FLOWSERVE®

Pump Division

Type: WDX

CENTRIFUGAL PUMPS

USER INSTRUCTIONS:
INSTALLATION, OPERATION, MAINTENANCE

PCN=71576322 06-05 (E)

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

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1 INTRODUCTION AND SAFETY

1.1 General

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

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

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

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

These instructions must be read prior to installing, operating, using and maintaining the equipment in any region worldwide. The equipment must not be put into service until all the conditions relating to safety noted in the instructions, have been met.

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 Pump Division to provide sound and all necessary information the content of this manual may appear insufficient and is not guaranteed by Flowserve as to its completeness or accuracy.

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

1.4 Copyright

1.5 Duty conditions

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

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

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

1.6 Safety

1.6.1 Summary of safety markings

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

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

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

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

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

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

 This symbol 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.

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

1.6.2 Personnel qualification and training

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

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

1.6.3 Safety action

This is a summary of conditions and actions to prevent injury to personnel and damage to the environment and to equipment. For products used in potentially explosive atmospheres section 1.6.4 also applies.

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

 GUARDS MUST NOT BE REMOVED WHILE THE PUMP IS OPERATIONAL

 DRAIN THE PUMP AND ISOLATE PIPEWORK BEFORE DISMANTLING THE PUMP
The appropriate safety precautions should be taken where the pumped liquids are hazardous.

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

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

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

 NEVER APPLY HEAT TO REMOVE IMPELLER
Trapped lubricant or vapour could cause an explosion.

 HOT (and cold) PARTS
If hot or freezing components or auxiliary heating supplies can present a danger to operators and persons entering the immediate area action must be taken to avoid accidental contact. If complete protection is not possible, the machine access must be limited to maintenance staff only, with clear visual warnings and indicators to those entering the immediate area. Note: bearing housings must not be insulated and drive motors and bearings may be hot.

If the temperature is greater than 68 °C (175 °F) or below 5 °C (20 °F) in a restricted zone, or exceeds local regulations, action as above shall be taken.

HAZARDOUS LIQUIDS
When the pump is handling hazardous liquids care must be taken to avoid exposure to the liquid by appropriate sitting of the pump, limiting personnel access and by operator training. If the liquid is flammable and/or explosive, strict safety procedures must be applied.

Gland packing must not be used when pumping hazardous liquids.

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

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

CAUTION START THE PUMP WITH OUTLET VALVE PART OPENED
(Unless otherwise instructed at a specific point in the User Instructions.)

This is recommended to minimize the risk of overloading and damaging the pump motor at full or zero flow. Pumps may be started with the valve further open only on installations where this situation cannot occur. Pump outlet valve shall 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 seal.

CAUTION DO NOT RUN THE PUMP AT ABNORMALLY HIGH OR LOW FLOW RATES
Operating at a flow rate higher than normal or at a flow rate with no backpressure on the pump may overload the motor and cause cavitations. Low flow rates may cause a reduction in pump/bearing life, overheating of the pump, instability and cavitations/vibration.

1.6.4 Products used in potentially explosive atmospheres

Ex Measures are required to:

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

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

1.6.4.1 Scope of compliance

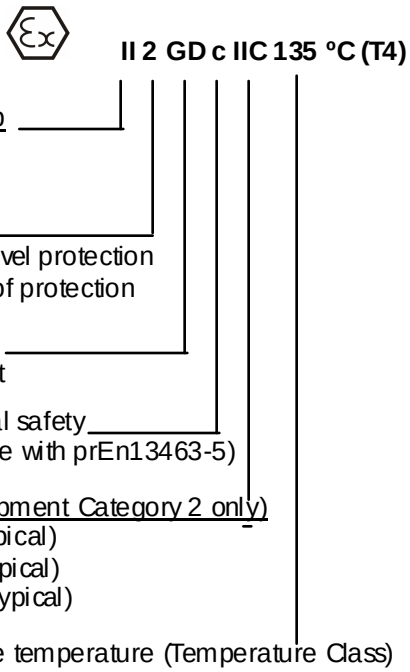
Ex Use equipment only in the zone for which it is appropriate. Always check that the driver, drive coupling assembly, seal and pump equipment are suitably rated and/or certified for the classification of the specific atmosphere in which they are to be installed.

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

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

1.6.4.2 Marking

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



1.6.4.3 Avoiding excessive surface temperatures

ENSURE THE EQUIPMENT TEMPERATURE CLASS IS SUITABLE FOR THE HAZARD ZONE

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

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

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

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

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

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

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

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

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

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

1.6.4.4 Preventing the build up of explosive mixtures

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

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

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

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

1.6.4.5 Preventing sparks

To prevent a potential hazard from mechanical contact, the coupling guard must be non-sparking. To avoid the potential hazard from random induced current generating a spark the ground contact on the baseplate must be used.

Avoid electrostatic charge: do not rub non-metallic surfaces with a dry cloth, ensure cloth is damp.
The coupling must be selected to comply with 94/9/EC and correct alignment must be maintained.

Additional requirements for metallic pumps on non-metallic baseplates
When metallic components are fitted on a non-metallic baseplate they must be individually earthed.

1.6.4.6 Preventing leakage

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

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

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

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

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

1.6.4.7 Maintenance to avoid the hazard

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

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

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

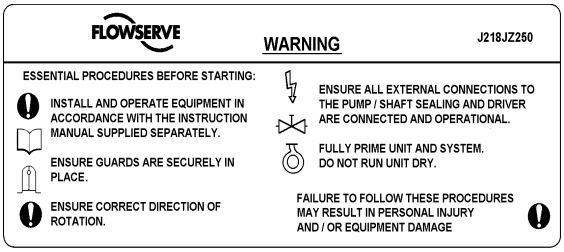
Where there is a risk from such tools or materials; maintenance must be conducted in a safe area. It is recommended that a maintenance plan and schedule is adopted. (See section 6, *Maintenance.)*

1.7 Safety labels summary

1.7.1 Nameplate

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

1.7.2 Warning labels



Oil lubricated units only:

1.8 Specific machine performance

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

1.9 Noise level

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

Pump noise level is dependent on a number of factors - the type of motor fitted, the operating capacity, pipework design and acoustic characteristics of the building. Typical sound pressure levels measured in dB and A-weighted are shown in the table below.

The figures are indicative only, they are subject to a +3 dB tolerance, and cannot be guaranteed.

The values are based on the noisiest ungeared electric motors which are likely to be encountered. They are L_{pA} sound pressure levels at 1m (3.3ft) from the directly driven pump, for "free field over a reflecting plane". For estimating L_{wA} sound power level (re 1 pW) add 14 dB(A) to the sound pressure value.

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

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

Typical sound pressure level, dBA, L_{pA} at 1 m reference 20 µPa *(L_{wA} sound power1 pW where L_{pA} >85 dBA)*

Motor size and speed kW (hp)	3550 r/min		2900 r/min		1750 r/min		1450 r/min	
	Pump and motor **dBA**	Pump only **dBA**	Pump and motor **dBA**	Pump only **dBA**	Pump and motor **dBA**	Pump only **dBA**	Pump and motor **dBA**	Pump only **dBA**
5.5 (7.5)	90 (*99*)	77	83	73	76	73	72	71
7.5 (10)	90 (*99*)	78	83	74	77	74	73	72
11 (15)	91 (*100*)	80	84	76	78	76	74	73
15 (20)	92 (*101*)	83	85 (*94*)	79	80	79	76	75
18.5 (25)	92 (*101*)	83	85 (*94*)	79	80	79	76	75
22 (30)	92 (*101*)	83	85 (*94*)	79	81	79	77	75
30 (40)	100 (*109*)	85 (*94*)	93 (*102*)	81	84	80	80	76
37 (50)	100 (*109*)	86 (*95*)	93 (*102*)	82	84	80	80	76
45 (60)	100 (*109*)	87 (*96*)	93 (*102*)	83	84	80	80	76
55 (75)	100 (*109*)	88 (*97*)	95 (*104*)	84	86 (*95*)	81	82	77
75 (100)	100 (*109*)	90 (*99*)	95 (*104*)	86 (*95*)	88 (*97*)	81	83	78
90 (120)	100 (*109*)	90 (*99*)	95 (*104*)	86 (*95*)	90 (*99*)	81	85 (*94*)	78
110 (150)	100 (*109*)	91 (*100*)	95 (*104*)	87 (*96*)	91 (*100*)	83	86 (*95*)	79
150 (200)	101 (*110*)	92 (*101*)	96 (*105*)	88 (*97*)	91 (*100*)	83	86 (*95*)	79
200 (270)	*	*	*	*	*	83	*	80
300 (400)	-	-	-	-	*	84	*	81
500 (670)	-	-	-	-	*	85 (*94*)	*	83

* Motors in this range are generally job specific and noise levels should be calculated based on actual equipment installed. For 960 rpm reduce 1450 rpm values by 5 dBA.

In areas where the staff has to intervene, remember that when the level of the sound pressure is:

Below 70 dBA :It is not necessary to take special precautions.

Above 70 dBA :People working continuously in the machine room must be supplied with protective devices against noise.

Below 85 dBA :No particular measures need to be taken for casual visitors staying in the room during a limited period.

Above 85 dBA :The room must be considered as a dangerous area because of the noise and a warning sign must be fixed at each entry warning the people coming into the room, even for a short period, that they must wear hearing protection.

Above 105 dBA:Special hearing protection adapted to this noise level and to the spectral noise components must be installed and a warning sign to this effect erected at each entry. The staff in the room must wear ear protection.

Make sure that the noise, which travels through the walls and windows, does not generate too high noise levels in the machine room's surroundings.

2 TRANSPORT AND STORAGE

2.1 Consignment receipt and unpacking

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

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

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

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

2.2 Handling

2.2.1 General instructions concerning handling

Boxes, crates, pallets or cartons may be unloaded using fork-lift vehicles or slings dependent on their size and construction. See 2.3.1 for positioning of slings.

To lift heavy pieces above 55 lb (25 kg), use a crane corresponding to the mass and in accordance with the current local regulations.

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

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

To increase the safety and efficiency of the lifting device, all the lifting elements must be as perpendicular as possible. If necessary a lifting beam can be placed between the crane and the load.

When heavy pieces are lifted up, never stay or work under the load or in the area which could be in the path of the load if it were to swing or fall away. Never leave a load hanging from a crane. The acceleration or the deceleration of lifting equipment must stay in the safety limits for the staff.

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

2.2.2 Pump masses

All masses, in the table below, are for 3 stages, in construction M2.

PUMP SIZE		MET PUMP MASS						MASS PER STAGE	
		WDX R/C		WDX E		WDX S			
		lb	kg	lb	kg	lb	kg	lb	kg
1.5WDX	Non cooled	298	135	271	123	243	110	23	10.5
	Cooled	309	140	295	134	267	121	23	10.5
2WDX	Non cooled	355	161	315	143	302	137	31	14
	Cooled	386	175	342	155	328	149	31	14
3WDX	Non cooled	483	219	450	204	421	191	46	21
	Cooled	516	234	478	217	450	204	46	21
4WDX	Non cooled	661	300	606	275	562	255	60	27
	Cooled	694	315	628	285	606	275	60	27

All masses, in the table below, are for 3 stages, in construction M3, M4, M5, M6, M7.

PUMP SIZE		MET PUMP MASS						MASS PER STAGE	
		WDX R/C		WDX E		WDX S			
		lb	kg	lb	kg	lb	kg	lb	kg
1.5WDX	Non cooled	324	147	298	135	260	118	25	11.5
	Cooled	335	152	322	146	293	133	25	11.5
2WDX	Non cooled	375	170	335	152	322	146	34	15.5
	Cooled	406	184	362	164	348	158	34	15.5
3WDX	Non cooled	527	239	494	224	465	211	51	23
	Cooled	560	254	522	237	494	224	51	23
4WDX	Non cooled	710	322	650	295	602	273	66	30
	Cooled	743	317	672	305	694	315	66	30

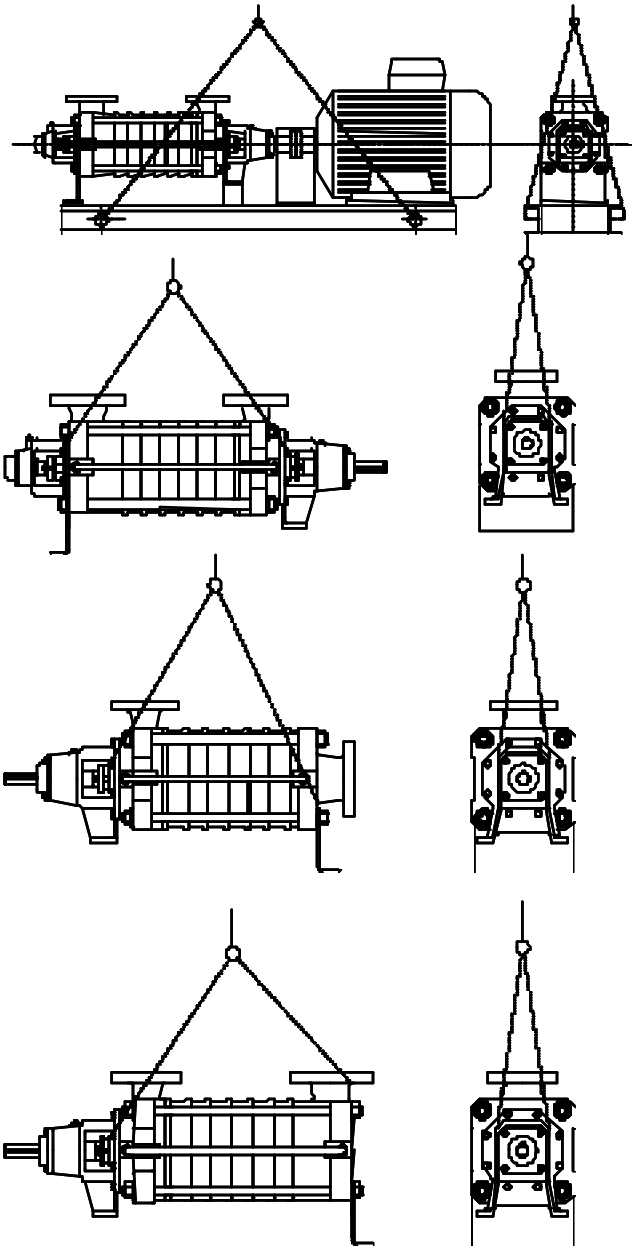
2.3 Lifting

2.3.1 Slinging of motor pumps units

Use handling means in accordance with motor pump unit mass mentioned on the CE plate. For the masses of the pumps bare end of shaft see table § 2.2.2 and nameplate.

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

Motor pump unit



When handling always wear gloves, safety shoes and an industrial safety helmet.

For masses above 55 lb (25 kg), manual handling is forbidden.

2.4 Storage

CAUTION Store the pump in a clean, dry location away from vibration. Leave piping connection covers in place to keep dirt and other foreign material out of pump casing. Turn pump at intervals to prevent brinelling of the bearings and the seal faces, if fitted, from sticking.

Do not store pumps starting on the fan guard.

The pump may be stored as above for up to 6 months. Consult Flowserve for preservative actions when a longer storage period is needed.

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.

