FLOWSERVE

USER INSTRUCTIONS

Worthington® HWX centrifugal pumps

Installation
Operation
Maintenance

Vertical single stage, single suction, radially split volute type centrifugal pumps

Original Instructions
PCN= 85392694 06-16 (E)

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

Experience In Motion

CONTENTS

1.0 INTRODUCTION AND SAFETY

1.1 General

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

Flowserve's products are designed, developed and manufactured with state-of-the-art technologies in modern facilities. The unit is produced with great care and commitment to continuous quality control, utilising sophisticated quality techniques, and safety requirements.
Flowserve is committed to continuous quality improvement and being at service for any further information about the product in its installation and operation or about its support products, repair and diagnostic services.
These instructions are intended to facilitate familiarization with the product and its permitted use. Operating the product in compliance with these instructions is important to help ensure reliability in service and avoid risks. The instructions may not take into account local regulations; ensure such regulations are observed by all, including those installing the product. Always coordinate repair activity with operations personnel, and follow all plant safety requirements and applicable safety and health laws/regulations.

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

1.2 CE marking and approvals

It is a legal requirement that machinery and equipment put into service within certain regions of the world shall conform with the applicable CE Marking Directives covering Machinery and, where applicable, Low Voltage Equipment, Electromagnetic Compatibility (EMC), Pressure Equipment Directive (PED) and Equipment for Potentially Explosive Atmospheres (ATEX).
Where applicable the Directives, and any additional Approvals, cover important safety aspects relating to machinery and equipment and the satisfactory provision of technical documents and safety instructions. Where applicable this document incorporates information relevant to these Directives.
To establish Approvals and if the product itself is CE Marked check the serial number plate and the Certification.

1.3 Disclaimer

Information in these User Instructions is believed to be reliable. In spite of all the efforts of Flowserve Corporation to provide sound and all necessary information the content of this manual may appear insufficient and is not guaranteed by Flowserve as to its completeness or accuracy.

Flowserve manufactures products to exacting International Quality Management System Standards as certified and audited by external Quality Assurance organisations. Genuine parts and accessories have been designed, tested and incorporated into the products to help ensure 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 authorised Flowserve parts and accessories is considered to be misuse. Damage or failure caused by misuse is not covered by Flowserve's warranty. In addition, any modification of Flowserve products or removal of original components may impair the safety of these products in their use.

1.4 Copyright

1.5 Duty conditions

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

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

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

1.6 Safety

1.6.1 Summary of safety markings

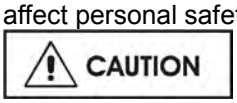
These user instructions contain specific safety markings where non-observance of an instruction would cause hazards. The specific safety markings are:

 DANGER

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

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

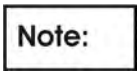
 This symbol indicates "hazardous and toxic fluid" safety instructions where non-compliance would affect personal safety and could result in loss of life.

 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 "strong magnetic field" safety instructions where non-compliance would affect personal safety, pacemakers, instruments or stored data sensitive to magnetic fields.

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

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

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

 This symbol indicates potential risks connected with extremely high temperatures.

 This symbol indicates potential risks connected with extremely low temperatures.

1.6.2 Personnel qualification and training

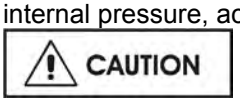
All personnel involved in the operation, installation, inspection and maintenance of the unit must be qualified to carry out the work involved. If the personnel in question do not already possess the necessary knowledge and skill, appropriate training and instruction must be provided. If required the operator may commission the manufacturer / supplier to provide applicable training.
Always co-ordinate repair activity with operations and health and safety personnel, and follow all plant safety requirements and applicable safety and health laws/regulations.

1.6.3 Safety action

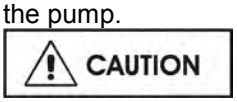
This is a summary of conditions and actions to help prevent injury to personnel and damage to the environment and to equipment. For products used in potentially explosive atmospheres section 1.6.4 also applies.

 PREVENT EXCESSIVE EXTERNAL PIPE LOAD

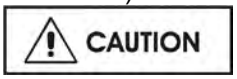
Do not use pump as a support for piping. Do not mount expansion joints so that their force, due to internal pressure, acts on the pump flange.

 ONLY CHECK DIRECTION OF MOTOR ROTATION WITH COUPLING ELEMENT/ PINS REMOVED

Starting in reverse direction of rotation will damage the pump.

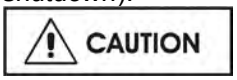
 ENSURE CORRECT LUBRICATION

(See section 5 *Commissioning, startup, operation and shutdown*.)

 START THE PUMP WITH OUTLET VALVE PART OPENED

(Unless otherwise instructed at a specific point in the user instructions.)

This is recommended to avoid 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 be adjusted to comply with the duty following the run-up process (See section 5 *Commissioning, startup, operation and shutdown*).

 START THE PUMP WITH OUTLET VALVE FULLY OPEN

This is recommended to avoid the risk of overloading and damaging the pump motor where greater power is taken at low or shut off flow. Pump outlet valve shall be adjusted to comply with the duty following the

run-up process (See section 5 *Commissioning, startup,* operation and shutdown).

CAUTION NEVER RUN THE PUMP DRY

CAUTION INLET VALVES TO BE FULLY OPEN WHEN PUMP IS RUNNING

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

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

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

CAUTION When ambient temperatures are likely to drop below freezing point, the pump and any cooling and flushing arrangements must be drained or otherwise protected.

HANDLING COMPONENTS

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

DANGER

NEVER DO MAINTENANCE WORK WHILST THE UNIT IS CONNECTED TO POWER

HAZARDOUS LIQUIDS

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

Gland Packing must not be used when pumping hazardous liquids.

DRAIN PUMP AND ISOLATE PIPEWORK BEFORE DISMANTLING THE PUMP

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

FLUORO-ELASTOMERS (When fitted)

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

GUARDS MUST NOT BE REMOVED WHILE PUMP IS OPERATIONAL

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, they must be shielded to avoid accidental contact. If complete protection is not possible, the machine access must be limited to maintenance staff only.

Note: bearing housings must not be insulated and drive motors and bearings may be hot.

If the temperature is greater than 68 °C (155 °F) or below 5 °C (41 °F) in a restricted zone, or exceeds local regulations, action as above shall be taken.

