This is the amount of shims [3126] to be installed between thrust ball bearing [3013] and shaft.

### 6.8.11 Set thrust bearing end-play



Thrust ball bearing requires 0.127 mm (0.005 in.) to 0.254 mm (0.010 in.) axial end-play.

- a) Install inboard end cover [3260] with shims [3126] and O-ring [4610]. Install lock-washers [6541] and cap screws [6570].
- b) Install a dial indicator on thrust bearing housing [3200] so indicator contacts the end of the shaft. Push rotor inboard (towards coupling end) and set indicator at zero. Push rotor outboard. The dial indicator will show amount of axial endplay. (Adjust this reading for the difference in width between the dummy bearing and the actual bearing.)

- If distance indicated is between 0.127 mm (0.005 in.) to 0.254 mm (0.010 in.) no further shim adjustment is required
- If distance indicated is above 0.254 mm (0.010 in.) remove inboard end cover [3260] and remove amount of shims [3126], which will reduce axial end-play to 0.127 mm (0.005 in.) to 0.254 mm (0.010 in.)
- If distance indicated is below 0.127mm (0.005 in.), remove inboard end cover [3260] and add shims [3126], which will increase axial end-play to 0.127 mm (0.005 in.) to 0.254 mm (0.010 in.). (Shims may be cut for ease of assembly.)

**6.8.12 Final plain bearing assembly**

- If pump is installed with a mechanical seal, install completely assembled mechanical seals [4200] to the shaft. Insert into seal chamber.



Do not tighten lock collar set-screws at this time.

- Slide pump-side flinger [2540] onto shaft and rest near the seal chamber. Do not tighten set-screws [6570] at this time.
- Slide pump side end cover onto shaft.
- Heat plain bearing [3011] and install on shaft.
- Install journal sleeve [2400], bearing lock-washer [6541] and bearing nut [3712] and tighten.
- Set locking tab of lock-washer.
- Assemble bearing housing [3200] into position over the plain ball bearing. Install dowel pins [6810] and snug down cap-screws.
- Apply a layer of liquid gasket to machined surface of end covers [3260]. Assemble bearing end covers to bearing housing. Install cap-screws [6570]. Torque cap-screws to proper value.
- Install coupling side flinger [2540]. Do not tighten set-screws at this time.

**6.8.13 Initial thrust bearing assembly**

- Using a strap wrench, rotate pump shaft to be sure rotor is properly aligned and does not bind.



Do not rotate pump shaft excessively. Internal parts depend on the liquid being pumped for lubrication.

- Position the plain bearing flingers [2540] approximately 1.02 mm (0.040 in.) from end covers and tighten set-screws [6570].
- Remove thrust bearing housing [3200] from pump.
- Remove bearing locknut [3712], bearing lock-washer [6541], journal sleeve [2400] and the dummy bearing from the pump shaft.

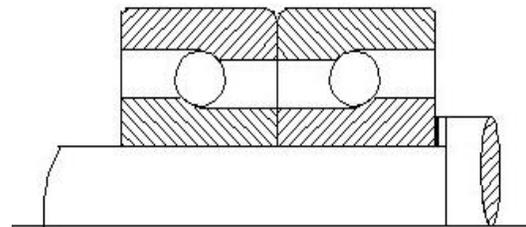
- Remove tape from shaft at seal chamber area and install mechanical seal [4200]. Tighten gland nuts [6580] of both mechanical seals as in the *seal chamber* section.



Do not tighten lock collar set-screws at this time.

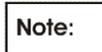
**6.8.14 Final thrust bearing assembly**

- Position flinger [2540], end cover [3260], O-ring [4610] and end cover shims [3126] in their approximate positions on the pump shaft.
- Install shaft shims [3126]. Make sure shims are correctly seated against shaft shoulder.
- Heat thrust bearing [3013] and install on the shaft in the back-to-back position (stamping will be face to face) as shown here.



Installing the bearings on the shaft

- Install journal sleeve [2400], bearing lock-washer [6541], bearing locknut [3712] and tighten.
- Carefully assemble bearing housing [3200] into position over the thrust ball bearing [3013].
- Install dowel pins [6810] and bearing housing to casing cap screws [6570] and tighten to the correct torque.

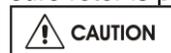


Ensure dowel pins [6810] seat correctly to obtain rotor alignment.