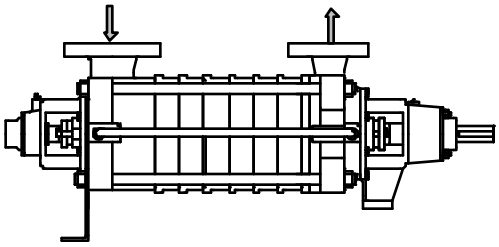
Make sure that hazardous substances or toxic fluid are disposed of safely and that the correct personal protective equipment is used. The safety specifications must be in accordance with the current regulations at all times.

3 PUMP DESCRIPTION

3.1 Configurations

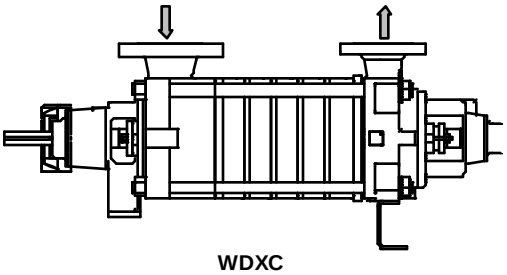
The WDX type pump is a horizontal, multistage, radial split case, vaned diffuser type centrifugal pump equipped with a special suction impeller for low NPSH. It can be used with motor, steam turbine and gasoline or diesel engine drives.
The WDX pumps are of modular construction with identical stages being stacked axially to achieve the desired pressure output. Four high strength external tie rods connecting the two end casings hold them together. A variety of optimal features and materials allow it to fit a wide range of applications such as boiler feed or reverse osmosis.
Various orientations for the radial suction and discharge nozzles are allowed every 90° except towards the bottom.

The WDX can have the following configurations:



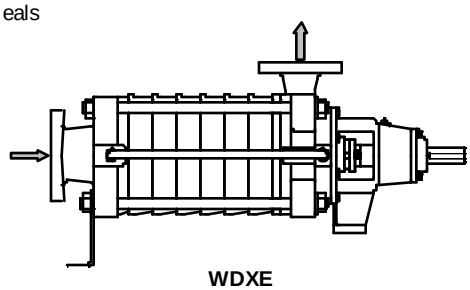
WDXR

Horizontal
Radial suction
Drive end on discharge side - CW
Thrust bearing on drive side
Radial bearing on suction side
2 shaft seals



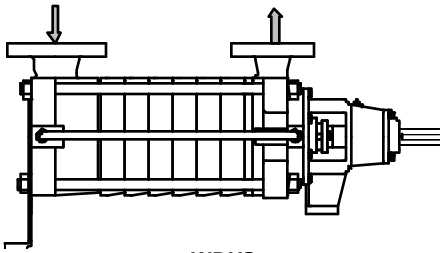
WDXC

Horizontal
Radial suction
Drive end on suction side - CCW
Thrust bearing on suction side
Radial bearing on discharge side
2 shaft seals



WDXE

Horizontal
End suction
Drive end on discharge side - CW
Thrust bearing on drive side
Sleeve bearing on suction side
1 shaft seal



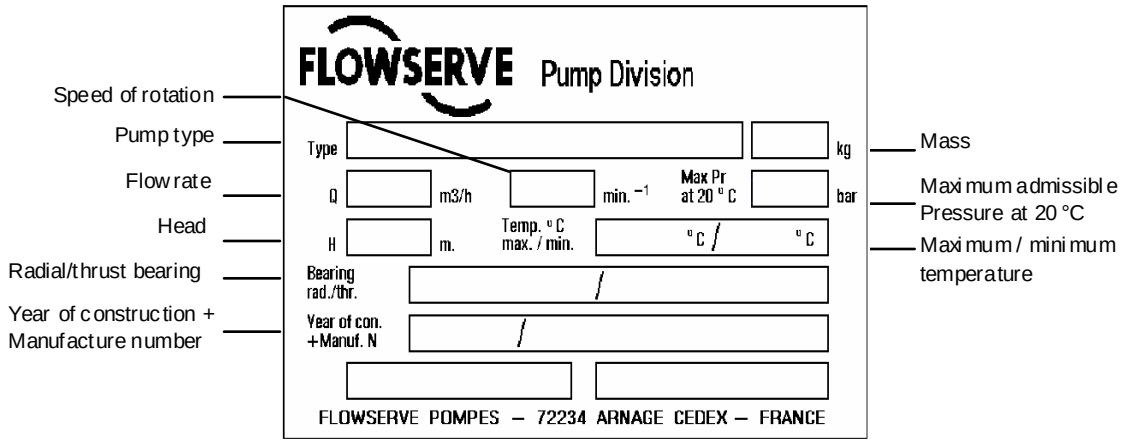
WDXS

Horizontal
Radial suction
Drive end on discharge side - CW
Thrust bearing on drive side
Sleeve bearing on suction side
1 shaft seal

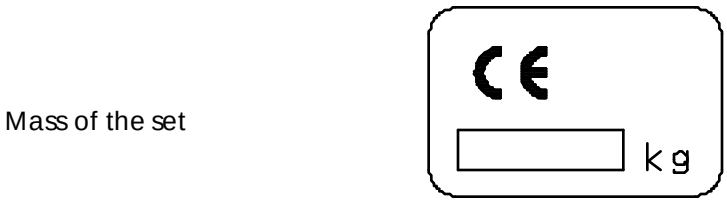
3.2 Nomenclature

Characteristics shown on the nameplate fixed on the pump are as shown below:

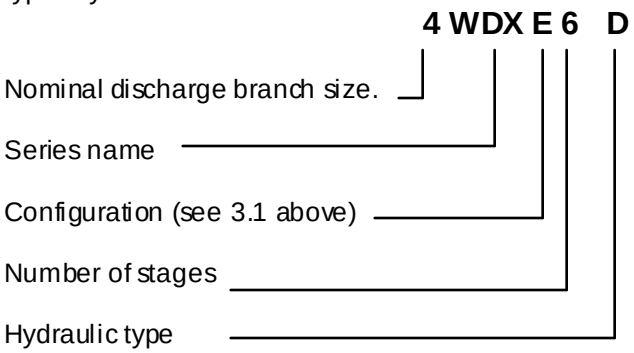
Each pump is supplied with the following nameplate:



Each pump unit is supplied with the following nameplate:



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



The typical nomenclature above is the general guide to the WDX configuration description. Identify the actual pump size and serial number from the pump nameplate. Check that this agrees with the applicable certification provided.

3.3 Design of major parts

3.3.1 Pump casing

The pump casings (suction, discharge and stage) are sealed with o'rings and designed to contain the pressures generated by the pump at the various possible design pressures and temperatures.

3.3.2 Impeller

The impeller is fully shrouded and may be fitted with optional wear rings.
The suction impeller is specifically designed to have a low NPSH requirement.

3.3.3 Diffuser

The diffusers are fully machined to optimise performance.

3.3.4 Shaft

The shaft mounted on bearings with a keyed drive end.

3.3.5 Pump bearings and lubrication
WDX pumps are designed so the antifriction bearings may be either oil or grease lubricated.

WDXE and WDXS have product lubricated line bearings with sleeve and bushing made of silicon carbide.

Bearing isolators or stationary labyrinths may be fitted as an option in the bearing covers to protect the bearings.

3.3.6 Bearing housing
Grease nipples enable grease lubricated bearings to be replenished between major service intervals. For oil-lubricated bearings, a constant level oiler is fitted.

3.3.7 Stuffing box housing
The stuffing box housing has a spigot (rabbet) fit between the pump casing and bearing housing for optimum concentricity. The design enables a number of sealing options to be fitted.

3.3.8 Shaft seal
The mechanical seal(s) attached to the pump shaft seals the pumped liquid from the environment. Stuffing boxes have been designed for component or cartridge seals. Gland packing may be fitted as an option.

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

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

3.4 Materials of construction

Material column	Casing	Impeller	Shaft
M2	Cast iron	Cast iron	Chrome steel
M3	Carbon steel	Cast iron	Chrome steel
M4	Carbon steel	Stainless steel	Chrome steel
M5	Chrome steel	Stainless steel	Chrome steel
M6	Duplex stainless steel	Stainless steel	Duplex stainless steel
M7	Stainless steel	Stainless steel	Duplex stainless steel

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

Note: The maximum allowable speed for cast iron impellers is 3600 RPM and for steel impellers is 4000 RPM.

3.5.1 Minimal flow
20 % of BEP up to 280° F (140 °C)
25 % of BEP between 280 °F (140 °C) and 410 °F (210 °C)

3.5.2 Clearance data

Size	Mat	Nominal wear ring clearance min/max mm (inch)	Nominal Interstage clearance min/max mm (inch)	Nominal Balance drum clearance min/max mm (inch)
1.5	M2 M3	0.170/0.259 (0.0067/0.0102)	0.170/0.259 (0.0067/0.0102)	0.150/0.226 (0.0059/0.0089)
1.5	M4 to M7	0.320/0.409 (0.0126/0.0161)	0.170/0.259 (0.0067/0.0102)	0.300/0.376 (0.0118/0.0148)
2	M2 M3	0.170/0.259 (0.0067/0.0102)	0.170/0.259 (0.0067/0.0102)	0.170/0.259 (0.0067/0.0102)
2	M4 to M7	0.330/0.419 (0.0130/0.0165)	0.170/0.259 (0.0067/0.0102)	0.470/0.559 (0.0185/0.0220)
3	M2 M3	0.200/0.303 (0.0079/0.0119)	0.200/0.303 (0.0079/0.0119)	0.170/0.259 (0.0067/0.0102)
3	M4 to M7	0.360/0.463 (0.0142/0.0182)	0.200/0.303 (0.0079/0.0119)	0.480/0.569 (0.0189/0.0224)
4	M2 M3	0.200/0.303 (0.0079/0.0119)	0.200/0.303 (0.0079/0.0119)	0.180/0.269 (0.0071/0.0106)
4	M4 to M7	0.410/0.513 (0.0161/0.0202)	0.200/0.303 (0.0079/0.0119)	0.500/0.603 (0.0197/0.0237)

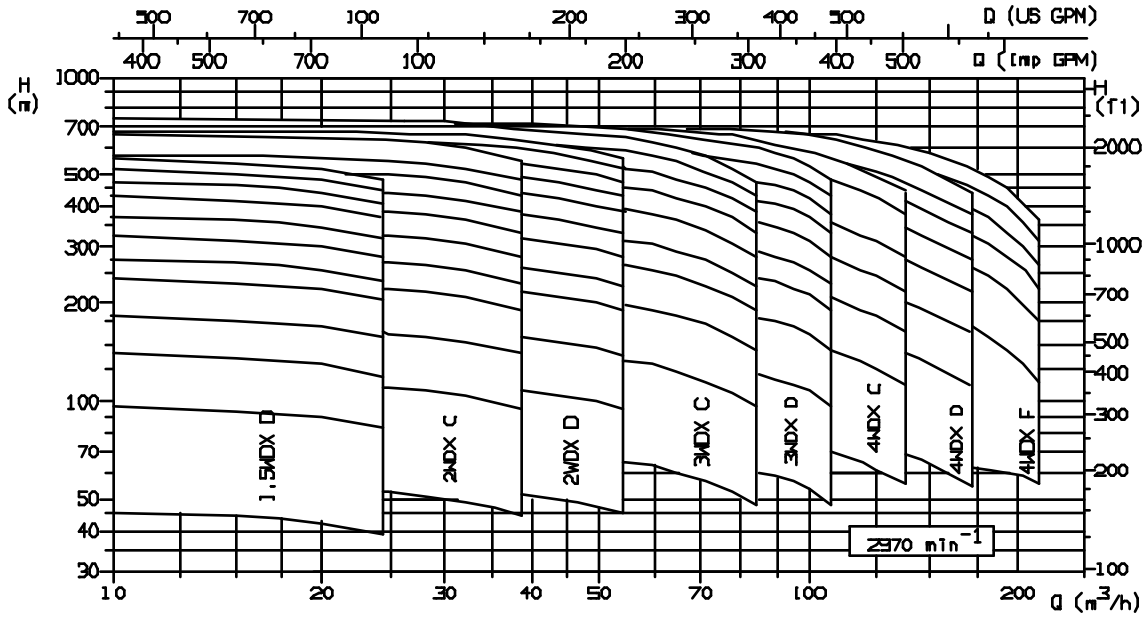
3.5.3 Sleeve bearing clearance (WDXE/S)

Pump size	Diametral clearance min/max mm (inch)
1.5 WDX	0.007 - 0.041 (0.0003 - 0.0016)
2 WDX	0.007 - 0.041 (0.0003 - 0.0016)
3 WDX	0.007 - 0.041 (0.0003 - 0.0016)
4 WDX	0.007 - 0.041 (0.0003 - 0.0016)

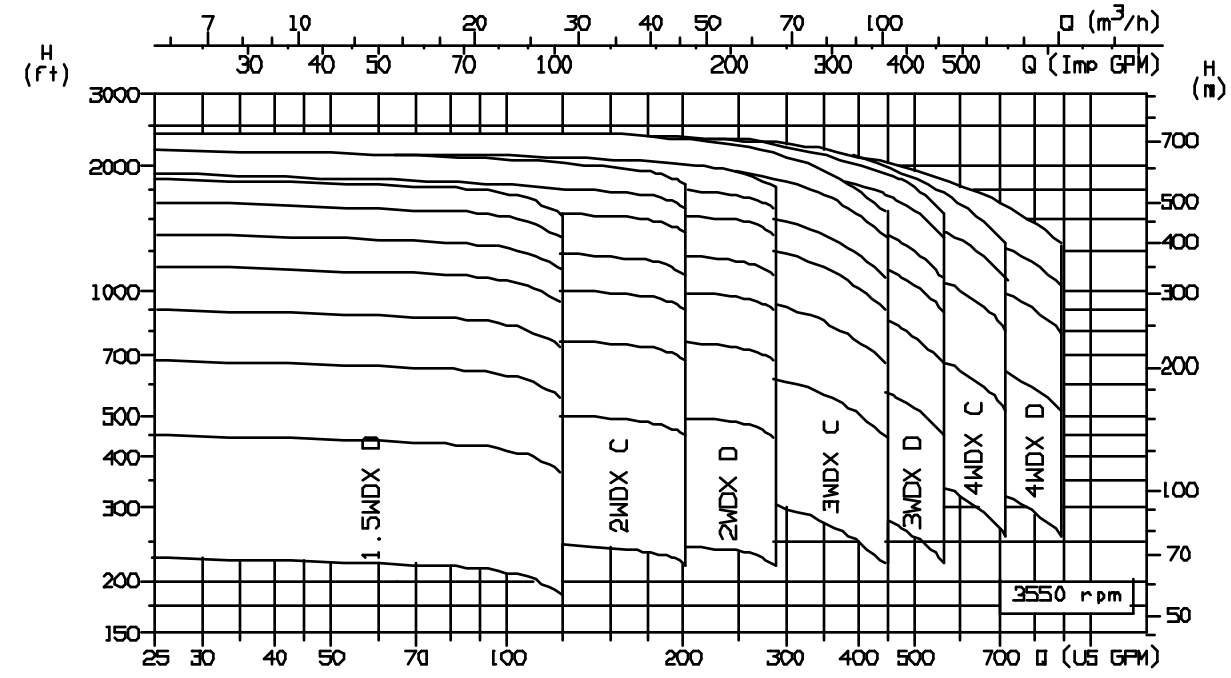
3.5.4 Bearing bushings
Interstage bearing bushings can be mounted on the pump. Their number and location depend on the material chosen and the number of stages of the pump. For further information, see general arrangement drawing of the pump.