1.6.4 Products used in potentially explosive atmospheres

Measures are required to:

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

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

1.6.4.1 Scope of compliance

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

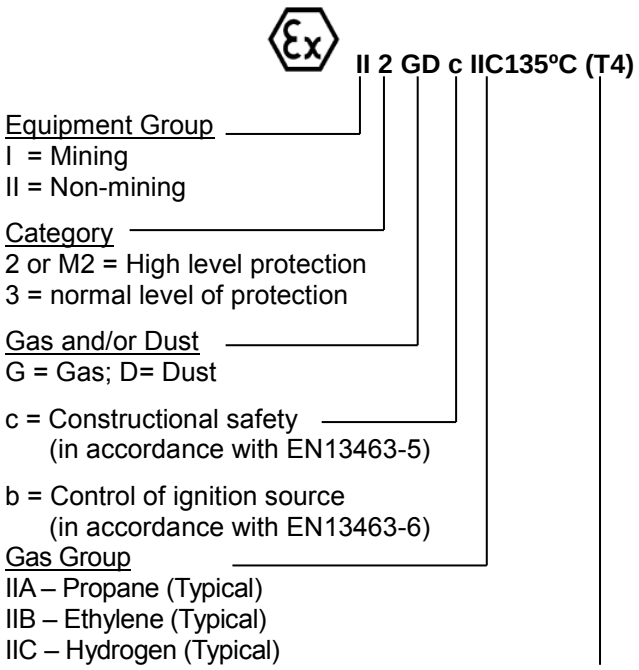
Where Flowserve has supplied only the bare shaft pump, the Ex rating applies only to the pump. The

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

The output from a variable frequency drive (VFD) can cause additional heating affects in the motor and so, for pump sets with a VFD, the ATEX Certification for the motor must state that it covers the situation where electrical supply is from the VFD. This is 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 an ambient in the range of -80 to +55 ºC (-112 to +131 ºF); refer to Flowserve for ambient temperatures outside this range for this product.

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

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

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

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

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

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

Do not attempt to check the direction of rotation with the coupling element/pins fitted due to the risk of severe 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 or a Power Monitor and make routine vibration monitoring.
In dirty or dusty environments, regular checks must be made and dirt removed from areas around close clearances, bearing housings and motors.

1.6.4.4 Preventing the build up of explosive mixtures

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

Ensure the pump and relevant suction and discharge pipeline system is totally filled with liquid at all times during the pump operation, so that an explosive

atmosphere is prevented. In addition it is essential to make sure that seal chambers, auxiliary shaft seal systems and any heating and cooling systems are properly filled.

If the operation of the system cannot avoid this condition the fitting of an appropriate Dry Run protection device is recommended (eg liquid detection or a Power Monitor).

To avoid potential hazards from fugitive emissions of 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 and anti-static.

To avoid the potential hazard from random induced current generating a spark the earth 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.

1.6.4.5 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.

1.6.4.6 Maintenance to the centrifugal pump 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*).to include the following.

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

1.7 Warning label

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

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

The usual approach is to control the exposure time to the noise or to enclose the machine to reduce emitted sound. You may have already specified a limiting noise level when the equipment was ordered, however if no noise requirements were defined, then attention is drawn to the following table to give an indication of equipment noise level so that you can take the appropriate action in your plant.
Pump noise level is dependent on a number of operational factors, flow rate, pipework design and acoustic characteristics of the building, and so the values given are subject to a 3 dBA tolerance and cannot be guaranteed.
Similarly the motor noise assumed in the “pump and motor” noise is that typically expected from standard and high efficiency motors when on load directly driving the pump. Note that a motor driven by an inverter may show an increased noise at some speeds.
If a pump unit only has been purchased for fitting with your own driver then the “pump only” noise levels in the table should be combined with the level for the driver obtained from the supplier. Consult Flowserve or a noise specialist if assistance is required in combining the values.
It is recommended that where exposure approaches the prescribed limit, then site noise measurements should be made.
The values are in sound pressure level L_{pA} at 1 m (3.3 ft) from the machine, for “free field conditions over a reflecting plane”.
For estimating sound power level L_{WA} (re 1 pW) then add 14 dBA to the sound pressure value.

Motor size and speed		**3500 rpm**		**2900 rpm**		**1750 rpm**		**1450 rpm**	
kW	**(hp)**	Pump only **dBA**	Pump & motor **dBA**	Pump only **dBA**	Pump & motor **dBA**	Pump only **dBA**	Pump & motor **dBA**	Pump only **dBA**	Pump & motor **dBA**
<0.55	(<0.75)	72	72	64	65	62	64	62	64
0.75	(1)	72	72	64	66	62	64	62	64
1.1	(1.5)	74	74	66	67	64	64	62	63
1.5	(2)	74	74	66	71	64	64	62	63
2.2	(3)	75	76	68	72	65	66	63	64
3	(4)	75	76	70	73	65	66	63	64
4	(5)	75	76	71	73	65	66	63	64
5.5	(7.5)	76	77	72	75	66	67	64	65
7.5	(10)	76	77	72	75	66	67	64	65
11	(15)	80	81	76	78	70	71	68	69
15	(20)	80	81	76	78	70	71	68	69
18.5	(25)	81	81	77	78	71	71	69	71
22	(30)	81	81	77	79	71	71	69	71
30	(40)	83	83	79	81	73	73	71	73
37	(50)	83	83	79	81	73	73	71	73
45	(60)	86	86	82	84	76	76	74	76
55	(75)	86	86	82	84	76	76	74	76
75	(100)	87	87	83	85	77	77	75	77
90	(120)	87	88	83	85	77	78	75	78
110	(150)	89	90	85	87	79	80	77	80
132	(175)	89	90	85	87	79	80	77	80
150	(200)	89	90	85	87	79	80	77	80
160	(215)	(1)	(1)	(1)	(1)	83	84	81	83
200	(270)	(1)	(1)	(1)	(1)	85	87	83	85
300	(400)					87	90	85	86
315	(422)					87	90	85	86
355	(475)					87	90	86	87
500	(670)					88	(1)	86	(1)
1000	(1300)					90	(1)	88	(1)
1500	(2000)					90	(1)	90	(1)

(1) Noise levels of machines in this range should be based on actual equipment selected
For 1180 and 960 r/min reduce the 1450 r/min values by 2dBA
For 880 and 720 r/min reduce the 1450 r/min values by 3dBA

1.10 CE Declaration

FLOWSERVE

CE

Austria , A-2345 Brunn am Geb., Industriestraße B Nr. 6, Tel:++43 2236 31530, Fax: ++43 2236 33430

DECLARATION OF CONFORMITY

Section 1.0 **MACHINE DESCRIPTION**

Serial No
Equipment/Item
Purchase Order
Model / Type
MAWP
CE Ex
Hydro. Pressure
Material
Date DD/MM/YY
Flow
Head
Speed Min-1 / RPM
Motor kW
Hz
Volts
Amps
Connection
Country of Destination

Section 2.0 APPLICABLE DIRECTIVES / REGULATIONS

- **Machinery Directive 2006/42/EC Annex IIA**
- **EMC Directive 2014/30/EU**
- **Explosive Atmospheres Directive 2014/34/EU (ATEX). Only applicable when the Ex marking appears in section 1.0 Equipment without the Ex marking must not be used in potentially explosive atmospheres.**
- **Notified Body holding the ATEX Technical Dossier - SIRA (518) Eccleston, ChesterCH4 9JN, United Kingdom**

Section 3.0 APPLICABLE STANDARDS / SPECIFICATIONS

- **EN809:1998+A1:2009, EN953:1997+A1:2009, ISO13857:2008, ISO12100:2010**
- **EN13463-1:2009, EN13463-5:2011, EN13463-6:2005**
- **API 610 8th ,9th, 10th or 11th ed. as applicable**
- **API 682 1st ,2ndor 3th ed. as applicable**

Section 4.0 DECLARATION

We, **Flowserve (Austria) GmbH**, at the above address, declare that under our sole responsibility for the supply of the machinery defined in **SECTION 1.0** above, the said machinery complies with all the applicable Directives and Regulations set out in **SECTION 2.0** above and with all the essential health and safety requirements applying to it when installed, operated and maintained in accordance with the applicable User Instruction manual(s).