- Assemble inboard end cover [3260] with shims [3126] and O-ring [4610] to bearing housing [3200]. Install lock-washers [6541] and cap-screws [6570]. Tighten to correct torque.
- Apply a layer of liquid gasket to the machined surface of end cover [3266]. Install end cover with cap screws [6570]. Tighten to correct torque.

**6.8.15 Final assembly**

- Position bearing flingers [2540] approximately 1.02 mm (0.040 in.) away from end covers and tightens the set-screws [6570].
- Using a strap wrench, rotate pump shaft to be sure rotor is properly aligned and does not bind.



Do not rotate pump shaft excessively. Internal parts depend on the liquid being pumped for lubrication.

- c) Install coupling key, pump half coupling, coupling nut and set coupling nut set-screws. (Refer to section 6.6.3, *Coupling removal*.)
- d) Check coupling/shaft alignment as described in section 4.4.1, *Shaft/coupling alignment*, and assemble coupling.
- e) Install coupling guard.
- f) Replace all auxiliary piping, instrumentation and pipe plugs.
- g) Fill bearing housing oil reservoir. (Refer to section 5.2, *Pump lubricants*.)
- h) Refer to section 5.8, *Running or operation*, for starting procedure.

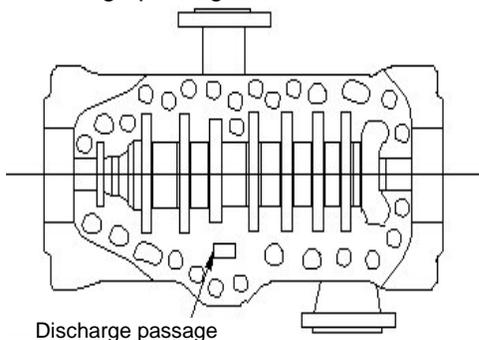
**6.8.16 Parting flange gasket**

- a) Using proper recommended 0.397 mm ( $1/64$  in.) thick gasket material, locate and cut stud holes, using upper half casing as a template.
- b) Lay gasket on lower half casing, using either a gasket adhesive or a band of shellac approximately 13 mm ( $1/2$  in.) wide on the outer edge of lower casing.
- c) Place upper half casing on top of gasket and allow time for gasket adhesive or shellac to set.
- d) Remove upper half casing.
- e) Using a sharp knife, cut gasket with downward strokes only. Make sure all cuts are neat and exact, especially on internal edges of casing. If this is not done, the high-pressure liquid will bypass and erode the ring fits.

**Note:** It is important that the gasket at the seal chamber be flush with the casing faces. It is necessary hang a little bit of gasket out and cut after the final torque.

**!** Do not use any hammering device to cut the gasket.

**!** CAUTION When cutting the parting flange gasket, do not forget to cut an opening for the discharge passage.



**Position of the parting flange gasket**

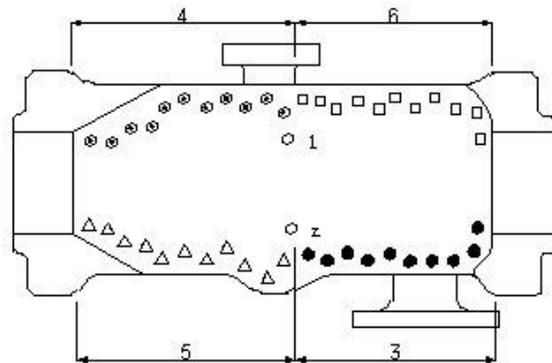
**6.8.17 Parting flange torque procedure**

Assemble upper half casing to lower half casing and secure with washers and cap-nuts listed on the parts list of the casing. Torque the cap-nuts in three or more complete passes of increasing torque values until the torque values in section 6.5.1 are achieved.

Minimum recommended torque passes:  
 First pass - 50% specified torque value  
 Second pass - 90% specified torque value  
 Final pass - 100% specified torque value

Tighten the cap-nuts in the following sequence during each pass:

- a) Torque both center cap-nuts – marked “O”.
- b) Torque the cap-nuts shown in diagram below, casing quadrant 3. Start approximately in the center of the pump and proceed towards the suction nozzle.
- c) Torque the cap-nuts on the opposite corner of the pump as indicated in diagram below, casing quadrant 4. Again, start at the center of the pump and work towards the opposite end.
- d) Torque the cap-nuts in diagram below, casing quadrant 5, in a similar manner.
- e) Torque the cap-nuts in diagram below, casing quadrant 6, in a similar manner.
- f) Repeat the same sequence two or more times using increasing torque values with each full pass.