3.6 Coverage charts

3.3.1 2970 min^{-1} (50 Hz): coverage charts (Q, H)



3.3.2 3550 min^{-1} (60 Hz): coverage charts (Q, H)



4 INSTALLATION

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

All equipment must be grounded.

4.1 Location

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

The pump should be located above the flood level. The pipework should be such that there is an adequate NPSH at the pump centreline. The foundation should provide enough support so that the pump is not supported by the pipework.

Refer to the general arrangement drawing for the pump set.

4.2 Cleaning prior to installation

Remove glue and dirt from suction and discharge flanges. Check motors to make sure no foreign objects have entered through fan and cooling openings. Remove any compounds on exposed areas of pump shaft. Clean pump and motor nameplate.

4.3 Foundation

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

4.3.1 General recommendations

Foundation bolts should be located or embedded in the concrete by lay-out or template in relation to the suction and discharge piping. Foundation bolts of the specified size may be enclosed in a pipe sleeve two or three diameters larger than the bolts to compensate for minor variation in alignment.

Standard accessory steel baseplates furnished with these pumps and motors 10 HP (7.5 kW) and under may be bolted to machine or equipment structures, either rigidly or, if flexible piping is used, with properly designed vibration isolators.

A unit mounted on steel work or structural members should be mounted over or adjacent to girders or walls so that no misalignment will occur from yielding or sagging of the structure.

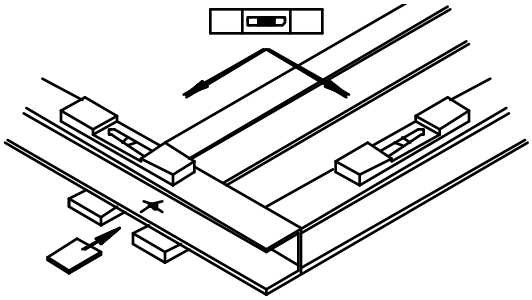
Anchor bolts must be in accordance with the foot bolt holes. Use anchor bolts of accepted standards and sufficient to ensure seave fitting in the foundation. Particularly, this applies to individual plates where the anchor bolts have to withstand the driving torque. Provide sufficient space in the foundation to accommodate the anchor bolts. If necessary, provide concrete risers.

4.3.2 Positioning on foundation

Pumps are generally shipped mounted, and it is usually unnecessary with units of moderate size to remove the pump or driver from its baseplate when levelling.

Ensure the following are met:

a) Clean the foundation thoroughly.
b) The baseplate should be mounted onto a firm foundation, either an appropriate thickness of quality concrete or sturdy steel framework capable of absorbing all normal vibrations. (It should NOT be distorted or pulled down onto the surface of the foundation, but should be supported to maintain the original alignment).
c) Install the baseplate onto packing pieces evenly spaced and adjacent to foundation bolts.



d) Level with shims, about 25 mm (1”), between baseplate and packing pieces.
e) Check the horizontal position by means of a precision level placed upon an adequate reference (discharge flange, machined surfaces of casings etc...). Tolerances within 0.5 mm per m (0.006 in per ft).
f) The pump and driver have been aligned before dispatch however the alignment of pump and motor half coupling must be checked. If this is incorrect, it indicates that the baseplate has become twisted and should be corrected by re-shimming.

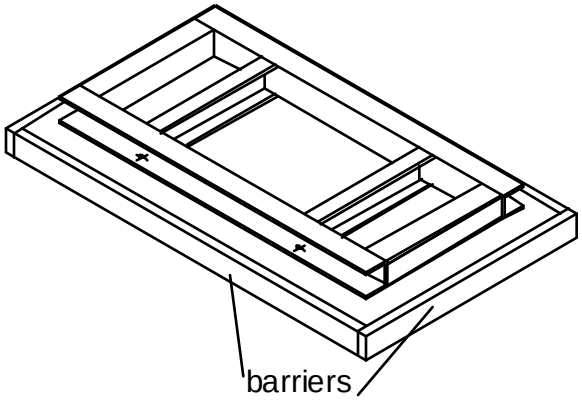
g) If anchor bolts have been embedded in the foundation, slightly tighten the anchor bolts. Otherwise let them hang in the foundation holes.
h) If not supplied, guarding shall be fitted as necessary to meet the requirements of EN292 and EN953 and or any applicable local safety regulations.

4.4 Grouting

Where applicable, grout in the foundation bolts.

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

Prepare the site for grouting. Before grouting clean the foundation surface thoroughly. Provide external barriers as shown:



Prepare grouting product (concrete, resin) in accordance with manufacturers' instructions.
(Use anti-shrink products)
To grout up to the required level. Polish surfaces. Take necessary precautions to avoid air bubbles. Lay-down the barrier, break external angles and polish the different surfaces.

Foundation bolts should only be fully tightened when the grout has cured.

4.5 Initial alignment

CAUTION Before connecting the couplings verify the motor rotation direction.

4.5.1 Thermal expansion

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

4.5.2 Alignment methods

DANGER Ensure pump and driver are isolated electrically and the half couplings are disconnected. Ensure that the pump pipework, suction and discharge, is disconnected.

CAUTION The alignment MUST be checked.

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

Pump-Driver unit supplied assembled on their baseplate:

The machines have originally been aligned in the work-shop.

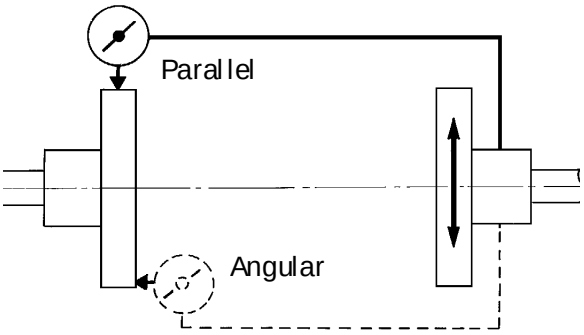
Pump and Driver supplied on separate baseplates:

The machines have originally been mounted on their respective baseplate in the workshop. The pump is to be installed first and should be considered as the fixed point. The alignment is then performed on the driver alone.

Before aligning verify that the pump is horizontal by using a flange surface or other horizontal surface. Adjust if necessary by adjusting the height of the wobble foot. Tighten any nuts that have been loosened.

Alignment is achieved by adding or removing shims under the motor feet and also moving the motor horizontally as required. In some cases where the alignment cannot be achieved it will be necessary to move the pump before recommencing the above procedure.

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



Maximum permissible misalignment at working temperature:

Parallel 0.2 mm (0.008 in.) TIR
Angular 0.1 mm (0.004 in.) TIR

When checking parallel alignment, the total indicator read-out (TIR) shown is twice the value of the actual shaft displacement.

Align in the vertical plane first, then horizontally by moving motor. When performing final alignment, check for soft-foot under the driver. A TIR indicator placed on the coupling, reading in the vertical direction, should not indicate more than 0.05 mm (0.002 in.) movement when any driver foot fastener is loosened.

While the pump is capable of operating with the maximum misalignment shown above, maximum pump reliability is obtained by near perfect alignment of 0.05 to 0.10 mm (0.002 to 0.004 in.) TIR parallel and 0.05 mm (0.002 in.) per 100 mm (4 in.) of coupling flange diameter as TIR angular misalignment. This covers the full series of couplings available.

Pumps with thick flanged non-spacer couplings can be aligned by using a straight-edge across the outside diameters of the coupling hubs and measuring the gap between the machined faces using feeler gauges, measuring wedge or calipers.

When the electric motor has sleeve bearings it is necessary to ensure that the motor is aligned to run on its magnetic centreline.

Refer to the motor manual for details.

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

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

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

4.6 Piping

The user must verify that the equipment is isolated from any external sources of vibration.

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

4.6.1 Suction and discharge pipework

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

Take into account the available NPSH must be higher than the required NPSH of the pump. When determining the NPSH available the vapour pressure at the operating temperature must be taken into account.

CAUTION Never use the pump as a support for piping.

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

- Prevent excessive external pipe load
- Never draw piping into place by applying force to pump flange connections.
- Do not mount expansion joints so that their force, due to internal pressure, acts on the pump flange. It is recommended that expansion joints use threaded rod to limit any forces of this type.
- Thermal expansions must be compensated in such a way that no additional forces act on the pump flanges.
- Make sure that piping flanges are square and concentric to the pump flanges.

The table in 4.6.3 summarizes the maximum forces and moments allowed on WDX pump casings. Refer to Flowserve for other configurations.

CAUTION Ensure piping and fittings are flushed before use.

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

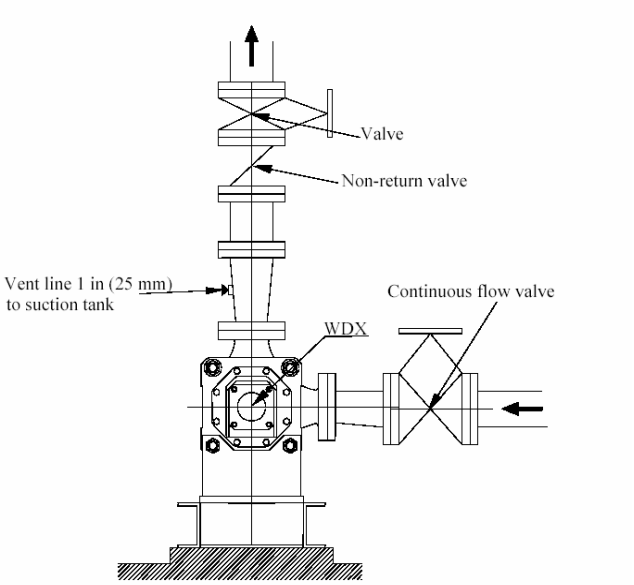
Excessive external strains (forces, moments) may cause misalignment, general vibrations, hot bearings or excessive wear on couplings and seals. In extreme cases, leakage may result with potential loss of life with hot or corrosive liquids.

4.6.2 Suction piping

Refer to the diagrams below for typical designs of suction piping for both flooded suction and suction lift.

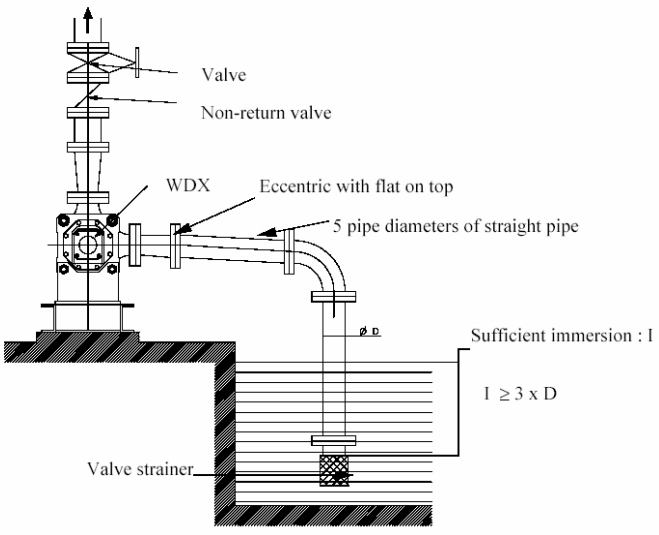
a) The inlet pipe should be one or two sizes larger than the pump inlet bore and pipe bends should be as large a radius as possible.
b) Pipework reducers should be conical and have a maximum total angle of divergence of 15 degrees.
c) Pipework should be arranged to avoid air pockets.
d) If high points cannot be avoided on the suction line equip them with air relief cocks.
e) On suction lift the piping should be inclined up towards the pump inlet with eccentric reducers incorporated to prevent air locks.
f) On positive suction, the inlet piping must have a constant fall towards the pump.
g) Flow should enter the pump suction with uniform flow, to minimize noise and wear. This is particularly important on large or high-speed pumps which should have a minimum of five diameters of straight pipe on the pump suction between the elbow and inlet flange. See section 10.3, *Reference 1,* for more detail.
h) Inlet strainers, when used, should have a net `free area' of at least three times the inlet pipe area.
i) Do not install elbows at an angle other than perpendicular to the shaft axis. Elbows parallel to the shaft axis will cause uneven flow.
j) Except in unusual circumstances strainers are not recommended in inlet piping. If considerable foreign matter is expected a screen installed at the entrance to the wet well is preferable.
k) Fitting an isolation valve will allow easier maintenance.
l) If an inlet valve is necessary, choose a model with full bore so as to limit losses. Valve stem should be in a vertical position. There should be a minimum of five pipe diameters between the pump and the valve.
m) Never throttle pump on suction side and never place a valve directly on the pump inlet nozzle.
n) Do not tighten flanges before the final check.

Typical design – flooded suction



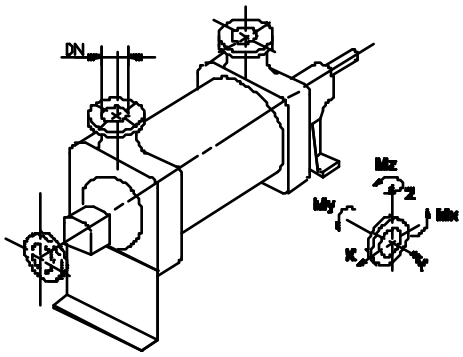
Note:
Ideally reducers should be limited to one pipe diameter change, ie 150 mm (6 in.) to 200 mm (8 in.). Must have a maximum total angle of divergence of 15 degrees.

Typical design – suction lift



Notes:
1. S = Minimum submergence >3E.
2. Ideally reducers to be limited to one pipe diameter change, ie 150 mm (6 in.) to 200 mm (8 in.). Must have a maximum total angle of divergence of 15 degrees.