Signed: Dipl.Ing.Goran Rakic
Authorised Techn.Manager

Date: 03.05.2016

2.0 TRANSPORT AND STORAGE

2.1 Consignment receipt and unpacking

Immediately after receipt of the equipment it must be checked against the delivery/ shipping documents for its completeness and that there has been no damage in transportation. Any shortage and or damage must be reported immediately to Flowserve and received in writing within one month of receipt of the equipment. Latter claims cannot be accepted.
Check any create/boxes/wrappings for any accessories or spare parts, which may be packed separately with the equipment or attached to side walls of the box or equipment.
Each product has a unique serial number. Check that this number corresponds with that advised and always quote this number in correspondence as well as when ordering spare parts or further accessories.

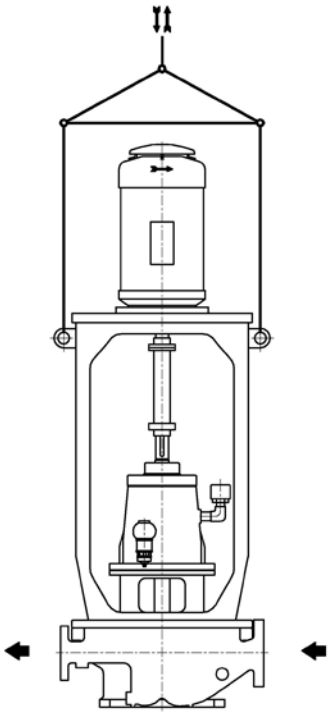
2.2 Handling

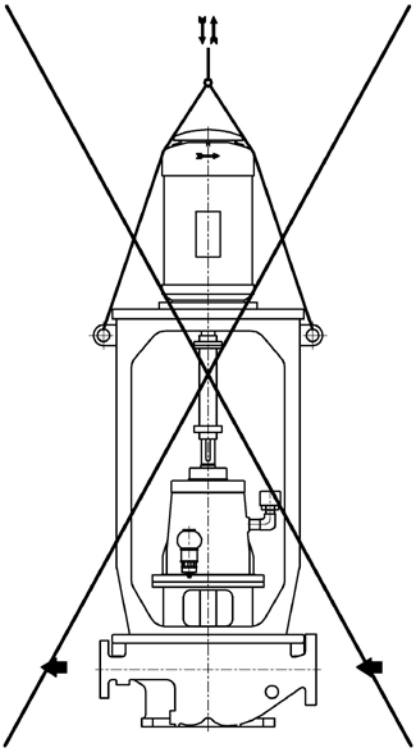
Boxes, crates, pallets or cartons may be unloaded using fork lift vehicles or slings dependent on their size and construction.

2.3 Lifting

Four lifting lugs are provided on the baseplate to lift the complete unit.

⚠ Take care by applying slings or ropes about auxiliary piping and seal systems.





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

2.4 Storage

If the unit will not be put immediately into service, it should be stored in a dry room. To avoid any damage during the storage period, the influence of any low or high frequency vibration must be totally inhibited. If the pump is delivered sealed in a plastic-wrapper, it is of max. importance to avoid any damage of that wrapper, because this will protect the pump against humidity. Therefore it must be checked if this wrapper has become cracked and if so, the wrapper must be renewed.

2.4.1 Long period storage

If the pump is delivered in a plastic bag, the preservations stands up for one year. If the storage period exceeds this time, the preservation must be checked and renewed. Also the air tight plastic bag must be changed. Moreover we recommend to order a Flowserve Service Engineer for checking the pump before the first start up.

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

3.0 DESCRIPTION

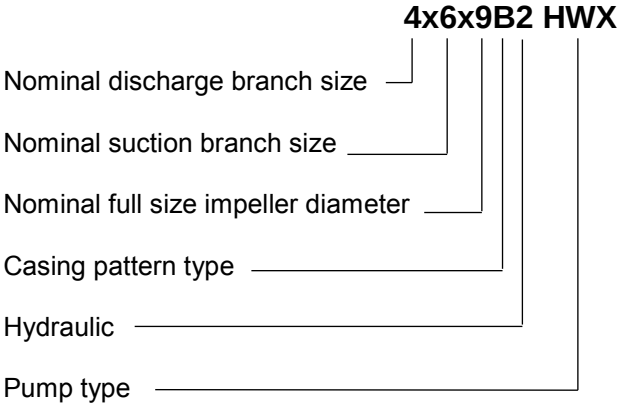
3.1 Configuration

The HWX pump is a vertical, single-stage, single suction, radially split centrifugal process pump. The pump conforms to the specifications outlined in API 610/682 and is intended for continuous duty service in all process and industrial applications within specified pressure and temperature limitations. Maintenance of the pump is facilitated by the in-line configuration, use of cartridge mechanical seals, and a spacer coupling designed to allow a back pull-out disassembly of the internal pump parts.


The sense of rotation of the pump is counter clockwise (CCW), looking from the coupling to the shaft end of the pump.

3.2 Nomenclature

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



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

3.3 Design of major parts

3.3.1 Pump casing

The casing is of single or dual volute design that reduces forces on the rotating element thereby minimizing vibration and shaft deflection.

Dual volute is standard on many 3 inch discharge pumps and on all pumps above 3 inch discharge.

Single volute is standard on some 3 inch discharge pumps and on all smaller sizes.

The fluid passages are designed to prevent turbulence and emphasize streamline flow.

Motor support heads are mounted directly on the casing for a true back-pull-out of the pump rotor without disturbing the driver electrical connections, nor casing.

3.3.2 Impeller

The HWX impeller is a fully shrouded, radial flow, single suction design. All sizes are precision cast to assure the highest attainable efficiency. All impellers are dynamically balanced keyed to the shaft and secured by locknut and lockscrew. Renewable wear rings are press fit onto the impeller hubs (front and back) and positively secured with axial screws or tack welding.

3.3.3 Casing cover

The casing cover is either fabricated from plate or cast, depending on the material of construction. Designed to the dimensional standards within the API 682 specification, the seal chamber can accommodate a wide variety of single or dual seal arrangements as standard.

3.3.4 Shaft

The shaft is of ample strength and rigidity. It is precision machined over its entire length and has generous fillet radii at each change of section to reduce stress concentrations. Shaft deflections at the seal chamber are minimal and fall within the guidelines stated in API 610.

3.3.5 Bearing housing

There are two types of bearing housing, depending on the desired lubrication: pure oil mist, and *Oil Cascade* sump. To maximise parts interchangeability, there are only two sizes of bearing housings and bearings used for all pump sizes. Operating speeds are from 900 to 3600 r.p.m. TRICO constant level oiler is supplied as standard for *Oil Cascade* sump and no constant level oiler is supplied for pure oil mist.