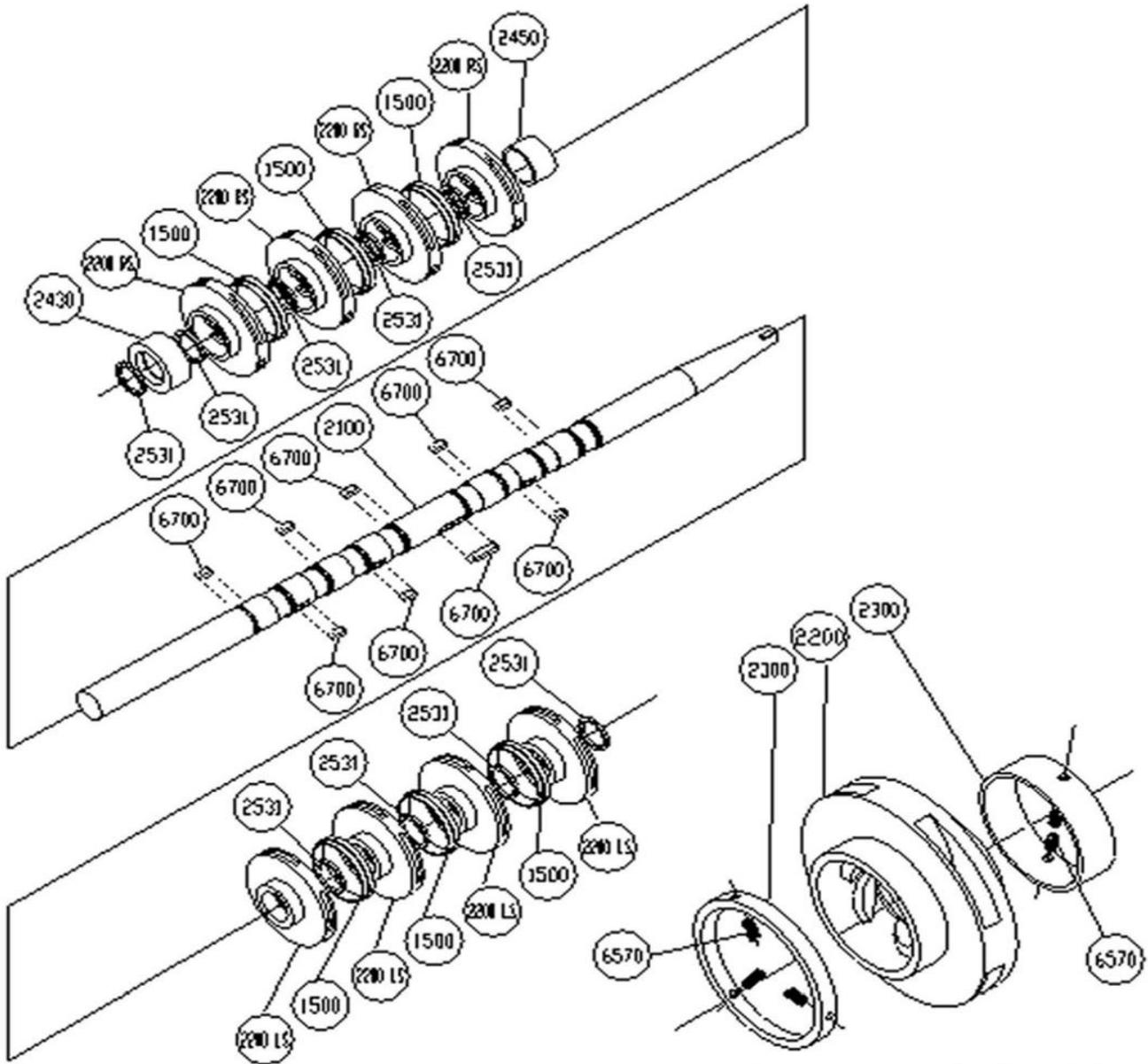
**Parting flange torque procedure diagram**