4.6.3 Maximum forces and moments allowed on WDX pump flanges



Direction of forces

Fx = horizontal parallel to pump axis
Fy = horizontal perpendicular to pump axis
Fz = vertical perpendicular to pump axis

Direction of moments
Mx = around a horizontal axis parallel to pump axis
My = around a horizontal axis nozzle axis
Mz = around a horizontal axis perpendicular to pump axis

PIPE CONFIGURATION	FLANGE Diameter	FORCES				MOMENTS			
		Fy	Fz	Fx	Σ F	My	Mz	Mx	Σ M
Vertical pipework perpendicular to the shaft	1.5 in	130 lbf	200 lbf	160 lbf	290 lbf	170 ft-lbf	260 ft-lbf	340 ft-lbf	460 ft-lbf
	40 mm	58 daN	89 daN	71 daN	128 daN	23 daN.m	35 daN.m	46 daN.m	62 daN.m
	2 in	130 lbf	200 lbf	160 lbf	290 lbf	170 ft-lbf	260 ft-lbf	340 ft-lbf	460 ft-lbf
	50 mm	58 daN	89 daN	71 daN	128 daN	23 daN.m	35 daN.m	46 daN.m	62 daN.m
	3 in	200 lbf	300 lbf	240 lbf	430 lbf	350 ft-lbf	530 ft-lbf	700 ft-lbf	950 ft-lbf
	80 mm	89 daN	133 daN	107 daN	193 daN	47 daN.m	72 daN.m	95 daN.m	128 daN.m
	4 in	260 lbf	400 lbf	320 lbf	570 lbf	500 ft-lbf	740 ft-lbf	980 ft-lbf	1330 ft-lbf
	100 mm	116 daN	178 daN	142 daN	256 daN	68 daN.m	100 daN.m	133 daN.m	180 daN.m
	6 in	460 lbf	700 lbf	560 lbf	1010 lbf	870 ft-lbf	1300 ft-lbf	1700 ft-lbf	2310 ft-lbf
	150 mm	205 daN	311 daN	249 daN	448 daN	118 daN.m	176 daN	230 daN.m	313 daN.m
Horizontal pipework perpendicular to the shaft	1.5 in	130 lbf	200 lbf	160 lbf	290 lbf	170 ft-lbf	260 ft-lbf	340 ft-lbf	460 ft-lbf
	40 mm	58 daN	89 daN	71 daN	128 daN	23 daN.m	35 daN.m	46 daN.m	62 daN.m
	2 in	130 lbf	200 lbf	160 lbf	290 lbf	170 ft-lbf	260 ft-lbf	340 ft-lbf	460 ft-lbf
	50 mm	58 daN	89 daN	71 daN	128 daN	23 daN.m	35 daN.m	46 daN.m	62 daN.m
	3 in	200 lbf	300 lbf	240 lbf	430 lbf	350 ft-lbf	530 ft-lbf	700 ft-lbf	950 ft-lbf
	80 mm	89 daN	133 daN	107 daN	193 daN	47 daN.m	72 daN.m	95 daN.m	128 daN.m
	4 in	260 lbf	400 lbf	320 lbf	570 lbf	500 ft-lbf	740 ft-lbf	980 ft-lbf	1330 ft-lbf
	100 mm	116 daN	178 daN	142 daN	256 daN	68 daN.m	100 daN.m	133 daN.m	180 daN.m
	6 in	460 lbf	700 lbf	560 lbf	1010 lbf	870 ft-lbf	1300 ft-lbf	1700 ft-lbf	2310 ft-lbf
	150 mm	205 daN	311 daN	249 daN	448 daN	118 daN.m	176 daN	230 daN.m	313 daN.m
Horizontal within the pump axis	3 in	240 lbf	200 lbf	300 lbf	430 lbf	350 ft-lbf	530 ft-lbf	700 ft-lbf	950 ft-lbf
	80 mm	107 daN	89 daN	133 daN	193 daN	47 daN.m	72 daN.m	95 daN.m	128 daN.m
	4 in	320 lbf	260 lbf	400 lbf	570 lbf	500 ft-lbf	740 ft-lbf	980 ft-lbf	1330 ft-lbf
	100 mm	142 daN	116 daN	178 daN	256 daN	68 daN.m	100 daN.m	133 daN.m	180 daN.m
	6 in	560 lbf	460 lbf	700 lbf	1010 lbf	870 ft-lbf	1300 ft-lbf	1700 ft-lbf	2310 ft-lbf
	150 mm	249 daN	205 daN	311 daN	448 daN	118 daN.m	176 daN.m	230 daN.m	313 daN.m

Notes:

1) F = External force (tension or compression).
   M = External moment, clockwise or counter-clockwise.
2) Forces and moments may be applied simultaneously in any direction.
3) Values apply to all materials.
4) Higher loads may be applicable, if direction and magnitude of individual loads are known, but these need written approval from Flowserve Pump Division.
5) Pumps must be on rigid foundations and baseplates must be fully grouted.
6) Pump/baseplate should not be used as pipe anchor. Suction and discharge piping should be anchored as close as possible to the pump flanges to reduce vibration and prevent strain on the pump casing. Expansion joints are recommended. They must be properly tied and located on the side of the pipe anchor away from the pump
7) The pump mounting bolt torques specified must be used to prevent relative movement between the pump casing and baseplate. (See section 6.6, *Fastener torques*.). The bolt material must have a minimum yield strength of 600 N/mm^2 (87 000 lb/in.^{2}).

4.6.4 Discharge piping
See section 4.6.2 for typical pipework design.

A non-return valve should be located in the discharge pipework to protect the pump from excessive back pressure and hence reverse rotation when the unit is stopped.

Pipework reducers should have a maximum total angle of divergence of 9 degrees.

Fitting an isolation valve will allow easier maintenance. It should be installed downstream of the non-return valve.

If needed a control pressure gauge may be installed on the pipework.

Do not tighten the pipe flanges before the final check.

4.6.5 Auxiliary piping

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

4.6.5.2 Pumps fitted with mechanical seals
Single seals requiring re-circulation will normally be provided with the auxiliary piping from pump casing already fitted.

If the seal requires an auxiliary quench then a connection must be made to a suitable source of liquid flow, low pressure steam or static pressure from a header tank. Recommended pressure is 0.35 bar (5 psi) or less. Check *General arrangement drawing*.

Special seals may require different auxiliary piping to that described above. Consult separate User Instructions and or Flowserve if unsure of correct method or arrangement.
For pumping hot liquids, to avoid seal damage, it is recommended that any external flush/cooling supply be continued after stopping the pump.

4.6.6 Final checks
Check the tightness of all bolts in the suction and discharge pipework. Tighten if necessary. Check also the tightness of all foundation bolts. Tighten if necessary. Check the tightness of all auxiliary piping. Tighten if necessary.

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.

Alignment can only be considered definitive after pipework has been connected.

4.8 Electrical connections

4.8.1 Safety conditions about electrical connections
DANGER Electrical connections must be made by a qualified Electrician in accordance with relevant local national and international regulations. This includes any grounding.

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.

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

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

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

A device to provide emergency stopping must be fitted.

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

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

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

4.9 Protection systems

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

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

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

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

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

If a defect of cooling can lead to temperature higher than those acceptable a system of cooling surveillance must be installed.

Except when explicitly required by the customer in the specifications, when a possibility of reverse rotation exists the customer must install a reverse rotation protection device.

The customer must install all equipment required to avoid water hammer.

5 COMMISSIONING, START-UP, OPERATION AND SHUTDOWN

These operations must be carried out by fully qualified personnel.

5.1 Pre-commissioning procedure

5.1.1 Lubrication

Determine the mode of lubrication of the pump set, eg grease, oil, product lubrication etc.

Grease lubricated pumps and electric motors are supplied pre-greased.

Other drivers and gearboxes, if appropriate, should be lubricated in accordance with their manuals.

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

5.1.2 Oil Lubrication

The bearings are lubricated by pins. A constant level oiler automatically maintains the correct oil level.

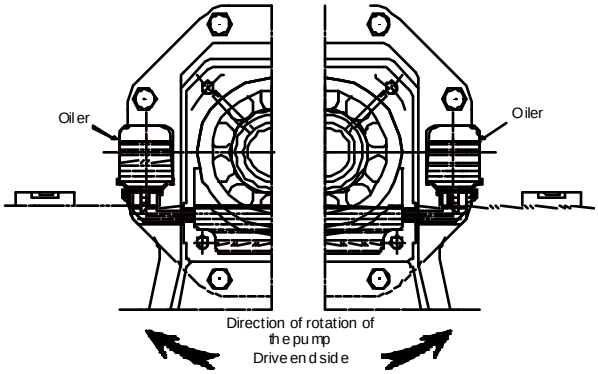
The oiler supplies the necessary quantity of oil. It operates on the liquid seal principal and feeds with oil only when the quantity of oil becomes too low in the bearing. It will stop to feed once a sufficient quantity of oil is in the bearing.

The reserve contained in the reservoir refills automatically the natural losses of the bearing. As soon as the oil level approaches the minimum level of the reservoir, refill the reservoir.

Regarding the quality and the quantity of the oil to be used, refer to the lubrication table and information below.

CAUTION For oil lubricated pumps, fill the bearing housing with correct grade of oil to the correct level, ie sight glass or constant level oiler bottle.

See below for the correct side on which constant level oilers should be installed.



When fitted with a constant level oiler, the bearing housing should be filled only by unscrewing or hinging back the transparent bottle and filling the bottle with oil. Do not fill the bearing housing through the breather hole.

Oil levels are as indicated below. The distance indicated is distance below the shaft centreline.

Pump size	Oil Level mm (inch)	
	Drive end	Non Drive end
1.5 WDX	41 (1.61)	41 (1.61)
2 WDX	46 (1.81)	46 (1.81)
3 WDX	56 (2.20)	46 (1.81)
4 WDX	66 (2.60)	46 (1.81)

The oil filled bottle should then be refitted so as to return it to the upright position. Filling should be repeated until oil remains visible within the bottle.

5.2 Pump lubricants

5.2.1 Recommended oil lubricants

Viscosity grade ISO 46 *Ambient temperature* *Bearings temperature 80 °C maximum*	TABLE OF EQUIVALENCE AND CHARACTERISTICS OF RECOMMENDED OILS						
MANUFACTURER TYPE CHARACTERISTICS	BP ENERGOL HLP 46	ELF TURBELF SA 46	ESSO TERESSO 46	MOBIL DTE Medium	SHELL TELLUS T 37	TOTAL PRESLIA 46	TOTAL AZOLLA ZS 46
Density at 15 C	0.885	0.881	0.868	0.878	0.87	0.872	0.877
Viscosity at 40 °C.cst	45	48.6	43	43	46	46	46
Viscosity at 50 °C.cst	30	31.5	29.4	28	30	29.5	30
Viscosity at 100 °C.cst	6.9	7.1	6.7	7	6.9	6.9	6.8
Pour-point °C	- 30	- 27	- 12	- 15	- 30	- 12	- 21
Flash-point °C	210	220	220	220	214	230	230
Fire-point °C	240	252		280	240		245
Aniline point °C	99	102	110	102	109	101	101
Viscosity index	105	106	109	105	113	100	100
Acid value	0.2	0.6	0.2	0.13	0.7	0.1	0.7 to 1.2
Colour	1 ½	2	1	2	2	1 ½	1
Anti erosion additives		yes		yes	yes	yes	yes
Foam inhibitors	yes	yes	yes	yes	yes	yes	yes
Anticorrosion additives	yes	yes	yes	yes	yes	yes	yes
Antioxidant	yes	yes	yes	yes	yes	yes	yes
Conradson carbon residue						0.01	0.2
Limits on temperature °C						- 12 to 120 °C	- 21 to 110 °C
Saponification						< 0.5	1.2

5.2.2 Recommended grease lubricants

Factory greasing : SHELL ALVANIA R2 or equivalent

Equivalent greases : MOBIL, Mobilux EP2
TOTAL, Multis 2
ELF, Elf Multi

Grease Quantity : 10 to 30 Grams

5.2.3 Recommended fill quantities

Pump size	Oil Quantity ISO VG 46	
	Drive end	Non Drive end
1.5 WDX	0.26 qt (0.250 Ltr)	0.21 qt (0.200 Ltr)
2 WDX	0.37 qt (0.350 Ltr)	0.25 qt (0.240 Ltr)
3 WDX	0.42 qt (0.400 Ltr)	0.25 qt (0.240 Ltr)
4 WDX	0.63 qt (0.600 Ltr)	0.32 qt (0.300 Ltr)

5.2.4 Lubrication schedule

5.2.4.1 Oil lubricated bearings

Operating conditions and severity of service will determine the intervals between oil changes. In general higher oil temperatures will require more frequent oil changes.

For pumps on hot service or in severely damp or corrosive atmosphere, the oil will require changing more frequently. If the bearings maintain a stable temperature and if there has been no contamination of the oil, the interval between changes may be longer.

Lubricant and bearing temperature analysis can be useful in optimising lubricant change intervals. Generally, the oil should be changed every 6 months. If the bearing temperature increases, check immediately for improper lubrication or a faulty bearing.

The lubricating oil should be a high quality mineral oil having foam inhibitors. Synthetic oils may also be used if checks show that the rubber oil seals will not be adversely affected.

The bearing temperature may be allowed to rise to 50 ºC (122 ºF).above ambient, but should not exceed 82 ºC (180 ºF). A continuously rising temperature or an abrupt rise, indicate a fault.

5.2.4.2 Grease lubricated bearings

The bearings are prelubricated when supplied. Lubrication frequency is as indicated in the table below. After a 2 years period the bearing should be completely cleaned, checked and repacked with new grease.

The free bearing space should not be filled up more that 50 % to 60 % of its content see 5.2.3. Care must be taken to avoid both under and over-lubrication.

Over lubrication will cause the bearings to run hotter than normal, while under-lubricated bearings could wear prematurely.

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

Pump size	Lubrication frequencies in hours of operation			
	1450 RPM	1750 RPM	2950 RPM	3550 RPM
1,5 WDX	3000	2200	1500	1200
2 WDX	3000	2200	1500	1200
3 WDX	2700	2000	1400	1100
4 WDX	2500	1700	1300	1000

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

5.3 Direction of rotation

CAUTION Starting or operating pumps with the wrong direction of rotation can be harmful to the pumps.

Ensure that the pump rotation is the same as the arrow on the pump casing.
It is preferable to check the direction of rotation before installing the coupling. If not, the pump must be filled in with the liquid before start-up.

CAUTION If maintenance work has been carried out to the site's electricity supply, the direction of rotation should be re-checked as above in case the supply phasing has been altered.

5.4 Guarding

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

5.5 Priming and auxiliary supplies

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

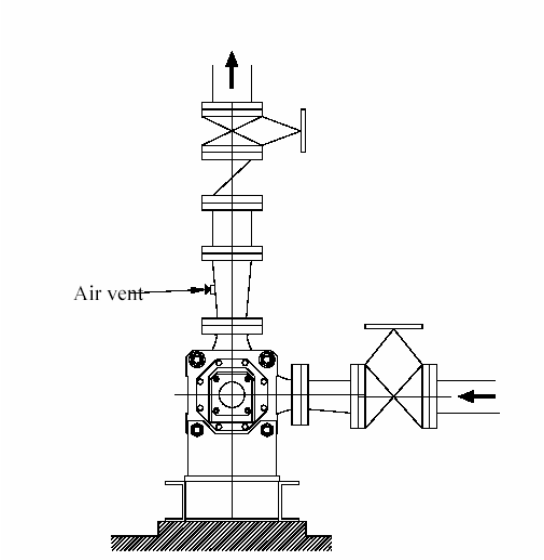
CAUTION Ensure all electrical, hydraulic, pneumatic, sealant and lubrication systems (as applicable) are connected and operational.

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

These operations must be carried out by personnel with approved qualifications.

5.5.1 Suction pressure above atmospheric pressure

Open the air vent connection to allow the trapped air to escape. Let liquid run out until free from air bubbles.



5.5.2 Suction lift with foot valve fitted

Fill suction pipe and casing with liquid at a pressure of 1 to 2 bar from an external source. Vent as described in section 5.5.1.

Note: Foot valves are not recommended when the pumped liquid has suspended solid particles. They may lodge between foot valve seat and shutter.

5.5.3 Suction lift without foot valve

Pump casing vents on the suction volute must be connected to an external vacuum pump priming system. If in doubt, please consult Flowserve.

5.6 Starting the pump

a) CAUTION Ensure flushing and/or cooling/ heating liquid supplies are turned ON before starting the pump.
b) CLOSE the outlet valve. If the pump is equipped with a non-return flow valve and is to be started with an opened discharge valve, verify that it is closed by an adequate back pressure.
c) OPEN all inlet valves.
d) Open all valves of the minimal flow line to ensure a minimal flow for the period the pump is running against the closed discharge valve.
e) Prime the pump.
f) Check that all plugs are tight.
g) Check that the gland lightly tightens the packing.
h) ⚠ Ensure all vent connections are closed before starting.
i) Start motor and check outlet pressure.
j) If the pressure is satisfactory, slowly OPEN outlet control valve.
k) CAUTION Do not run the pump with the outlet valve closed for a period longer than 20 seconds.
l) If NO pressure, or LOW pressure, STOP the pump. Refer to section 7, *Faults; causes and remedies*, for fault diagnosis.