Fan cooling is supplied always as a standard for *Oil Cascade* sump. No cooling is required for pure oil mist application.

3.3.6 Pump bearings and lubrication

The standard bearing arrangement for all HWX pumps is angular contact deep groove ball thrust bearings arranged back to back and a deep groove ball radial bearing able to ensure long life under the most severe operating conditions.

Thrust Bearings are brass cage design and line bearing is metal cage design in accordance with normal oil industry preferences and API 610 requirement. Bearing manufacturers must be FPD approved suppliers.
Lubrication of the bearings is provided by oil cascade or pure oil mist.

3.3.7 Shaft seal

The mechanical seal is a cartridge type design for single, tandem, and double seals to control the leakage of liquid to the environment. The cartridge design provides for proper axial alignment of the seal faces and minimises the contamination of sensitive seal faces during installation.
Lubrication of the mechanical seal is provided by the pumped liquid or by an auxiliary seal-flush system. A vent connection is provided to eliminate the possibility of the seal becoming vapour bound.

3.3.8 Driver

The driver is normally an electric motor mounted on a support head and coupled to the pump by a flexible spacer coupling.

3.3.9 Coupling/Coupling guards

Flexible spacer couplings are provided in various makes and models to suit customer preference. (Aluminium non- hinged guards are provided)

3.3.10 Mounting Plate and Motor Support Head

HWX pumps are supplied with a mounting plate as a standard, already suitable for levelling screws installation.

Extended dimension mounting plates are available on request for applications where coolers or seal pots are required and need to be contained within the mounting plate.

The motor support head is a heavy duty, register-fit motor mount with generous openings allowing easy accessibility for field maintenance. The open compartments allow easy access to all bolting and removal of the entire rotor with the bearing housing from either side.

3.3.11 Accessories

Accessories may be fitted when specified by the customer.

3.4 Performance and operating limits

CAUTION In the interest of operator safety the unit must not be operated above the nameplate conditions. Such operation could result in unit failure causing injury to operating personnel. Consult instruction book for correct operation and maintenance of the pump and its supporting components.

4.0 INSTALLATION

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

4.1 Location

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

Refer to the general arrangement drawing for the pump set.

4.2 Part Assemblies

The pumps are delivered completely mounted and prealigned with the motor. Also the shaft seal is in the correct position. Final alignment after complete installation is necessary. If drivers and/or seal systems are delivered separately, follow the assembly procedure in section 6.8.

4.3 Foundation

The foundation shall be located on a place that allows a minimum of pipe work and that is easily accessible for inspection during operation. According to the environment the foundation may consist of concrete or of steel. It must be rigid and heavy enough to absorb normal vibrations and shocks.

4.3.1 Horizontal alignment of the baseplate

Horizontal alignment is done with levelling screws. Use a spirit level for correct horizontal alignment of the baseplate.

The max. misalignment is 0.5 mm/m baseplate length.

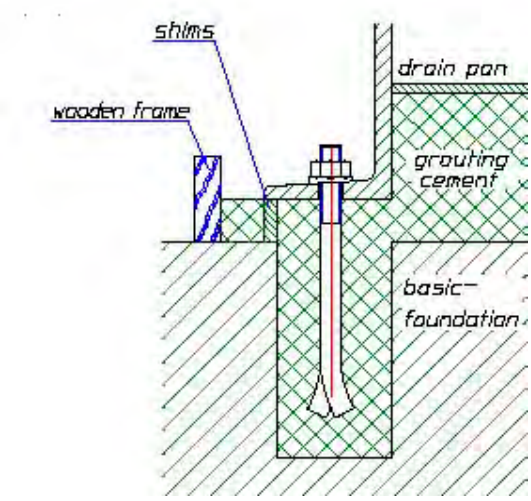
4.3.2 Steel foundation

When the pump unit is mounted directly on structural steel frame, it shall be well supported by constructural beams. It is recommended to check the natural frequency of the steel frame, because it shall not coincide with the pump speed. The exact horizontal alignment is very important!

4.3.3 Concrete foundation

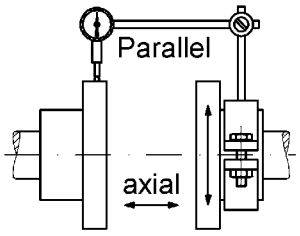
A concrete foundation must have an exact horizontal alignment and must be placed on solid ground. First a basic foundation shall be built with square shaped holes for embedding the foundation bolts. After putting the base plate into the foundation the proper alignment can be obtained by adjusting it with shims under the base plate. Now insert the foundation bolts and grout the space between the basic foundation and the base plate with grouting cement (refer to illustration)

It is very helpful to use a properly made and stable wooden frame around the base plate. So the grouting cement will not flow side. When the grouting is totally set and hardened the foundation bolts shall be tightened in a firm and symmetrical way.



4.4 Initial alignment

The adjustment of motor and pump must be checked (if necessary, make a new adjustment) before first start up of the unit.



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

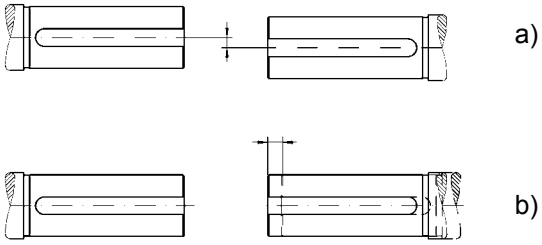
Align the motor to the pump, not the pump to the motor. Alignment of the motor is achieved by using the adjustment screws.

4.4.1 Permissible misalignment limits at working temperature

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

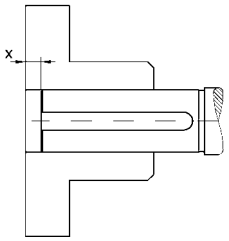
The pump is only pre-aligned! Carefully check and readjust alignment before start of the unit.
Take out the spacer of the coupling and check the alignment of shafts end of pump and driver. The maximum parallel offset should not exceed 0.05 mm (0.002 in.)and the axially offset can be ± 1 mm (0.04 in.).

For more details refer to the manufacturer's instruction manual of coupling.

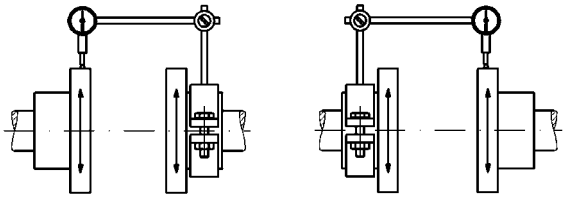


a) Parallel Offset: The median lines run parallel. The maximum allowable parallel offset depends on the size of coupling and is indicated in the instruction manual of manufacturer of coupling
b) Axially Offset: Another offset is the displacement of one or both of the shafts. A typical example is thermal expansion.

Note: The DBSE (distance between shaft ends) is shown on the General Arrangement Drawing and is larger than the length of the coupling spacer. This is necessary to compensate all manufacturing tolerances of line shafts and column pipes.
For installation of the coupling spacer the coupling hub on the pump shaft must be axially moved to match the spacer. This results in an axial clearance "x" between coupling hub and shaft end, which is taken into account by the coupling selection.