Pump overheats and seizes									
↓ Bearings have short life									
↓ ↓ Pump vibrates or is noisy									
↓ ↓ ↓ Mechanical seal has short life									
↓ ↓ ↓ ↓ Mechanical seal leaks excessively									
↓ ↓ ↓ ↓ ↓ Pump requires excessive power									
↓ ↓ ↓ ↓ ↓ ↓ Pump loses prime after starting									
↓ ↓ ↓ ↓ ↓ ↓ ↓ Insufficient pressure developed									
↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ Insufficient capacity delivered									
↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ Pump does not deliver liquid									
↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓									
					<b>PROBABLE CAUSES</b>			<b>POSSIBLE REMEDIES</b>	
				●	●	●	Wearing ring surfaces worn.	Replace worn wear ring/ surfaces.	
	●				●	●	Impeller damaged or eroded.	Replace or CONSULT FLOWSERVE for improved material selection.	
			●				Leakage under sleeve due to joint failure.	Replace joint and check for damage .	
		●	●				Shaft sleeve worn or scored or running off center.	Check and replace defective parts.	
		●	●	●			Mechanical seal improperly installed.	Check alignment of faces or damaged parts and assembly method used. Refer to mechanical seal instructions.	
●	●	●	●	●			Shaft running off center because of worn bearings or misalignment.	Check misalignment and correct if necessary. If alignment satisfactory check bearings for excessive wear.	
●	●	●	●	●			Impeller out of balance resulting in vibration.	Check and CONSULT FLOWSERVE.	
			●	●	●		Abrasive solids in liquid pumped.		
			●	●			Mechanical seal was run dry.	Check mechanical seal condition and source of dry running and repair.	
●	●	●					Excessive thrust caused by a mechanical failure inside the pump.	Check wear condition of impeller, its clearances and liquid passages.	
	●	●					Lack of lubrication for bearings.	Check hours run since last change of lubricant. Check oil level and add if necessary.	
	●	●					Improper installation of bearings (damage during assembly, incorrect assembly, wrong type of bearing etc).	Check method of assembly, possible damage or state of cleanliness during assembly and type of bearing used. Remedy or CONSULT FLOWSERVE, if necessary.	
	●	●					Damaged bearings due to contamination.	Check contamination source and replace damaged bearings.	
●	●	●	●	●			Rotating assembly out of balance.	Check balance, runouts, balance as required. CONSULT FLOWSERVE.	
●	●	●	●	●			Coupling out of balance	Check for missing parts or damage. CONSULT FLOWSERVE.	
		●					Cavitation	Check pump is primed, check for obstruction in suction line.	
<b>C. ELECTRICAL TROUBLES</b>									
	●			●	●	●	Wrong direction of rotation.	Reverse 2 phases on motor terminal box.	
				●		●	Motor running on 2 phases only.	Check supply and fuses.	
●	●					●	Motor running too slow.	Check motor terminal box connections and voltage.	