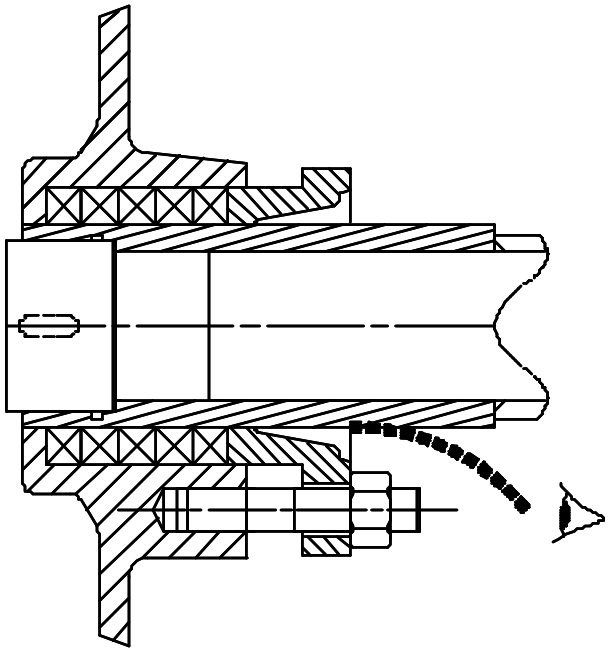
5.7 Running the pump

5.7.1 Venting the pump

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

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

5.7.2 Pumps fitted with packed gland



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

The gland must be adjusted evenly to give visible leakage and concentric alignment of the gland ring [4120] to avoid excess temperature. If no leakage takes place the packing will begin to overheat. If overheating takes place the pump should be stopped and allowed to cool before being re-started. When the pump is re-started, check to ensure leakage is taking place at the packed gland.

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

The pump should be run for ten minutes with steady leakage and the gland nuts tightened by 10 degrees at a time until leakage is reduced to an acceptable level. The temperature of the gland should be checked after each round of tightening. If the temperature starts to climb rapidly then back off the gland nuts until the temperature drops down. Wait for the temperature to stabilize before tightening again. The leakage must not be reduced below a rate of 20 drops per minute. Bedding in of the packing may take several hours.

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

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

5.7.3 Pumps fitted with mechanical seal

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

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

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

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

5.7.4 Bearings

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

If bearing temperatures are to be monitored it is essential that a benchmark temperature is recorded at the commissioning stage and after the bearing temperature has stabilized.

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

It is important, particularly with grease lubrication, to keep a check on bearing temperatures. After start up the temperature rise should be gradual, reaching a maximum after approximately 1.5 to 2 hours. This temperature rise should then remain constant or marginally reduce with time. (Refer to section 6.2.3.1 for further information.)

5.7.5 Normal vibration levels, alarm and trip

For guidance, pumps generally fall under a classification for rigid support machines within the International rotating machinery standards and the recommended maximum levels below are based on those standards.

CAUTION Alarm and trip values for installed pumps should be based on the actual measurements (N) taken on site on the bearing housings of the pump in the fully commissioned as new condition.

The example (N) value is given for the preferred operating flow region (typically this may extend to 70 to 120 % of the pump best efficiency point); outside the preferred flow region the actual vibration experienced may be multiplied by up to 2.

These standard values can vary with the rotational speed and the power absorbed by the pump. For any special case, do not hesitate to consult us.

Measuring vibration at regular intervals will then show any deterioration in pump or system operating conditions.

Vibration Velocity - unfiltered		Horizontal Configuration mm/s (in./s) r.m.s.
Normal	**N**	≤ 5.6 (0.22)
Alarm	**N** x 1.25	≤ 7.1 (0.28)
Shutdown Trip	**N** x 2.0	≤ 11.2 (0.44)

5.7.6 Stop/start frequency

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

Motor rating kW (hp)	Maximum stop/starts per hour
Up to 15 (20)	15
Between 15 (20) and 90 (120)	10
90 (120) to 150 (200)	6
Above 150 (200)	Refer

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

5.8 Stopping and shutdown

a) CAUTION Close the outlet valve, but ensure that the pump runs in this condition for no more than a few seconds.
b) Stop the pump.
c) Avoid having the unit turn in the opposite direction of the normal running conditions
d) Protect the pump against water hammer.
e) Make sure that the discharge line pressure does not reach the foot valve.
f) Switch off flushing and/or cooling/heating liquid supplies at a time appropriate to the process.
g) CAUTION For prolonged shut-downs and especially when ambient temperatures are likely to drop below freezing point, the pump and any cooling and flushing arrangements must be drained or otherwise protected. When draining the pump, first verify that the liquid temperature has cooled sufficiently to allow safe maintenance.

5.9 Hydraulic, mechanical and electrical duty

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

5.9.1 Specific gravity (SG)

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

5.9.2 Viscosity

For a given flow rate the total head reduces with increased viscosity and increases with reduced viscosity. Also for a given flow rate the power absorbed increases with increased viscosity, and reduces with reduced viscosity.

It is important that checks are made with your nearest Flowserve office if changes in viscosity are planned.

5.9.3 Pump speed

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

5.9.4 Net positive suction head ($NPSH_A$)

NPSH available ($NPSH_A$) is the head available at the impeller inlet, above the vapour pressure of the pumped liquid.

NPSH required ($NPSH_R$) is the minimum head required at the impeller inlet, above the vapour pressure of the pumped liquid, to avoid excessive cavitation and extreme performance degradation.

It is important that $NPSH_A > NPSH_R$. The margin between $NPSH_A > NPSH_R$ should be as large as possible.

If any change in $NPSH_A$ is proposed, ensure these margins are not significantly eroded. Refer to the pump performance curve to determine exact requirements particularly if flow has changed. If in doubt please consult your nearest Flowserve office for advice and details of the minimum allowable margin for your application.

5.9.5 Pumped flow

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

5.10 Pumps for Food Use or Potable Water

If the pump has not been specifically ordered for a food or drinking water application it must not be used for these types of applications. If it has been ordered for this type of application the following recommendations are to be followed.

5.10.1 Cleaning prior to operation

Pumps that are to be used for a food or drinking water application should be cleaned before being put into initial operation and after the installation of spare parts that are in contact with the liquid.

Cleaning once the pump has been commissioned will depend on the application and operating conditions. The user must ensure that the cleaning procedures are suitable for the application and operating conditions, and local regulations.

6 MAINTENANCE

6.1 General

If a belt drive is used, the assembly and tension of the belts must be verified during regular maintenance procedure.

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

It is the plant operator's responsibility to ensure that all maintenance, inspection and assembly work is carried out by authorized and qualified personnel who have adequately familiarized themselves with the subject matter by studying this manual in detail. (See also section 1.6.2.)

Any work on the machine must be performed when it is at a standstill. It is imperative that the procedure for shutting down the machine is followed, as described in section 5.8.

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

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

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

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

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

Do not spray air or compressed inert gas on skin.

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

Never use air or compressed inert gas to clean clothes.

Before working on the pump, take measures to prevent an uncontrolled start. Put a warning board on the starting device with the words:
"Machine under repair: do not start".
With electric drive equipment, lock the main switch open and withdraw any fuses. Put a warning board on the fuse box or main switch with the words:
"Machine under repair: do not connect".

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

6.2 Maintenance schedule

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

a) The pump must be completely vented and drained and rendered inert before any disassembly operation.
b) Any auxiliary systems installed must be monitored, if necessary, to ensure they function correctly.
c) During cleaning of the pump ensure the compatibility between the cleaning products and the gaskets.
d) Verify the condition of the gaskets
e) Gland packings must be adjusted correctly to give visible leakage and concentric alignment of the gland follower to prevent excessive temperature of the packing or follower. Mechanical seals should present no leakage.
f) Check for any leaks from gaskets and seals. The correct functioning of the shaft seal must be checked regularly.
g) Check bearing lubricant level, and if the hours run show a lubricant change is required.
h) Check that the duty condition is in the safe operating range for the pump.
i) Check vibration, noise level and surface temperature at the bearings to confirm satisfactory operation.
j) Check the tightness of the connections.
k) Check dirt and dust is removed from areas around close clearances, bearing housings and motors.
l) Check coupling alignment and re-align if necessary.
m) Verify the correct operation of the system.

The equipment used for maintenance and disassembly in an ATEX zone must be in conformity with the requirements zone.

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

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

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

6.2.1 Routine inspection (daily/weekly)

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

a) Check operating behaviour. Ensure noise, vibration and bearing temperatures are normal.
b) Check that there are no abnormal fluid or lubricant leaks (static and dynamic seals) and that any sealant systems (if fitted) are full and operating normally.
c) Check that shaft seal leaks are within acceptable limits.
d) Check the level and condition of oil lubricant. On grease lubricated pumps, check running hours since last recharge of grease or complete grease change.
e) Check any auxiliary supplies eg heating/cooling, if fitted, are functioning correctly.

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

6.2.2 Periodic inspection (six monthly)

a) CAUTION Check foundation bolts for security of attachment and corrosion.
b) Check pump running records for hourly usage to determine if bearing lubricant requires changing.
c) The coupling should be checked for correct alignment and worn driving elements.

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

6.2.3 Re-lubrication

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

6.2.3.1 Oil lubrication

CAUTION Maintaining the correct oil level is very important.

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

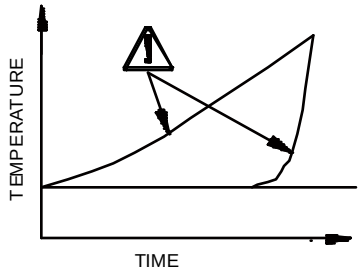
Refer to section 5.1.1 for methods of oil fill, section 5.2.1 for oil grade recommendations and 5.2.4 for the schedule and temperature limits.

6.2.3.2 Grease lubrication

CAUTION See section 5.2.2 for grease recommendations.

Regrease – refer to section 5.2.4.2.

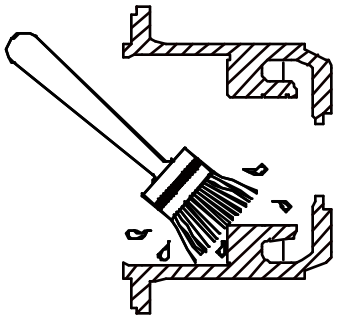
a) It is important not to under or over grease the bearings as this will lead to over heating and premature failure. Grease lubricated bearing housings have grease nipples fitted in the bearing covers.
b) The used grease should be seen to evacuate through the bottom of the bearing housing.
c) The maximum allowable operating temperatures for anti friction bearings will vary from unit to unit, depending on ambient and fluid temperature. The rise above ambient should not normally exceed 55 °C (131 °F) or a combined maximum of 95 °C (204 °F).
d) A continuously rising temperature or an abrupt temperature rise indicates a problem. If these symptoms occur, stop the pump immediately and investigate the cause.



Grease change - every 2 years or sooner depending on the severity of the application.

a) Remove the bearing housing from the pump assembly.
b) Brush the bearing housing with hot kerosene (100 to 115 °C/212 to 240 °F) or other non-toxic solvent.

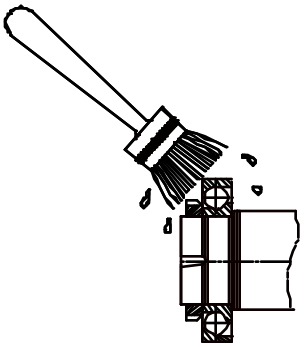
c) Clean and flush out the housing with a light mineral oil.



d) Do not use waste oil to clean the housing.

To clean the bearings:

a) Wipe off as much grease as possible with a clean lint-free cloth.
b) Brush bearings with hot kerosene (80 to 90 °C/ 175 to 195 °F) while gently spinning the outer bearing ring.
c) Spin each ball to ensure that it is clean.



To remove badly oxidized grease which refuses to come off:
Dry and reflush the bearing with clean light oil.

It is important not to under or over grease the bearings as this will lead to over heating and premature failure. It is recommended that the bearings be filled with grease using a suitable spatula. In addition the housings should be no more than half filled.

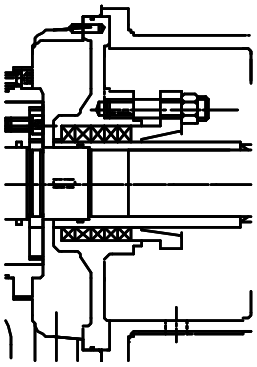
6.2.4 Mechanical seals

The current maintenance is limited to seal control. It is necessary to detect any small leakage which announces the beginning of the deterioration of friction faces or secondary seal elements (rings, bellows, synthetic membranes). It is advisable to stop the pump as soon as possible. Have an approved seal vendor replace or repair the seal.

6.2.5 Gland packing

6.2.5.1 Pump fitted with a packed gland

A well run in and correctly adjusted packing gland requires little maintenance.
If, after some time, the leakage becomes too great, the gland should be tightened again in order to return these to a normal level.
If re-tightening is not possible, new packing must be installed.



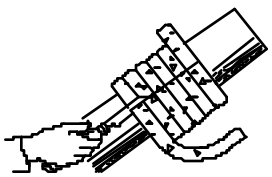
6.2.5.2 Gland packing inspection and removal

a) Remove the shield guards
b) Slide back the gland
c) Remove the packing rings with an extractor designed for this purpose (including the lantern ring if it exists; note its position and its direction of rotation).
d) Inspect the state of the sleeve surface; the presence of many marked grooves will indicate that it must be replaced.
e) Carefully clean the different pieces of the packing gland.

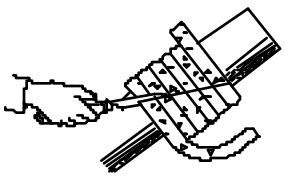
6.2.5.3 Gland packing fitting

If the packing is supplied as cord the packing must be cut so that the external diameter is lightly tightened and there is an initial gap between the sleeve and the packing ring.

For that purpose, wind the packing helically around the shaft sleeve or a chuck of the same diameter. (Take precautions to avoid damaging sleeve).



Example of straight cut

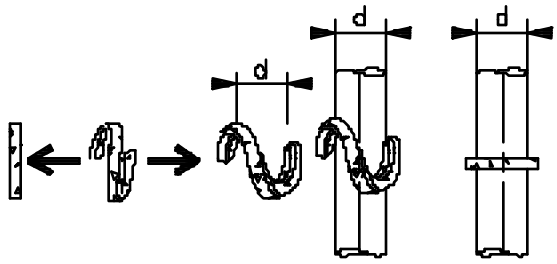


Example of bevel cut

CAUTION Ensure a tightening on the stuffing box housing and not on the sleeve.

If the packing is in rings:

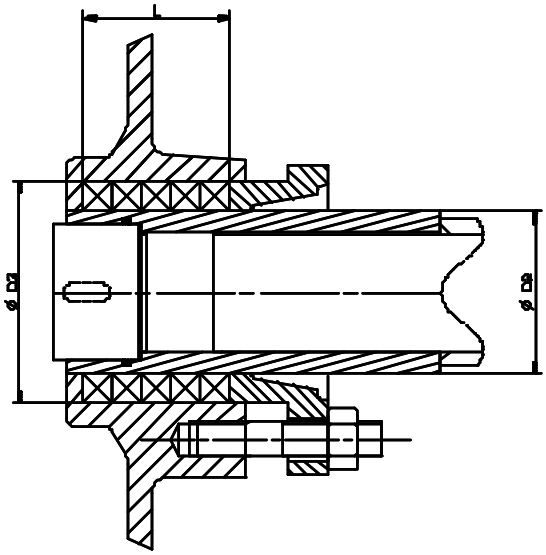
Follow the instructions:
Assemble of the packing in S.
Stagger by about 90° between two rings.
Place the rings one at a time.