How the alignment of the coupling should be done you can see on the sketches and explanations below!



a) Fix the dial gauge on the driven shaft and check the concentricity by turning of both hubs; correct it if necessary.
b) Fix the dial gauge on the driving shaft and check the concentricity by turning of both hubs; correct it if necessary.

If the pump is handling hot liquid, the alignment must be rechecked in warm condition of the unit.

4.5 Piping

4.5.1 General

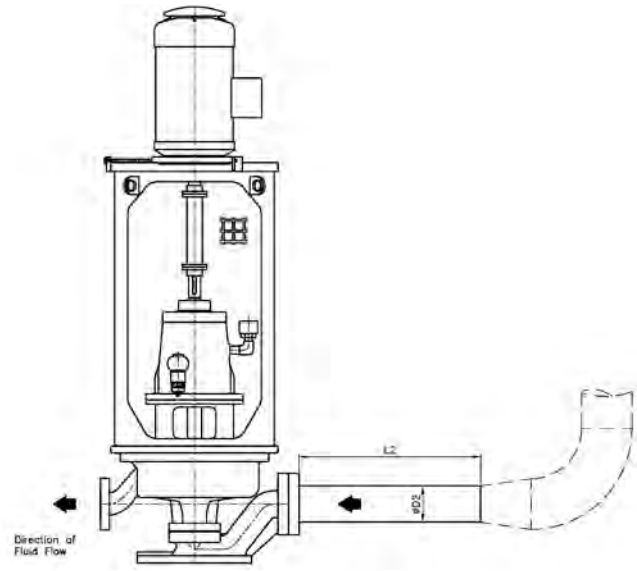
Protective covers are fitted to the pipe connections to prevent foreign particles entering during transportation and installation. Ensure that these covers are removed from the pump before connecting any pipes.
Maximum forces and moments allowed on the pump flanges vary with the pump size and type. To minimize these forces and moments which may cause misalignment, hot bearings, worn couplings, vibration and a possible failure of the pump, the following points shall be strictly followed:

a) Prevent excessive external pipe load.
b) Do not connect piping by applying external force (use of wrenches, crane,...). Piping shall be aligned without residual stress.
c) Do not mount expansion joints so that their force, due to internal pressure, acts on the pump flange.

Fitting an isolator and non-return valves can allow easier maintenance. Never throttle pump on suction side and never place a valve directly on the pump inlet nozzle.
A non-return valve shall be located in the discharge pipework to protect the pump from excessive back pressure and hence reverse rotation when the unit is stopped.
Piping and fittings shall be flushed before use. To avoid damages of the pump install a Y-strainer or a strainer of 40 mesh.
Piping for corrosive liquids shall be arranged to allow pump flushing before removal of a unit.

4.5.2 Inlet Piping Requirements *

Inlet flow disturbances, such as swirl, unbalance in the distribution of velocities and pressures, and sudden variations in velocity can be harmful to the hydraulic performance of a pump, its mechanical behavior, and its reliability.



The minimum required straight pipe length (L2) before pump suction inlet is specified in Table 01. The straight pipe section is to be the same diameter as that of the pump section nozzle.

Table 01

Fitting*	Number of pipe diameters (ØD2)	
	Long radius **	Short radius **
90° elbow	4	5
Reducing elbow with <30% area reduction	3	4
Reducing elbow with 30 to <50% area reduction	2	3
Reducing elbow with >50% area reduction	0	1
Reducers	Concentric	Eccentric
-) 1 pipe size reduction	0 (<10°)	0 (<20°)
-) 2 pipe size reductions	0 (<20°)	1 (<30°)
-) 3 pipe size reductions	1 (<20°)	2 (<30°)
-) 4 pipe size reductions	2 (<20°)	3 (<40°)
-) 5 pipe size reductions	3 (<30°)	4 (<40°)

* excerpt from ANSI/HI 9.6.6-2009
** according to ASME B16.9-2003

4.5.3 Drain

This connection is used for total drainage of the pump casing. A flanged drain is standard and can be optionally equipped with various kinds of valves. Refer to GA drawing for details of the drain connection.

CAUTION By pumping toxic or explosive media, provide the necessary security actions, e.g. flushing with nitrogen.

4.6 Electrical connections

DANGER

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

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

DANGER

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

DANGER

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

A device to provide emergency stopping must be fitted.

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

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

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

4.7 Final shaft alignment check

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

5.0 COMMISSIONING START-UP, OPERATION AND SHUTDOWN

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

5.1 Precommissioning procedure

The following steps should be followed at initial start up and after the equipment has been overhauled:

a) Prior to installing the pump, flush the suction side of the system to remove all deposit (slag, bolts etc).
b) Ensure the pump and piping is clean. Before putting the pump into operation, the piping should be thoroughly back flushed to remove any foreign matter which may have accumulated during installation. Take all possible care not to contaminate your system.
c) Fill the bearing housing with the appropriate oil to the correct level (if applicable). Bearing must receive a small amount of oil prior to starting to ensure adequate lubrication at start up. (Refer to Section 5.2).
d) Turn pump rotor by hand or with a strap wrench to make sure it turns smoothly.
e) Assure that correct seal piping has been installed and has not been damaged.
f) Prior to coupling installation, bump start motor to check for correct rotation. If rotation is not correct refer to motor manual for appropriate connections to change rotation (Shut down all power prior to change).
g) Ensure coupling is correctly aligned and lubricated. (Refer to Section 4.4).
h) Ensure coupling guard is correctly installed.

The unit must not be operated unless coupling guard is securely and completely bolted in place. Failure to observe the warning could result in injury to operating personnel.

Check torque of all bolting and the plugs for tightness.

5.2 Pump Lubricants

5.2.1 Lubrication

The bearing housing shall be filled with proper lubricating oil prior to start up. If the pump will be started after a longer storage period, the bearing housing should be first flushed and cleaned with gasoline. It is not necessary to remove the preservation oil as this will mix up thoroughly with the lubrication oil.
Lubrication is provided by the pumping effect of the rotating ball bearings. Maintaining the correct oil level (middle of the oil sight glass) ensures that the lower

ball bearing is covered with oil.
For recommended lubricating oils refer to the lubrication table 5.2.6

5.2.2 Oil change

After first start up, the oil shall be changed after 200 service hours.
Every further oil change shall take place after about 2000 service hours or at least every 6 month.
To change the oil, use the following procedure:

a) Remove the reservoir (for some type of oilers you must loose a fixing screw or lock nut, refer to section 5.2.4 *Oil level*).
b) Open the oil drain on the bearing housing to remove the oil.
c) Close the oil drain and fill in Oil through the oiler until the oil level reaches the bottom of the sight glass.
d) Fill the reservoir and put it quickly to the body of the oiler. Observe the level in the reservoir. It will decrease until the required oil level is reached (middle of the sight glass). Ensure that enough oil remains in the reservoir.
e) If necessary, the oil level can be adjusted by refering to section 5.2.4 *Oil level*.