## 8 PARTS LIST AND DRAWINGS

### 8.1 Typical rotor assembly



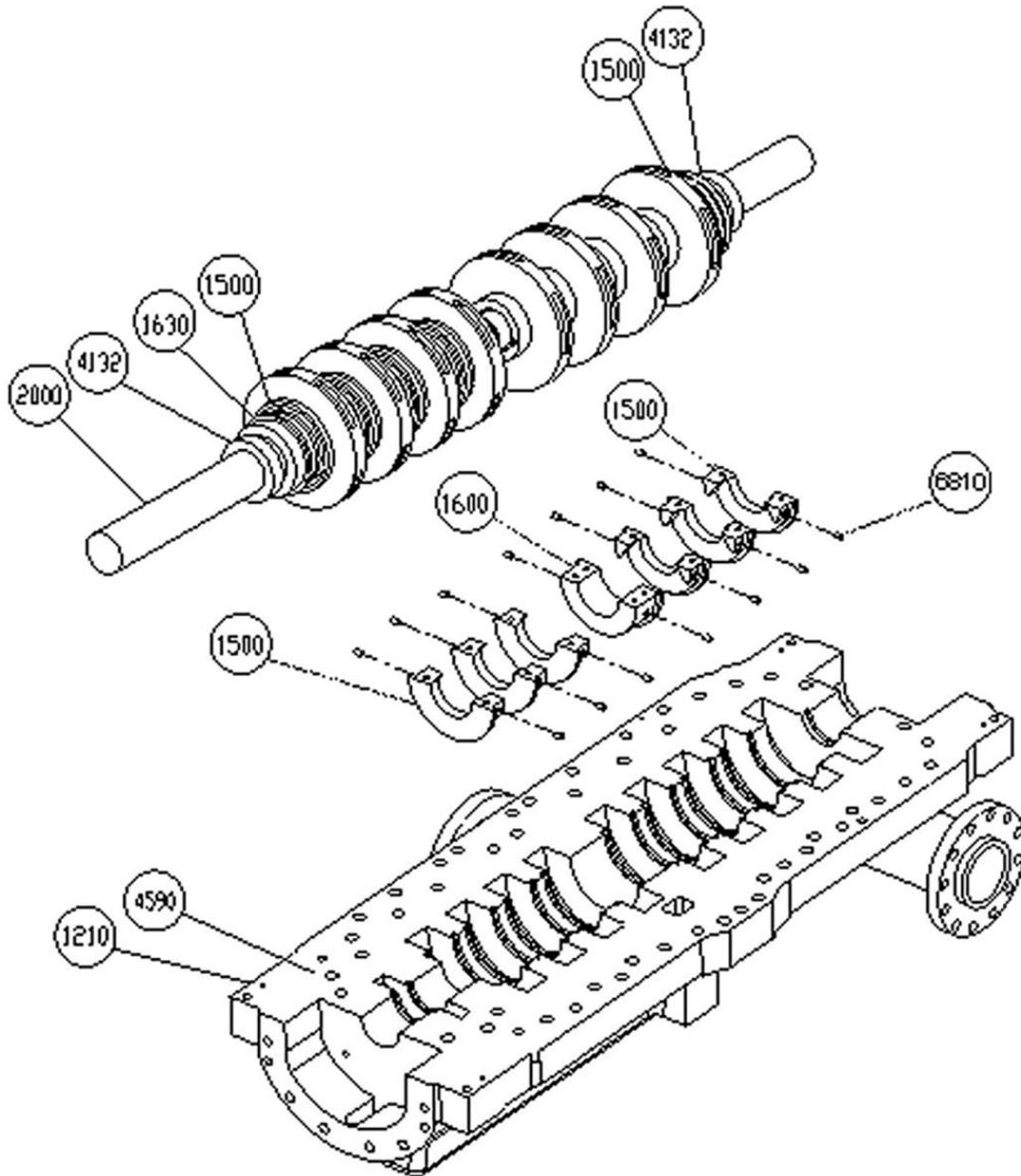
Impeller sub-assembly

Part no.	Description
1500	Ring casing
2100	Shaft
2200LS	Impeller assembly, left hand side
2200RS	Impeller assembly, right hand side
2430	Sleeve – bleed off/throttling
2450	Sleeve
2531	Split ring
6700	Key

Impeller assembly 2200LS consists of:

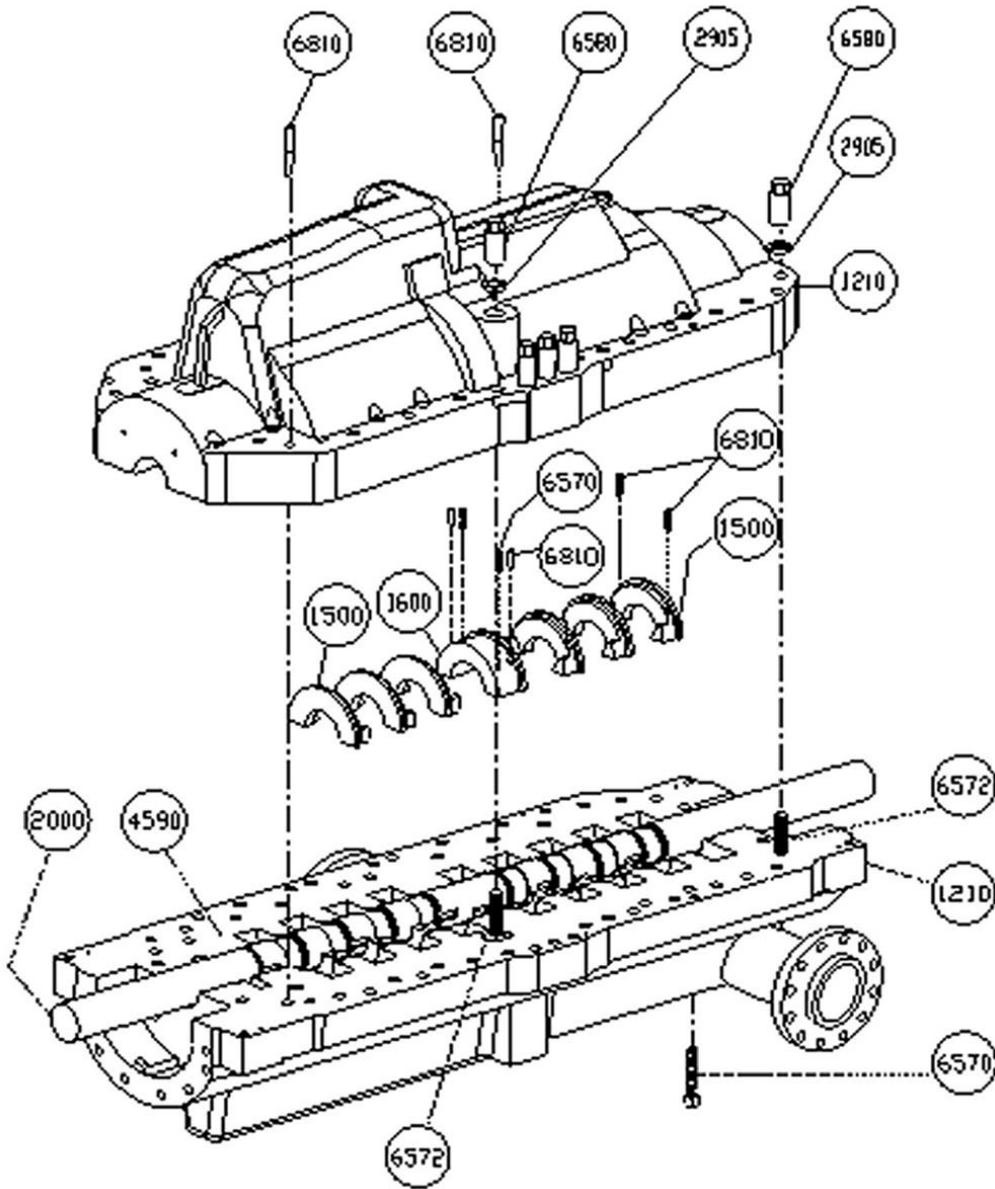
2200	Impeller
2300	Impeller ring
6570	Set screw – HD less

## 8.2 Lower half bushings, rotor and casing assembly



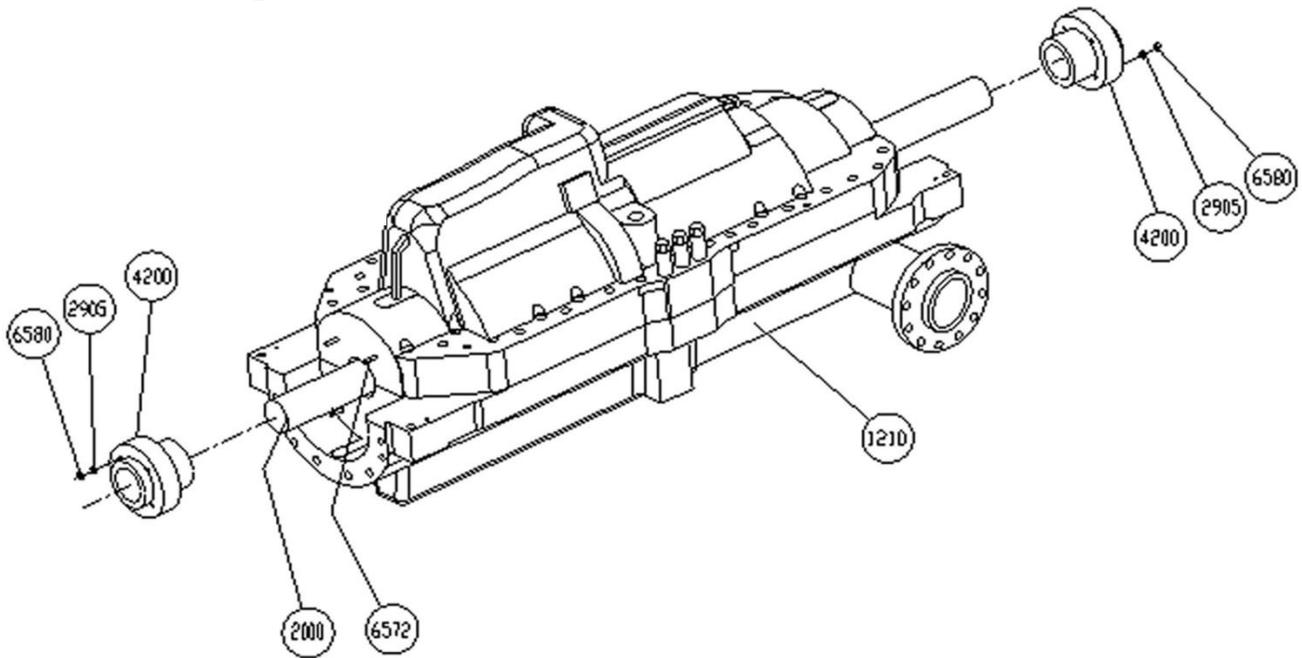
Part no.	Description
1210	Casing
1500	Ring
1600	Bushing, lower half
1630	Bushing, throttling
2000	Rotor, assembly or spin rotor
4132	Bushing, stuffing box
4590	Gasket, main parting flange
6810	Pin