After setting the last packing ring, secure the packing with the gland and tighten the nut by hand.

After tightening, the shaft should turn by hand as easily as before the setting of the packing.

6.2.5.4 Gland packing dimensions

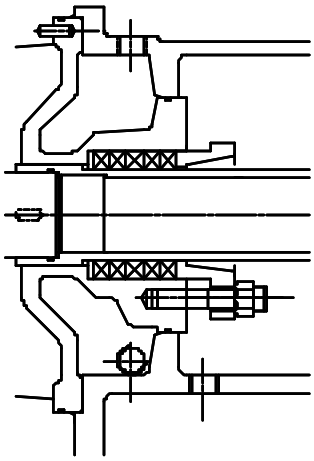


Pump size	Drive End			
	D_2	D_3	L	Packing □
1.5	45 (1.77)	65 (2.56)	50 (1.97)	10 (0.394)
2	48 (1.89)	65 (2.68)	50 (1.97)	10 (0.394)
3	55 (2.17)	75 (2.95)	50 (1.97)	10 (0.394)
4	60 (2.36)	80 (3.15)	50 (1.97)	10 (0.394)

Pump size	Non-Drive End			
	D_2	D_3	L	Packing □
1.5	45 (1.77)	65 (2.56)	50 (1.97)	10 (0.394)
2	45 (1.77)	65 (2.56)	50 (1.97)	10 (0.394)
3	45 (1.77)	65 (2.56)	50 (1.97)	10 (0.394)
4	45 (1.77)	65 (2.56)	50 (1.97)	10 (0.394)

6.2.6 Gland cooling

WDX Pumps are designed with an optional stuffing box cooling. The purpose of this is to cool the pumped liquid before it reaches the packing. Such cooling is required if the liquid temperature is over 220° F (105°C).



6.3 Spare parts

6.3.1 Ordering of spares

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

1) Pump serial number.
2) Pump size.
3) Part name – taken from assembly drawing.
4) Part number – taken from assembly drawing.
5) Number of parts required.

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

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

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

6.3.2 Storage of spares

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

6.4 Recommended spares and consumable items

For start up purposes:

1 - complete set of gland packing
1 - complete set of mechanical seals
1 - set of gaskets and seals
1 - set of bearings

For 2 years operation:

1 - set of bearings (line and thrust)
1 - set of gaskets and seals
1 - set of bearing sleeves
1 - complete set of gland packing
1 - complete set of piston drum and sleeve
(optional: 2 - mechanical seals with sleeves
1 set of impeller wear rings)

For 4 years operation:

1 - set of bearings (line and thrust)
1 - set of gaskets and seals
1 - set of bearing sleeves
1 - complete set of gland packing
1 - complete set of mechanical seals and sleeves
1 - complete set of piston drum and sleeve
1 - complete set of wear rings (casing and impeller)
1 - complete set of impellers
1 - shaft

6.5 Tools required

A typical range of tools that will be required to maintain these pumps is listed below.

Readily available in standard tool kits, and dependent on pump size:

- Open ended spanners (wrenches) to suit up to M 33 screws/nuts
- Socket spanners (wrenches), up to M 33 screws
- Allen keys, up to 10 mm (A/F)
- Range of screwdrivers
- Soft mallet

More specialized equipment:

- Bearing pullers
- Bearing induction heater
- Dial test indicator
- C-spanner (wrench) - for removing shaft nut. (If difficulties in sourcing are encountered, consult Flowserve.)

6.6 Fastener torques

6.6.1 Tie rods

Pump size	Torque Nm (lb•ft)
1.5 WDX	305 (225)
2 WDX	430 (320)
3 WDX	650 (480)
4 WDX	905 (670)

6.6.2 Other fasteners

Bolt size	Torque Nm (lb•ft)	
	Steel fastener	Stainless steel fastener
M6	N/A	2.5 (1.84)
M8	17 (12.5)	6 (4.43)
M10	33 (24.3)	13 (9.59)
M12	58 (42.8)	22 (16.2)

6.7 Renewal clearances

As wear takes place between the impeller and casing ring the overall efficiency of the pump set will decrease. To maintain optimum efficiency it is recommended that rings are replaced and the impeller renovated when the diametral clearance detailed in section 3.5.2 has doubled.
For WDXE and WDXS it is recommended to renovate or change line bearings when clearances have doubled from those indicated in section 3.5.3.

6.8 Disassembly

⚠ Refer to section 1.6, *Safety*, and section 6.1 *Maintenance*, before dismantling the pump.

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

Refer to sectional drawings for part numbers and identification.

When dismantling, for convenience at reassembly, lay out all parts in the order in which they are removed. Protect all machined faces against metal-to-metal contact and corrosion.
Disassembly is preferably carried out with the pump in a vertical position.

6.8.1 Initial procedure

1. If bearings are oil lubricated, drain housings and remove oilers.

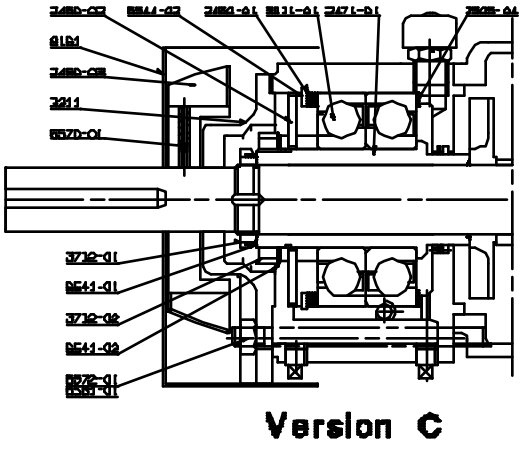
2. Disconnect external piping such as balancing drum bleed line, cooling connections or mechanical seal pipework.

3. Disconnect the coupling halves. If oil-lubricated couplings are used, drain the oil before unbolting.

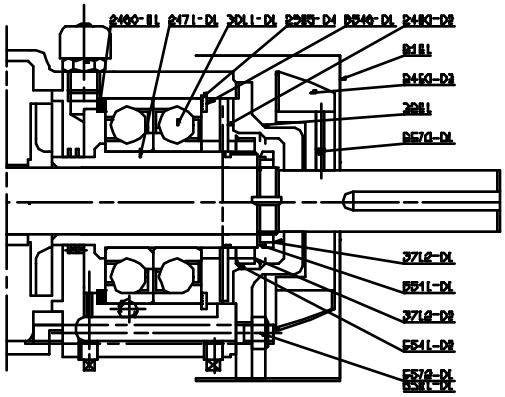
4. Remove the coupling half from the pump shaft and take off the key.

6.8.2 Dismantling antifriction thrust bearing
For all WDX variants

6.8.2.1 Oil lubricated bearings



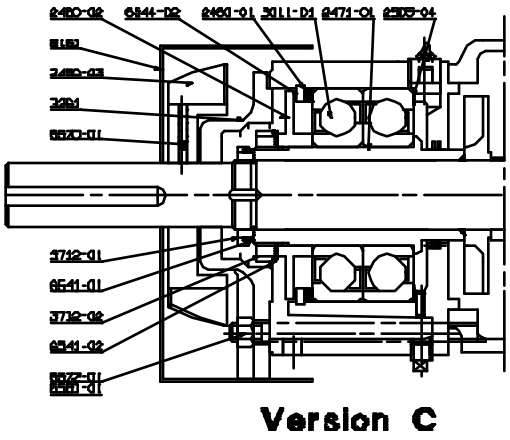
Version C



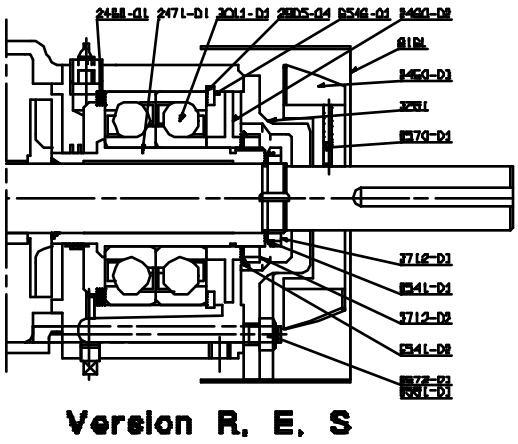
Version R, E, S

Dismount the fan cover [8162] by loosening the screws.
Remove the fan [2450-03] by loosening screw [6570-01].
Unscrew the four bearing nuts [6572].
Remove the bearing cover [3211].
Straighten tab on bearing lock washer [6541-01] and unscrew bearing lock nut [3712].
Repeat the operation for the second blockage.
Remove the spacer sleeve [2460-02].
Remove the snap ring [6544-02].
Remove the spacer sleeve [2460-01].
The whole thrust bearing assembly can then be removed from the shaft.

6.8.2.2 Grease lubricated bearings



Version C

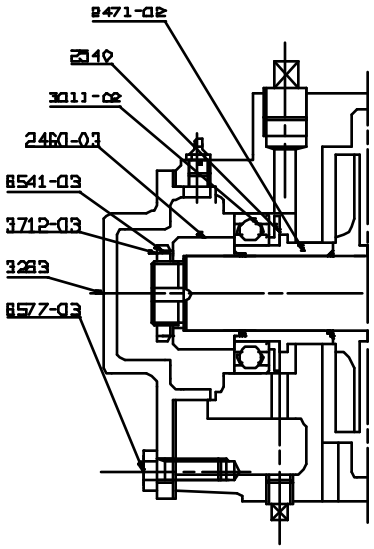


Version R, E, S

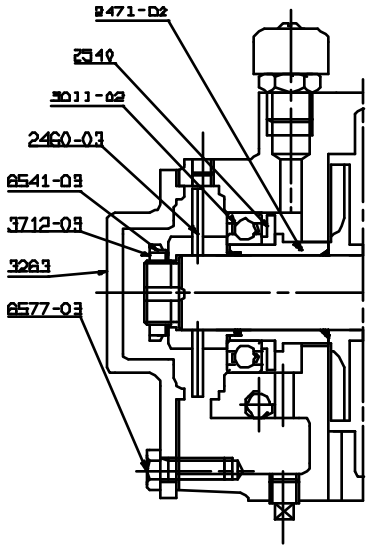
Dismount the fan cover [8162] by loosening the screws.
Remove the fan [2450-03] by loosening screw [6570-01].
Unscrew the four bearing nuts [6572].
Remove the bearing cover [3211].
Straighten tab on bearing lock washer [6541-01] and unscrew bearing lock nut [3712].
Repeat the operation for the second blockage.
Remove the spacer sleeve [2460-02].
Remove the snap ring [6544-02].
Remove the spacer sleeve [2460-01].
The whole thrust bearing assembly can then be removed from the shaft.

6.8.3 Dismantling radial bearing

6.8.3.1 Antifriction bearings (WDXR and WDXC)



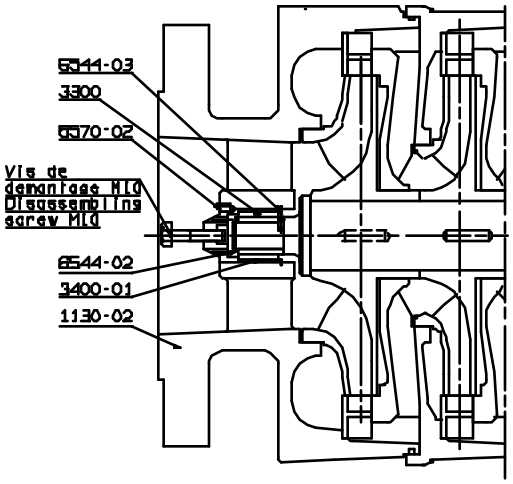
Grease lubricated



Oil lubricated

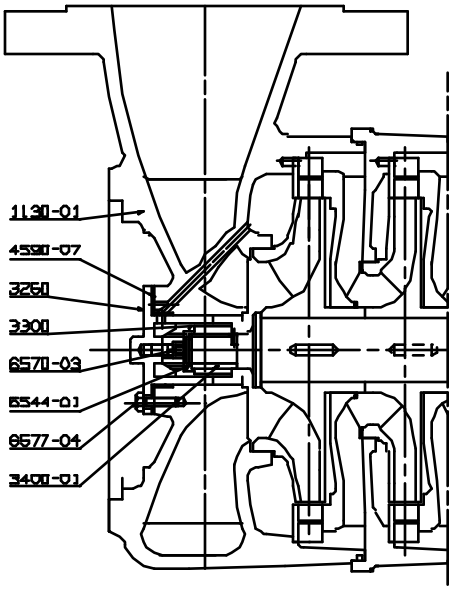
Remove the four cap screws of the bearing cover [6577-03].
Remove the bearing cover [3263].
Straighten tab on bearing lock washer [6541-03] and unscrew bearing lock nut [3712-03].
Remove the coupling spacer piece [2460-03].
Remove the eight cap screws of the bearing housing [6577-04].
The whole line bearing assembly can then be removed.

6.8.3.2 Line bearings (WDXE)



Free the bearing by removing screw [6570-02].
Remove the bearing bushing [3300] by means of a disassembling screw M10.
Remove the snap ring [6544-03] and slide off the shaft sleeve [3400-01].

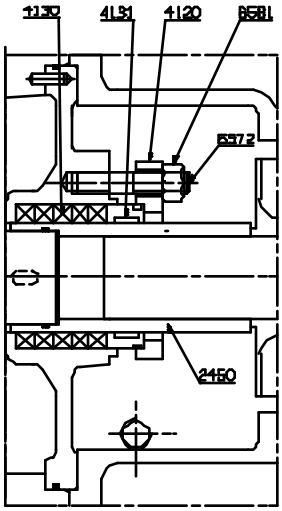
6.8.3.3 Line bearings (WDXS)



Unscrew the bearing cap screws [6577-04].
Remove the bushing cover [3260].
Remove the snap ring [6544-01] and slide off the shaft sleeve [3400-01].

6.8.4 Dismantling shaft sealing

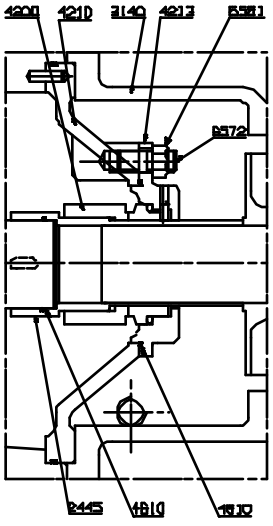
6.8.4.1 Packing



The gland packing replacement does not require further dismounting operations.
Remove the gland nuts [6581].
Remove the flange [4120].
Pull the gland [4131] as far as possible away from the stuffing box.
Pull out the packing [4130] one after the other taking care to avoid marking the sleeve.

Check the surface quality of the sleeve for any running marks made by the packing (for sleeve changing, thrust and line bearing assemblies must be dismounted, see sections 6.8.2 and 6.8.3).