5.2.3 Oil level

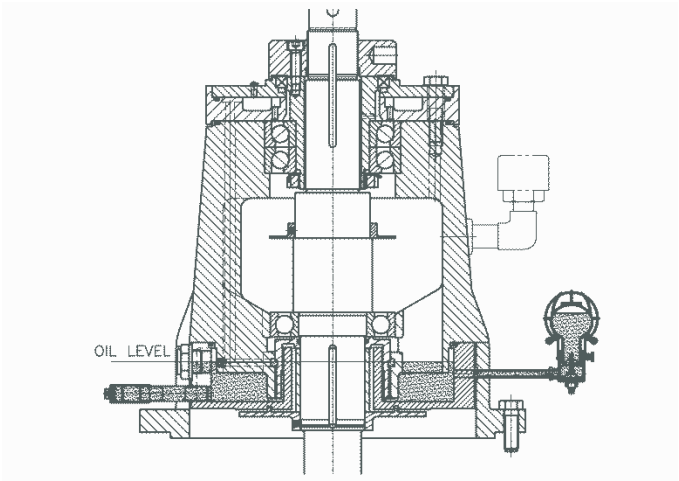
The correct oil level is in the middle of the oil sight glass and shall be checked when pump is not in operation.
Periodically check if the lubricating oil is mixed with any condensed water. Careful opening of the oil drain during a stop of the pump will show any water.

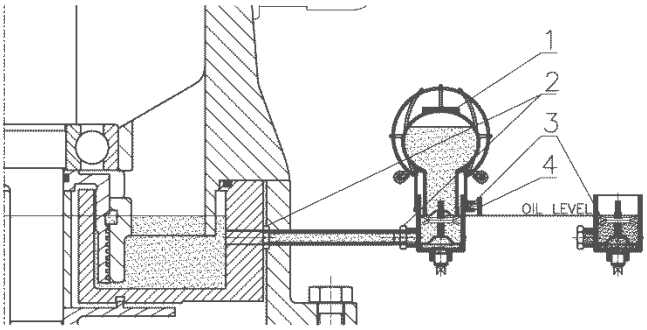
Note: During operation the level will decrease due to circulation of the oil through the bearings.

⚠ A too high oil level will result in higher bearing temperatures and therefore poorer lubrication.

5.2.3.1 Adjusting of TRICO Constant Level Oiler

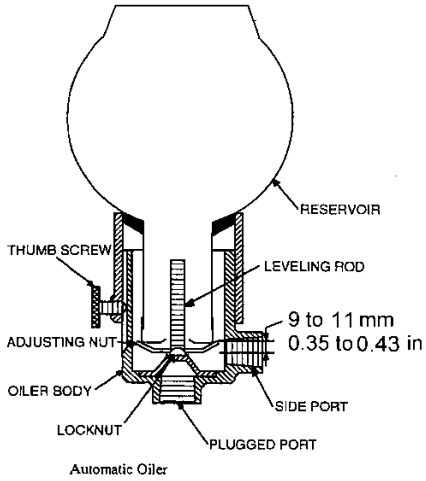
If the pump is fitted with a Constant Level Oiler type „TRICO“, the correct oil level has to be checked after fitting the pump!





1	Trico-Oiler	2	Counter nut
3	Leveling screw	4	Fixing screw

a) To check quickly the correct oiler adjustment, loosen the thumb screw and remove the reservoir. Turn the adjusting nut until you reach 0.35 to 0.43 in. (9 to 11mm) distance from the top of the adjusting nut to the centerline of the side port.
b) Additionally you can check the correct oiler adjustment by an oil sight glass (minimum oil level is the middle of the oil sight glass).
c) After a correct oiler adjustment, reinstall the reservoir and the oiler body and tighten the thumb screw.



Automatic Oiler

5.2.4 Oil quality

Oil used for lubrication should only be of high quality. The viscosity of the oil at working temperature must be at least 10 cSt. The pouring point of the oil must be in accordance with the lowest expected temperature of the bearing housing during a stop of the pump. For recommended lubricating oils refer to the lubrication table.
Having selected the corresponding oil quality the actual oil temperature at the bearing housing must be checked after two service hours of the pump. Considering this measured oil temperature the actual viscosity must be determined by using the data sheet of the oil, to verify the minimum required viscosity of 10 cSt. Do not forget, the oil temperature in the bearing itself is about 10 °C (Δ 18 °F) higher than the oil temperature at the bearing housing. On the following table the oil viscosity is given at 40 °C (104 °F). Determining the correct lubricating oil one must take into consideration that all bearings will have higher temperatures during the first 20 service hours. In constant operation the bearing temperature will decrease about 10 °C (50 °F). The oil temperature shall be lower than 85 °C (185 °F) after this running-in time. The bearing outer race temperature should not exceed 95°C (203°F). If the temperature is higher, the reason may be a wrong oil quality, wrong oil level or overload of the pump because of excessive wear. If the humidity at the site is high, the roller bearings become easily rusty during stand still periods. To avoid that, we recommend to mix the lubricating oil with a corrosion inhibitor contact your lubrication oil supplier for proper additives inhibitors.

5.2.5 Oil quantity

The bearing housing size can be identified from the thrust bearing size indicated by nameplate.

Bearing Housing Size	**Bearing Designation**	**Oil quantity** l (Fl.oz)
#1	7311	0.86 (29.1)
#2	7313	1.52 (51.4)

5.2.6 Lubrication Table

	Oil	Oil Bath and Purge Oil Mist Lubrication			Pure Oil Mist Lubrication
Centrifugal Pump Lubrication	Lubrication service	Ball bearing			
	Type	Mineral Oil (Petroleum Based)			Mineral Oil (Petroleum Based)
	Ambient temperature °C (°F)	-20 to 35 (-4 to 95)		35 to 60 (95 to 140)	-5 to 60 (23 to 140)
	Oil temperature range* °C (°F)	-5 to 65 (23 to 149)	up to 85 (up to 185)	up to 100 (up to 212)	15 and above (59 and above)
	Viscosity mm²/s 40°C [cSt]	32	46	68	100
	First Oil Change	200 hours	200 hours	200 hours	200 hours
	Further Oil Changes	2000 hours or at least every 6 months	2000 hours or at least every 6 months	2000 hours or at least every 6 months	2000 hours or at least every 6 months
	Designation according to DIN51502 ISO VG	32	46	68	100
Oil Companies and Lubricants	**BP**	BP Energol HL32 BP Energol HLP32	BP Energol HL46 BP Energol HLP46	BP Energol HL68 BP Energol HLP68	-
	CASTROL	Perfecto T32**	Perfecto T46**	Perfecto T68	-
	OMV	OMV turb HTU 32**	OMV turb HTU 46**	OMV turb HTU 68	-
	Aral	Aral Vitam GF 32	Aral Vitam GF 46	Aral Vitam GF 68	-
	Esso	NUTO H32	NUTO H46	NUTO H68	-
	LSC (for oil mist)	LSO 32 Synthetic oil	LSO 46 Synthetic oil	LSO 68 Synthetic oil	LSO 100 Synthetic oil
	Mobil	Mobil Nuto H32 Mobil DTE13M Mobil DTE24	Mobil Nuto H46 Mobil DTE15M Mobil DTE25	Mobil Nuto H68 Mobil DTE16M Mobil DTE26	-
	Shell	Shell Tellus 32 Shell Turbo T32**	Shell Tellus 46 Shell Turbo T46**	Shell Tellus 68 Shell Turbo T68	-
	Texaco	Rando HD 32	Rando HD 46	Rando HD 68	-
	Total	Azolla ZS32	Azolla ZS46	Azolla ZS68	-
	Wintershall (BASF Group)	Wiolan HN32 Wiolan HS32	Wiolan HN46 Wiolan HS46	Wiolan HN68 Wiolan HS68	-

* Note that it normally takes 2 hours for bearing temperature stabilize and the final temperature will depend on the ambient, r/min, pumpage temperature and pump size. Viscosity index shall be at least 95.