### 8.3 Typical upper half bushings and casing assembly



Part no.	Description
1210	Casing, upper and lower
1500	Ring
1600	Bushing, assembly
1630	Bushing, throttling
2000	Rotor, assembly or spin rotor
2905	Washer, stage stud, main parting flange
4132	Bushing, seal chamber
4590	Gasket, main parting flange
6570	Screw
6572	Stud, main parting flange
6580	Cap nut, main parting flange
6810	Pin

### 8.4 Shaft sealing



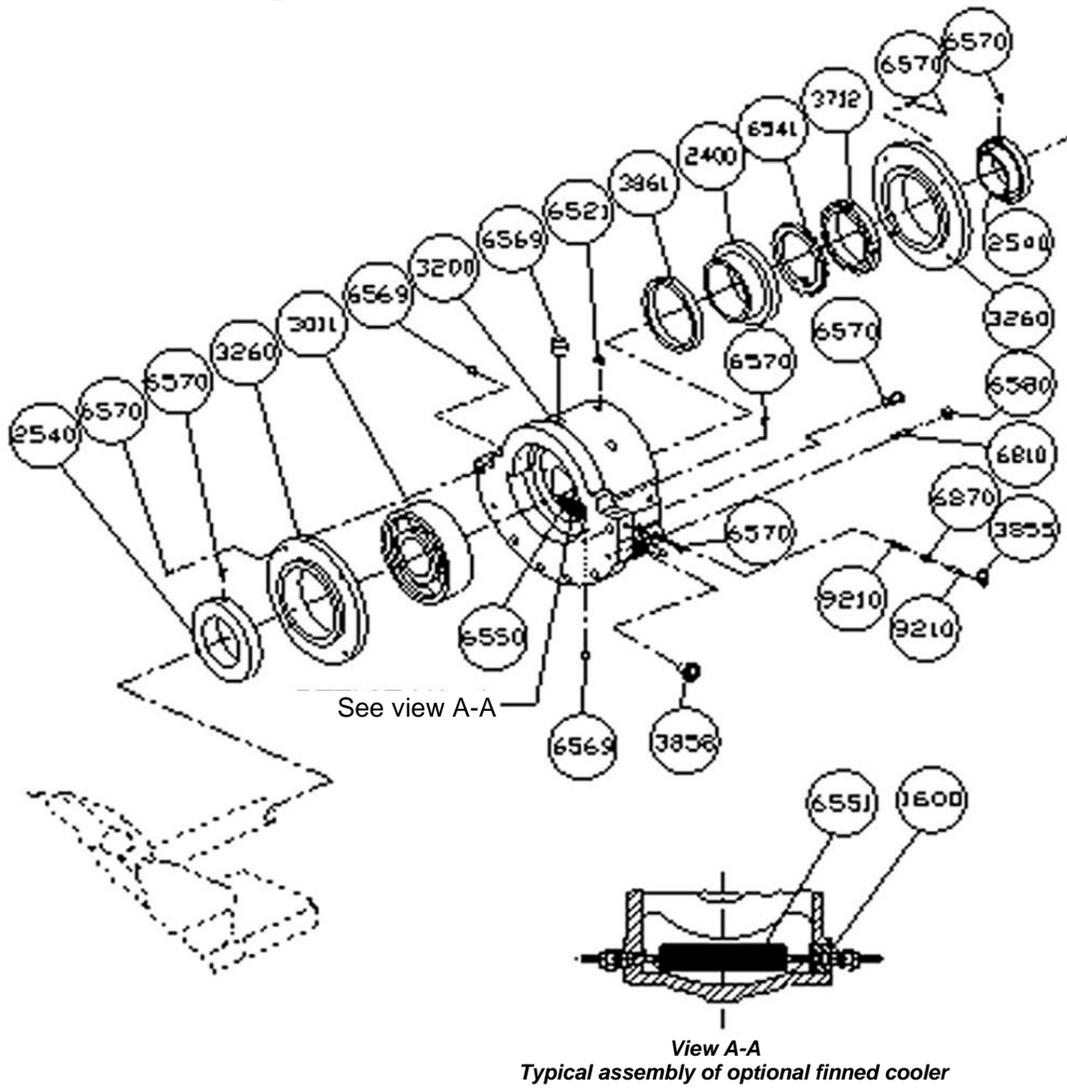
**Shaft sealing parts**

Part no.	Description
1210	Casing, assembly
2000	Rotor, assembly or spin rotor
6572	Stud, main parting flange

**Mechanical seal**

2905	Washer
4200	Mechanical seal
6580	Nut

### 8.5 Radial bearing end



Part no.	Description
1600	Bushing
2400	Journal sleeve
2540	Flinger
3011	Radial ball bearing
3200	Bearing housing
3260	Cover
3712	Bearing locknut
3855	Constant level oiler
3858	Sight glass
3861	Oil ring

6521	Breather
6541	Bearing lock washer
6551	Finned cooler
6569	Pipe plug
6570	Screw
6580	Dowel pin nut
6810	Pin
6870	Union
9210	Pipe nipple



## 9 CERTIFICATION

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

## 10 OTHER RELEVANT DOCUMENTATION AND MANUALS

### 10.1 Supplementary User Instruction manuals

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

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

### 10.2 Change notes

If any changes, agreed with Flowserve, 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:*

Pumping Manual, 9<sup>th</sup> edition, T.C. Dickenson, Elsevier Advanced Technology, United Kingdom, 1995.

*Reference 3:*

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

*Reference 4:*

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

*Reference 5:*

ANSI B31.3 - Process Piping.

## 10.4 Customer data sheet

### 10.4.1 Order information

Purchaser:

Location:

Flowserve order:

Serial numbers:

### 10.4.2 Technical information

Pump application:

Liquid pumped:

Specific gravity:

Pump size and type:

Driver:

Pump rating:

Net positive suction head required (NPSH<sub>R</sub>):

Net positive suction head available (NPSH<sub>A</sub>):

Total head:

Suction pressure:

Discharge pressure:

Minimum flow:

Pump efficiency at design:

Brake horse power (design/max) with pumped liquid:

Pump rotation from coupling end:

Hydrotest pressure:

Maximum temperature:

Bearing lubrication:

Pump hold-down bolt torque value:

### 10.4.3 Weights

Pump weight:

Driver weight:

Baseplate weight:

Total weight:

**Notes:**

**Notes:**

**Notes:**

**Your Flowserve factory contacts:**

Flowserve Corporation  
Parallelweg 13  
4878 AH Etten-Leur  
The Netherlands  
Telephone +31 76 502 8100

Flowserve Spain, S.A.  
Poligono Industrial  
Avda. Fuentemar, 26-28  
E28823 Coslada (Madrid), Spain  
Telephone +34 91 660 4600

Flowserve S.A.  
Chuisaca 302  
5547 Godoy Cruz  
Mendoza, Argentina  
Telephone +54 261 405 3100

Flowserve Corporation  
2300 East Vernon Avenue  
Vernon, CA, USA 90058  
Telephone +1 323 587 6171

**Your local Flowserve representative:**

*To find your local Flowserve representative please  
use the Sales Support Locator System found at  
[www.flowserve.com](http://www.flowserve.com)*

**FLOWSERVE REGIONAL  
SALES OFFICES:****USA and Canada**

Flowserve Corporation  
5215 North O'Connor Blvd.,  
Suite 2300  
Irving, Texas 75039-5421 USA  
Telephone +1 937 890 5839

**Europe, Middle East, Africa**

Flowserve Corporation  
Parallelweg 13  
4878 AH Etten-Leur  
The Netherlands  
Telephone +31 76 502 8100

**Latin America**

Flowserve Corporation  
Martin Rodriguez 4460  
B1644CGN-Victoria-San Fernando  
Buenos Aires, Argentina  
Telephone +54 11 4006 8700  
Telefax +54 11 4714 1610

**Asia Pacific**

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