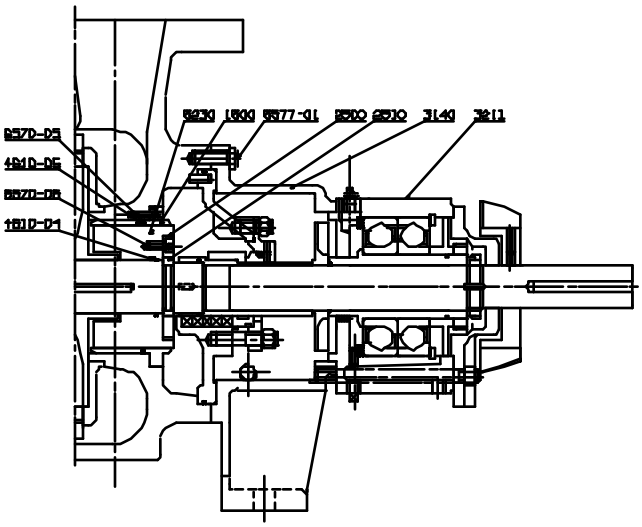
6.8.4.1 Mechanical seal



The replacement of a mechanical seal requires the dismantling of thrust and line bearing assembly. The dismantling procedure of the mechanical seal is self explanatory when viewing the respective seal drawing.

6.8.5 Dismantling of balancing drum and ring

6.8.5.1 Variants WDXR/E/S



Dismantle the thrust bearing assembly see section 6.8.2.

Provide independent support under the discharge casing.

Remove the eight cap screws [6570-06] of the bearing support [3140].

Remove the bearing support and the sealing housing with all seal components.

Remove the drum screws [6570-05] and the drum ring [6234].

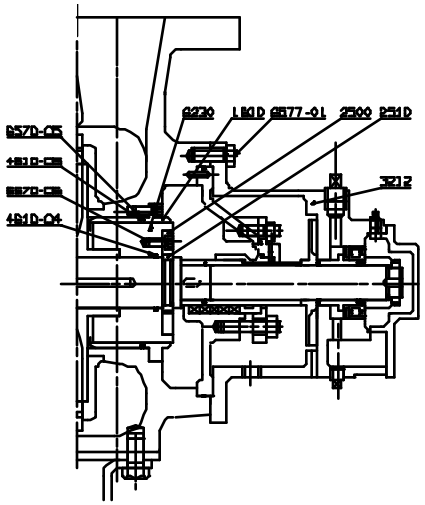
Remove the split ring [2510].
Pull out the drum by means of threaded holes in the drum:

M8 (4 WDX and 3 WDX)
M6 (2 WDX and 1.5 WDX)

Remove the bushing cap screws [6570-07].

Pull out the bushing by means of threaded holes in the bush [1600].

6.8.5.2 Variant WDXC



Dismount the line bearing assembly; see section 6.8.3.
Remove the seal component.
Remove the drum screws [6570-06] and the drum ring [2500].
Remove the split ring [2510].
Pull out the drum by means of threaded holes in the drum.
Remove the bushing cap screws [6570-05].
Pull out the bushing [1600] by means of threaded holes in the bush.

6.8.6 Disassembly of pump casings
After having dismounted bearings and shaft seals, unscrew the four tie rod nuts. The rest of dismounting is self explanatory when viewing the respective sectional drawing.

For WDX pumps of construction M4 M5 M6 M7 (steel or stainless steel), an intermediate bushing is assembled at the middle of the pump. Take note of its position and on reassembly, assemble it in the same place.

6.9 Inspection of components

With pump dismantled, clean all parts and check for worn and damaged areas. Clean and inspect gasket and O-rings seals. Check wearing ring, interstage seal and balancing drum surfaces. Casing and impeller wearing ring and interstage seal surfaces may be either be part of the individual casing diffuser and impeller or separate parts. See sections 3.5.2 and 3.5.3 for standard clearances for impeller wearing ring, interstage seal and balancing drum.

6.9.1 Precision surfaces
Check for damage to precision surfaces that locate casings and bearing housings to preserve proper internal alignment. Check for corrosion due to leakage. Check axial impeller hub and sleeve surfaces for damage to insure proper axial alignment of rotor.

6.9.2 Stuffing box
Remove any dirt or scale from stuffing box cavity. Replace O-ring seals. Replace gland studs if badly corroded.

6.9.3 Mechanical seals
It is not recommended that mechanical seals be reused. Using an old one leaves too much chance of failure to make the risk worthwhile, considering the usual cost of installing and removing a pump from its system. Attempts to lap the mechanical seal faces may be possible but require specialized technical knowledge, skills and equipment beyond the scope of these instructions. Complete mechanical seal rotors and seats are available from your FLOWSERVE representative as are any other repair parts.

6.9.4 Stuffing box sleeves
Check the stuffing box shaft sleeve outside surface for scoring. If used with packing, any scoring will shorten the life of the packing proportional to the amount of scoring present. If used with a mechanical seal, the outside surface must not be scored in the area where the seal rotor bellows or sealing ring touches.

6.9.5 Ball bearings
It is not recommended that the bearings be reused. However, if reuse is intended, clean bearings with petroleum solvent or kerosene and inspect for any indications of damage or wear, such as metal shavings, rust or surface galling. Further, judge the condition of the bearings by rotating by hand. Replace any bearing which shows any sign of damage or that has been in service for an extended period. Serviceable bearings should be spun in light oil to completely remove the solvent after cleaning, or coated by hand with an anti-corrosion agent if they are not to be reassembled immediately and wrap at once in clean oil proof paper while awaiting reassembly. The use of chlorinated solvents of any kind is not recommended in bearing cleaning operations because of the rust hazard involved, nor is the use of compressed air found desirable in cleaning operations.

6.9.6 Diffusers and interstage casings

There is normally no need to separate the diffusers and interstage casings, however, if they do become separated, or new interstage casings or diffusers are to be installed, care must be taken to insure that the diffuser is seated (in contact) with the back surface of the interstage casing, and that the pin fits correctly in the hole.

6.10 Assembly

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

Ensure threads, gasket and O-ring mating faces are clean and that ball bearings are C3 fit. Apply thread sealant to non-face sealing pipe thread fittings.

Do not force when assembling the various components.
Coat all fittings with an antifriction product.
To assemble the pump, start from the suction side.

Assembly work should be preferably carried out with the pump in a vertical position.
To assemble the pump, reverse the dismantling procedures previously described, see the cross sectional drawings. Consult the sectional drawing to organize the required operations. Replace all components in their original place.

6.10.1 Shaft seal assembly

Packed Stuffing box:
as per section 6.2.5.

Mechanical seal:
Refer to assembly drawings for the seal and pump.
Great care must be taken concerning the cleanliness during the mounting operation.
Remove the surface protection of the rings just before installation.
As some O-ring materials do not support grease or oil, water is preferred for easing assembling, where compatible with the product to be pumped.

6.10.2 Product lubricated bearings (WDXE/S)

Install the bearing components after the whole pump has been assembled; see sections 6.8.3.2 and 6.8.3.3 for diagrams.
- Put the sleeve onto the shaft end in taking care that the shaft pin fits into the slot.
- Put the circlip [6544-01] in the shaft groove.
- Install the bushing [3300] in the suction casing.

6.10.3 Anti friction bearings

Antifriction bearings should be preassembled so that the complete bearing set can be mounted on the pump casing. To do this, reverse the dismantling in sections 6.8.2 and 6.8.3.

7 FAULTS; CAUSES AND REMEDIES

FAULT SYMPTOM

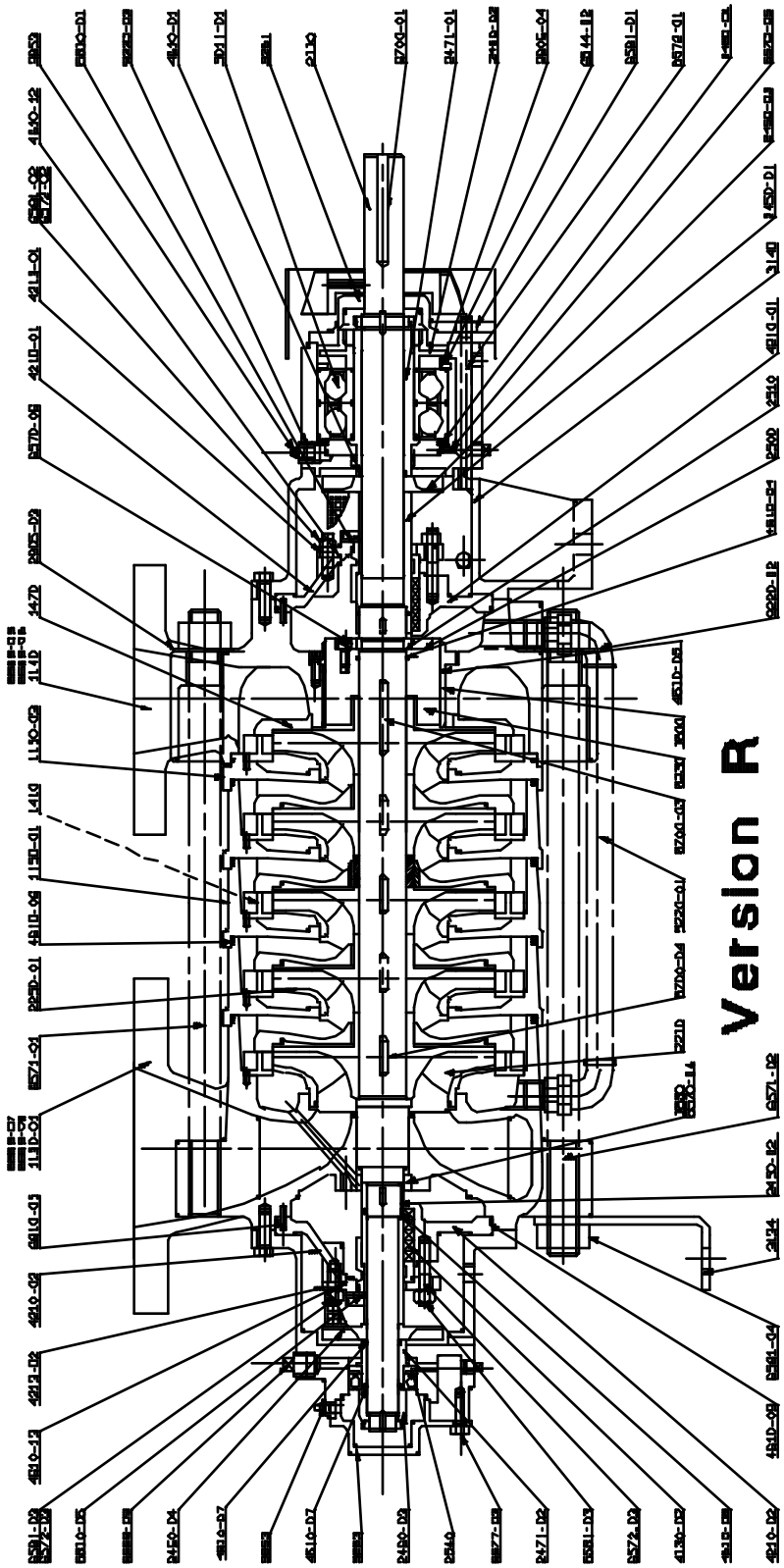
Pump overheats and seizes	Bearings have short life	Pump vibrates or is noisy	Mechanical seal has short life	Mechanical seal leaks excessively	Pump requires excessive power	Pump loses prime after starting	Insufficient pressure developed	Insufficient capacity delivered	Pump does not deliver liquid	PROBABLE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

FAULT SYMPTOM

Pump overheats and seizes	Bearings have short life	Pump vibrates or is noisy	Mechanical seal has short life	Mechanical seal leaks excessively	Pump requires excessive power	Pump loses prime after starting	Insufficient pressure developed	Insufficient capacity delivered	Pump does not deliver liquid	PROBABLE CAUSES	POSSIBLE REMEDIES
●	●	●			●					Rotating part rubbing on stationary part internally.	Check and CONSULT FLOWSERVE, if necessary.
●	●	●	●	●						Bearings worn.	Replace bearings.
					●		●	●		Wearing ring surfaces worn.	Replace worn wear ring/surfaces.
		●					●	●		Impeller damaged or eroded.	Replace or CONSULT FLOWSERVE for improved material selection.
				●						Leakage under sleeve due to joint failure.	Replace joint and check for damage.
			●	●						Shaft sleeve worn or scored or running off centre.	Check and renew defective parts.
			●	●	●					Mechanical seal improperly installed.	Check alignment of faces or damaged parts and assembly method used.
			●	●	●					Incorrect type of mechanical seal for operating conditions.	CONSULT FLOWSERVE.
●	●	●	●	●						Shaft running off centre because of worn bearings or misalignment.	Check misalignment and correct if necessary. If alignment satisfactory check bearings for excessive wear.
●	●	●	●	●						Impeller out of balance resulting in vibration.	Check and CONSULT FLOWSERVE.
			●	●	●					Abrasive solids in liquid pumped.	
			●	●						Internal misalignment of parts preventing seal ring and seat from mating properly.	
			●	●						Mechanical seal was run dry.	Check mechanical seal condition and source of dry running and repair.
			●	●						Internal misalignment due to improper repairs causing impeller to rub.	Check method of assembly, possible damage or state of cleanliness during assembly. Remedy or CONSULT FLOWSERVE, if necessary.
●	●	●								Excessive thrust caused by a mechanical failure inside the pump.	Check wear condition of impeller, its clearances and liquid passages.
	●	●								Excessive grease in ball bearings.	Check method of regreasing.
	●	●								Lack of lubrication for bearings.	Check hours run since last change of lubricant, the schedule and its basis.
	●	●								Improper installation of bearings (damage during assembly, incorrect assembly, wrong type of bearing etc).	Check method of assembly, possible damage or state of cleanliness during assembly and type of bearing used. Remedy or CONSULT FLOWSERVE, if necessary.
	●	●								Damaged bearings due to contamination.	Check contamination source and replace damaged bearings.
										C. MOTOR ELECTRICAL PROBLEMS	
		●			●		●	●		Wrong direction of rotation.	Reverse 2 phases at motor terminal box.
					●			●		Motor running on 2 phases only.	Check supply and fuses.
	●	●						●		Motor running too slow.	Check motor terminal box connections and voltage.