** For ambient temperature from -12°C (10 °F) upwards

For temperatures below -5 °C (-23 °F) use lubrication oil class SAE 5W-50 or API-SJ.

	Seal System / Pumped Liquid	Quench-Oil	General Features
Barrier/Buffer Fluid for Mech. Seal	Tandem Seal to -40 °C (-40 °F) Back to back Seal with gascoffer-dam Conventional back to back Seal	- Raffinated Hydraulic Oil - Synthetic Oil - Mixture of water / glykol **ATTENTION**: Do not use Methanol	appr. 10-15 cST at 40°C (104 °F) below -40°C (-40 °F) Pourpoint vaporization above 80°C (176 °F)
	Tandem Seal to -60°C (-76 °F)	Ethanol/Propanol	
The sequence of the suppliers of the lubricants does not represent any indication of their superiority. [1] Viscosity at 40 °C (104 °F) in cSt [mm²/s] DIN 51562			

5.3 Direction of rotation

CAUTION The sense of rotation of the pump is counter clockwise (CCW); looking from the coupling to the shaft end of the pump.

The rotation of the driver shall be checked.

5.4 Guarding

Be sure that the coupling guard is mounted correctly at the baseplate prior to start up.

5.5 Priming and auxiliary supplies

The pump must be completely primed prior to start up.

a) The pump casing is considered as self venting, so no vent connections are provided.
b) Auxiliary systems, e.g. barrier /buffer fluid systems, cooling circuits, shall be filled according to the user instructions.

5.6 Starting the pump

a) Start the driver according to the specification. (Refer to driver IOM).

Note: Pumps are usually started against closed discharge valve.

b) Check the discharge and suction pressure gauge to verify the pumps delivered head. Open the discharge valve slowly, until the pump reaches the specified operation point. The pump must operate smoothly, and the vibration must be below 5 mm/s (0.2 in./sec) (API 610 vibration limits).

The discharge valve must be opened within 30 sec. after start up. Longer operation against closed discharge valve will damage the pump. If a minimum flow valve is installed, take pressure gauge readings to verify the correct operation.

Note: If the backpressure of the discharge pipe is sufficient, pumps can be started against open valve.

Ensure that your driver is capable deliver the higher torque required by starting against open valve.

To prevent the pump from reverse rotation after shut down, the installation of a check valve is recommended.

Although the pump is not affected by reverse rotation because of spezial couppling design , it can be an issue with the driver.

Check the discharge and suction pressure gauge to verify the pumps delivered head.
The pump must operate smoothly, and the vibration must be below 5 mm/s (0.2 in./sec) (API 610 vibration limits).
If a minimum flow valve is installed, take pressure gauge readings to verify the correct operation.

c) Check the pipe system against any leakage.
d) Check the mechanical seal against any leakage.

Note: Right after start up a minor leakage of the mechanical seal is quite normal. Normally this leakage disappears after few minutes of operation.

5.7 Operation

a) Verify that the pump is operating within the specified limits, min/max flow, pressure, temperature, vibration, power
b) The bearing housing temperature shall not exceed 80 °C (176 °F). If higher bearing temperature are observed, check the viscosity grade of the used lubrication oil.

CAUTION The minimum viscosity is 10 cSt at the expected oil temperature.
(Oil temperature = bearing gland temperature + 10 °C (50 °F))

c) From time to time check the pump shaft seal. Leakage of 10 - 20 drops per hour is also with a mechanical shaft seal unavoidable.
d) Observe the power consumption of the pump to detect excessive wear.

5.8 Stopping and Shutdown

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

Note: For automatic start/stop operation of the pump, ensure that all steps described in chapter 5.5, 5.6, 5.7 and 5.8 are implemented in the control logic.

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 will help the user to 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. Power varies as speed ratio cubed. If increasing speed it is important therefore to ensure the maximum pump working pressure is not exceeded, the driver is not overloaded, NPSH**A**>NPSH**R**, and that noise and vibration are within local requirements and regulations.

5.9.4 Net positive suction head (NPSH$_A$)

NPSH available (NPSH**A**.) is a measure of the energy available in the pumped liquid, above its vapour pressure, at the pump suction branch.
NPSH required (NPSH**R**.) - is a measure of the energy required in the pumped liquid, above its vapour pressure, to prevent the pump from cavitating.
It is important that NPSH**A** >NPSH**R.** The margin between NPSH**A** >NPSH**R** should be as large as possible. If any change in NPSH**A** is proposed, ensure these margins are not significantly eroded. Refer to the pump performance curve to determine exact requirements particularly if flow has changed. If in doubt please consult your nearest Flowserve office for advise 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.

6.0 MAINTENANCE

6.1 General


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

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 5.9.

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

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

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

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

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

Do not spray air or compressed inert gas on skin.

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

Never use air or compressed inert gas to clean clothes.

Before working on the pump, take measures to prevent an uncontrolled start. Put a warning board on the starting device with the words:
"Machine under repair: do not start".

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

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

6.2 Maintenance schedule

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

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

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

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

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

6.2.1 Routine Inspection (daily/weekly)

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

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

6.2.2 Periodic Inspection (every 6 Month)

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

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

6.3 Spare parts

6.3.1 Ordering of spares

When ordering spare parts we need the following information:

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

Example: for HWX pump:
HWX, serial number G202222/01
1 piece impeller Pos. 2200

The serial number of each pump is indicated on the name plate. If the material should be changed from the original delivered one, additionally indicate the exact material specification. If ordered impellers shall have smaller or larger outer diameter, indicate also with your order. Without a special remark the spare impellers will be delivered with the diameter of the original impellers.

If you need the wear rings oversized or undersized, please indicate, otherwise the wear rings will be delivered with standard size.

To ensure continuous 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 parts) 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 retreatment of metallic surfaces (if necessary) with preservative is recommended at a 6 monthly interval.