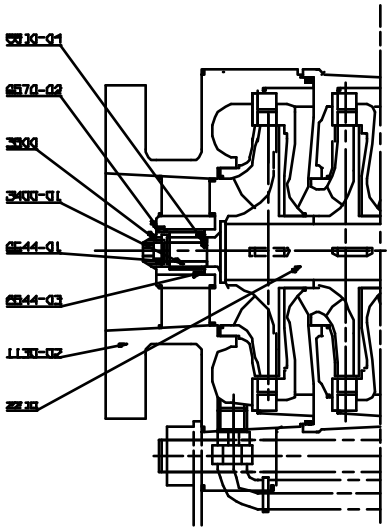
8 PARTS LISTS AND DRAWINGS

8.1 Sectional drawings, WDXR grease lubricated uncooled

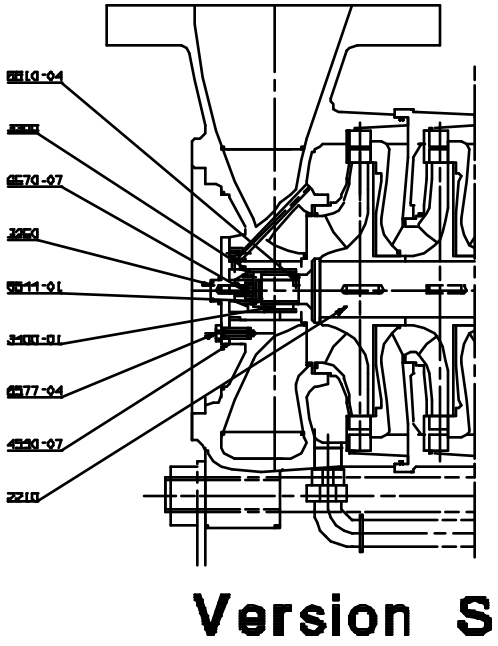


8.2 Sectional drawings, variants

8.2.1 WDXE and WDXS

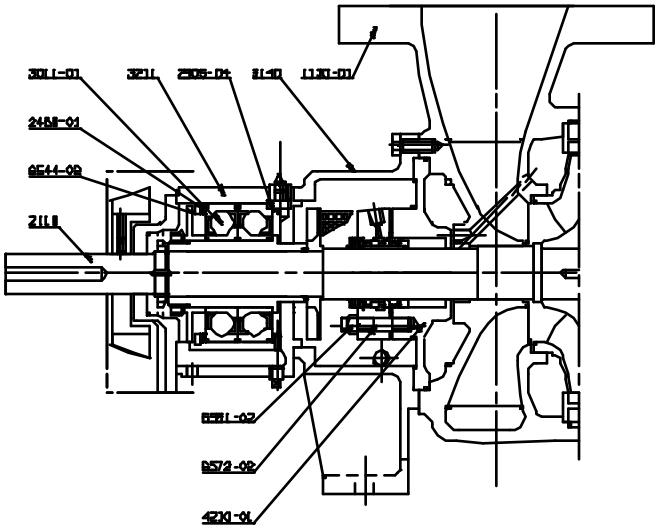


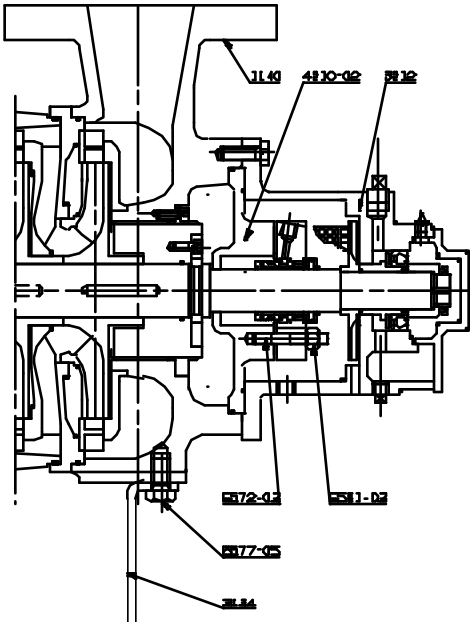
Version E



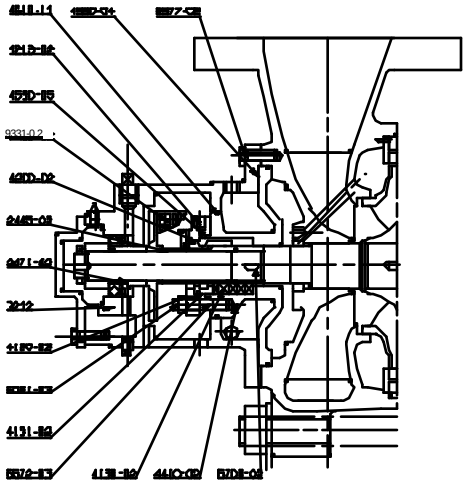
Version S

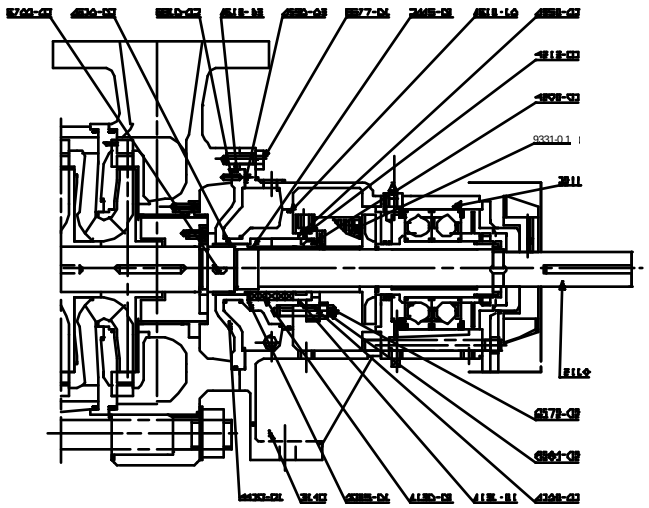
8.2.2 WDXC





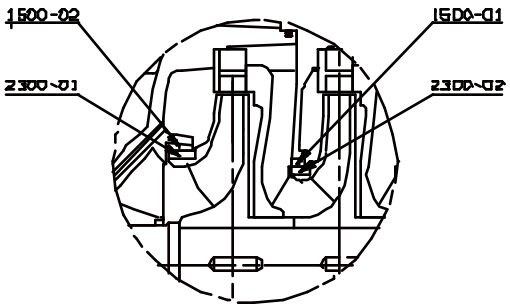
8.2.3 Cooled version



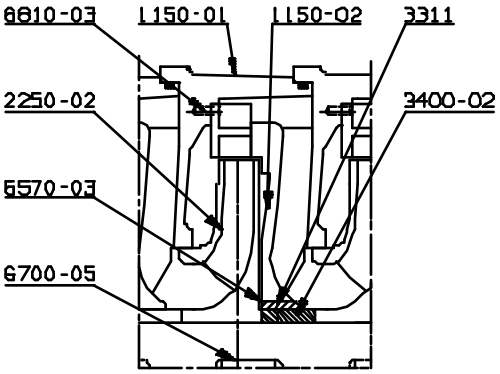


8.3 Sectional drawings, other details

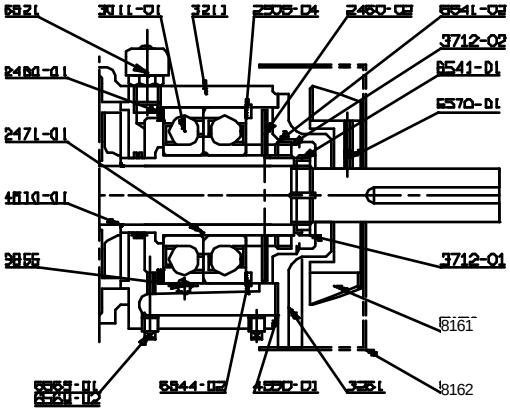
8.3.1 Wear rings



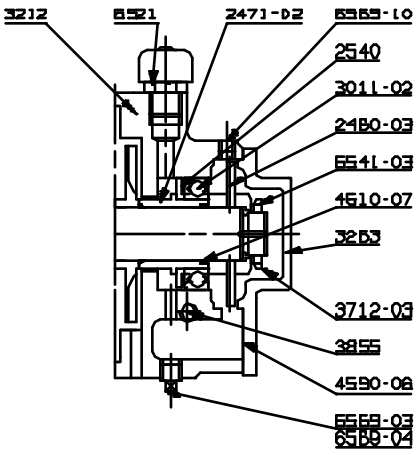
8.3.2 Intermediate bearing bush



8.3.3 Oil bearing drive end



8.3.4 Oil bearing non drive end



8.4 Sectional drawings part list

ITEM	DESIGNATION
1130-01	Suction casing, radial
1130-02	Suction casing, axial
1140	Discharge casing
1150-01	Stage casing
1150-02	Stage casing for internal bearing bush
1150-03	Stage casing, End
1410	Diffuser C
1410	Diffuser D
1470	Closing plate discharge
1500-01	Casing wear ring, stage casing
1500-02	Casing wear ring, suction casing
1600	Bush, Balance drum
1630	Throttling bush
2110	Pump shaft
2210	Impeller, suction stage
2250-01	Impeller C
2250-01	Impeller D
2250-02	Impeller C for internal bearing bush
2250-02	Impeller D for internal bearing bush
2300-01	Impeller wear ring, suction impeller
2300-02	Impeller wear ring, stage impeller
2445-01	Shaft sleeve for mechanical seal, Drive side
2445-02	Shaft sleeve for mechanical seal, Non drive side
2450-01	Shaft sleeve, Drive side
2450-02	Shaft sleeve, Non drive side
2450-03	Inside fan Drive side
2450-04	Inside fan Non drive side
2460-01	Spacer sleeve for bearing Drive side
2460-02	Spacer sleeve for bearing Drive side
2460-03	Spacer sleeve for bearing Non drive side
2471-01	Bush, under bearing Drive side
2471-02	Bush, under bearing Non drive side
2500	Ring, Drum
2510	Spacer ring, drum in 2 parts
2540	Deflector, Non drive side
2905-01	Washer for gland packing Drive side (cooled)
2905-02	Washer for gland packing Non drive side (cooled)
2905-03	Washer, plain
2905-04	Washer, Curved spring

ITEM	DESIGNATION
3011-01	Radial ball bearing, Drive side 2x7300
3011-02	Radial ball bearing, Non drive side 6000
3134	Support foot
3140	Bearing bracket, Drive side
3211	Bearing housing, Drive side
3212	Bearing housing, Non drive side
3260	Bearing cover, Drive side
3261	Bearing cover, Drive side
3263	Bearing cover, Non drive side
3300	Bearing bush
3311	Bearing bush, internal
3400-01	Bearing sleeve for bearing bush
3400-02	Bearing sleeve for internal bearing bush
3712-01	Bearing nut, Drive side
3712-02	Bearing nut, Drive side
3712-03	Bearing nut, non-Drive side
3853	Grease nipple
3855	Constant level oiler
4120-01	Gland, flange Drive side
4120-02	Gland, flange Non drive side (no cooled)
4120-03	Gland, flange Non drive side (cooled)
4130-01	Gland packing, Drive side
4130-02	Gland packing, Non drive side (no cooled)
4130-02	Gland packing, Non drive side (cooled)
4131-01	Follower, Drive side
4131-02	Follower, Non drive side (no cooled)
4131-02	Follower Non drive side (cooled)
4200-01	Mechanical seal, Drive side
4200-02	Mechanical seal, Non drive side
4210-01	Gland packing and/or mechanical seal housing, no cooled Drive side
4210-02	Gland packing and/or mechanical seal housing, no cooled Non dive side
4213-01	Mechanical seal cover, Drive side
4213-02	Mechanical seal cover, Non drive side
4410-01	Coolant housing, for Gland packing and/or mechanical seal housing cooled Drive side
4410-02	Coolant housing, for Gland packing and/or mechanical seal housing cooled Non drive side
4590-01	Gasket for oil bearing cover Drive side
4590-02	Gasket for mechanical seal cover Drive side

ITEM	DESIGNATION
4590-03	Gasket for seal housing cooled Drive side
4590-04	Gasket for seal housing cooled Non drive side
4590-05	Gasket for mechanical seal cover Non drive side
4590-06	Gasket for oil bearing cover Non drive side
4590-07	Gasket, bearing bush cover
4610-01	O ring bush under bearing Drive side
4610-02	O ring shaft sleeve Drive side
4610-03	O ring Seal housing Drive side
4610-04	O ring under balance drum
4610-05	O ring balance drum bush
4610-06	O ring stage casing
4610-07	O ring bush under bearing Non drive side
4610-08	O ring shaft sleeve Non drive side
4610-09	O ring Seal housing Non drive side
4610-10	O ring Seal housing cooled Drive side
4610-11	O ring Seal housing cooled Non drive side
4610-12	O ring, mechanical seal cover Drive side
4610-13	O ring, mechanical seal cover Non drive side
6230	Balance drum
6521	Snifter valve
6541-01	Lockwasher, Drive side
6541-02	Lockwasher, Drive side
6541-03	Lockwasher, Non drive side
6544-01	Circlip for shaft
6544-02	Circlip, bore
6544-03	Circlip, bore
6569-01	Plug, Screwed 1/4" NPT Drive side
6569-02	Plug, Screwed 1/2" NPT bearing Drive side
6569-03	Plug, Screwed 1/4" NPT bearing Non drive side
6569-04	Plug, Screwed 1/2" NPT bearing Non drive side
6569-05	Plug, Screwed discharge
6569-06	Plug, Screwed discharge
6569-07	Plug, Screwed suction
6569-08	Plug, Screwed suction
6569-09	Plug, Screwed for bearing Non drive side
6569-10	Plug, Screwed for bearing Non drive side

ITEM	DESIGNATION
6570-01	Screw, cap Hc, Fan
6570-02	Screw, cap Hc, Bearing bush
6570-03	Screw, cap Hc, Internal bearing bush
6570-04	Screw, cap Hc
6570-05	Screw, cap Hc
6570-06	Screw, Hexagon socket head cap Chc Drum
6570-07	Screw, Hexagon socket head cap Bearing bush
6571-01	Tie bolt, upper
6571-02	Tie bolt, lower
6572-01	Stud, Bearing Drive side
6572-02	Stud, gland packing /MS Drive side
6572-03	Stud, gland packing /MS Non drive side
6577-01	Hexagon head Screw, Drive side
6577-02	Hexagon head Screw, Non drive side
6577-03	Hexagon head Screw, Non drive side
6577-04	Hexagon head Screw, Bearing bush cover
6577-05	Hexagon head Screw, Support foot
6581-01	Nut, Hexagon H, bearing cover drive side
6581-02	Nut, Hexagon H, MS drive side
6581-03	Nut, Hexagon H, Gland Packing/MS non drive side
6581-04	Nut, tie bolt
6700-01	Key, coupling
6700-02	Key, under shaft sleeve
6700-03	Key, last impeller
6700-04	Key, under impeller
6700-05	Key, under bearing sleeve
6810-01	Grooved pin, MS Drive side
6810-02	Grooved pin, shaft seal housing Drive side
6810-03	Grooved pin, stage casing
6810-04	Grooved pin, bearing sleeve
6810-05	Grooved pin, shaft seal housing Non drive side
6810-06	Grooved pin, MS Non drive side
8161	Outside fan
8162	Fan cover
9220-01	Fitting, balancing line
9220-02	Fitting, union T
9220-03	Fitting, reduction coupling
9331-01	Cover plate, Drive side
9331-02	Cover plate, Non drive side

8.5 General arrangement drawing

The typical general arrangement drawing and any specific drawings required by the contract will be sent to the Purchaser separately unless the contract specifically calls for these to be included into the User Instructions. If required, copies of other drawings sent separately to the Purchaser should be obtained from the Purchaser and retained with these User Instructions.

9 CERTIFICATION

Certificates determined from the Contract requirements 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 Instructions

Supplementary instructions such as for a driver, instrumentation, controller, seals, sealant system etc are provided as separate documents in their original format. If further copies of these are required they should be obtained from the supplier for retention with these User Instructions.

10.2 Change notes

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

10.3 Additional sources of information

Reference 1:
NPSH for Rotordynamic Pumps: a reference guide, Europump Guide No. 1, Europump & World Pumps, Elsevier Science, United Kingdom, 1999.
Reference 2:
Pumping Manual, 9th edition, T.C. Dickenson, Elsevier Advanced Technology, United Kingdom, 1995.
Reference 3:
Pump Handbook, 2nd edition, Igor J. Karassik et al, McGraw-Hill Inc., New York, 1993.
Reference 4:
ANSI/HI 1.1-1.5, Centrifugal Pumps - Nomenclature, Definitions, Application and Operation.
Reference 5:
ANSI B31.3 - Process Piping.

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