6.4 Recommended spares

	Spares Recommended						
Part	**Start up**			**Normal Maintenance**			
No. of identical pumps	1 - 3	4 - 6	7+	1 - 3	4 - 6	7 - 9	10+
Case							1
Head (case cover and stuffing box)							1
Bearing housing							1
Shaft (w/key)				1	1	2	1
Impeller				1	1	2	3
Wear rings (set)	1	1	1	1	1	2	3
Bearings complete (antifriction, radial)	1	2	3	1	2	3	3
Bearings complete (antifriction, thrust)	1	2	3	1	2	3	3
Mechanical seal complete (Cartridge)	1	2	3	1	2	3	3
Shaft sleeve and stage bushing (set)	1	2	3	1	2	3	3
Gaskets, O-rings (set)	1	2	3	1	2	3	3

6.5 Tightening torque & tightening sequence

6.5.1 Tightening torque

Tightening Torque M_A Nm (lbf.ft)										
	Carbon Steel									
Size of Screw	A193 B7M, A320 L7M (NACE)		A193 B7, A320 L7, 8.8		3.6		4.6		10.9	
	[Nm]	[lbf.ft]	[Nm]	[lbf.ft]	[Nm]	[lbf.ft]	[Nm]	[lbf.ft]	[Nm]	[lbf.ft]
M4	4.2	(3.1)	3	(2.2)	0.8	(0.6)	1.1	(0.8)	4.6	(3.4)
M5	8.3	(6.1)	5.9	(4.4)	1.6	(1.2)	2.2	(1.6)	8.6	(6.3)
M6	14.2	(10.5)	10.1	(7.4)	2.8	(2.1)	3.7	(2.7)	14.9	(11)
M8	35	(26)	24.6	(18.1)	6.8	(5)	9.1	(6.7)	36	(27)
M10	68	(50)	48	(35)	13.7	(10.1)	18.3	(13)	71	(52)
M12	118	(87)	84	(62)	23	(17)	31	(23)	123	(91)
M14	187	(138)	133	(98)	37	(27)	50	(37)	195	(144)
M16	290	(214)	206	(152)	57	(42)	76	(56)	302	(223)
M18	335	(247)	295	(218)	80	(59)	106	(78)	421	(311)
M20	472	(348)	415	(306)	112	(83)	150	(111)	592	(437)
M22	644	(475)	567	(418)	151	(111)	202	(149)	807	(595)
M24	811	(598)	714	(527)	193	(142)	257	(190)	1017	(750)
M27	1193	(880)	1050	(774)	284	(209)	379	(280)	1496	(1103)
M30	1614	(1190)	1420	(1047)	386	(285)	515	(380)	2033	(1500)
M33	2191	(1616)	1928	(1422)	523	(386)	697	(514)	2747	(2026)
M36	2820	(2080)	2482	(1831)	672	(496)	897	(662)	3535	(2607)
M39	3645	(2689)	3208	(2366)	870	(642)	1160	(856)	4569	(3370)
M42	3920	(2891)	3980	(2936)	1146	(845)	1447	(1067)	5670	(4182)

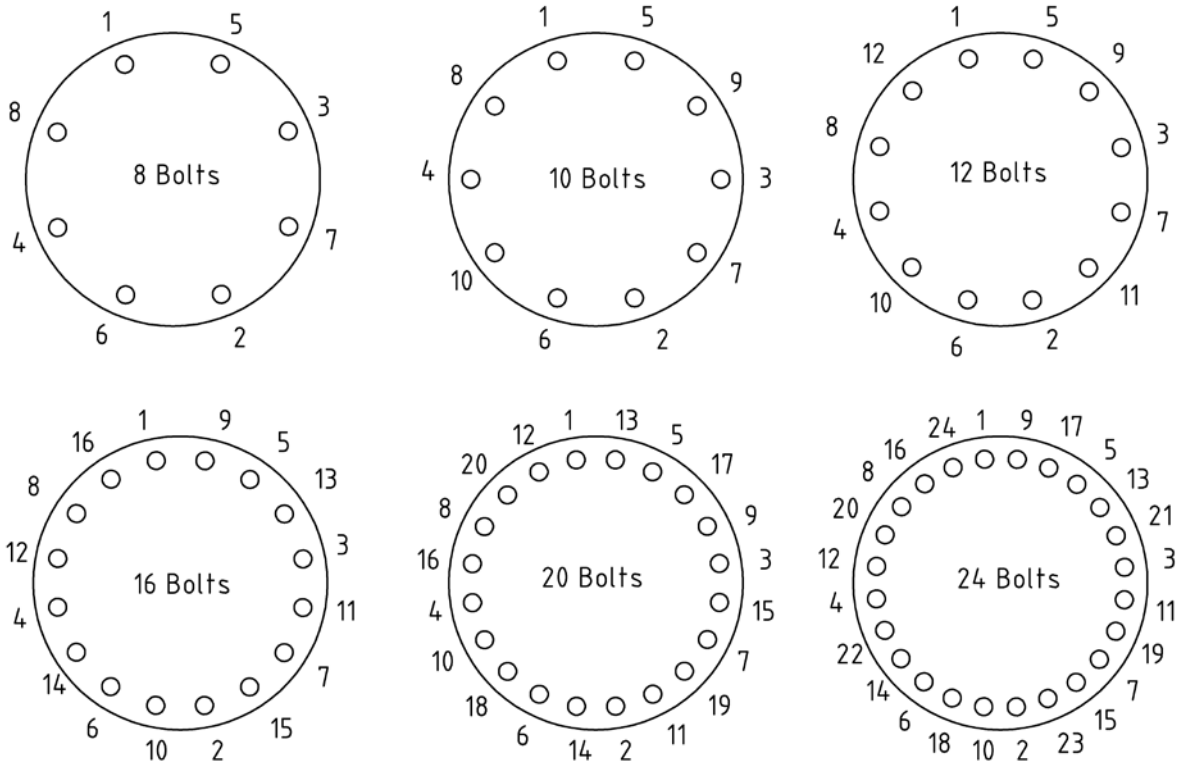
M45	4875	(3596)	4950	(3651)	1425	(1051)	1800	(1328)	7050	(5200)
M48	5899	(4351)	5990	(4418)	1724	(1272)	2178	(1606)	8530	(6292)
M64	14083	(10388)	14300	(10548)	4117	(3037)	5201	(3836)	20370	(15025)
M68	16998	(12538)	17260	(12731)	4969	(3665)	6277	(4630)	24580	(18130)
M76			25230	(18610)	8270	(6100)				

Tightening Torque M_A Nm (lbf.ft)										
	Duplex SS		Austenitic SS						other alloys	
Size of Screw	S32760, S31803, 1.4462		A193 B8M Cl2		A4-70, A2-70		A193 B8/B8M, A193 B8MA (NACE) A2-50, A4-50		N08825	
	[Nm]	[lbf.ft]	[Nm]	[lbf.ft]	[Nm]	[lbf.ft]	[Nm]	[lbf.ft]	[Nm]	[lbf.ft]
M4	2.1	(1.5)	3.2	(2.4)	1.9	(1.4)	0.9	(0.7)	1.1	(0.8)
M5	4.1	(3)	6.4	(4.7)	3.6	(2.7)	1.6	(1.2)	2.2	(1.6)
M6	7.1	(5.2)	10.9	(8)	6.3	(4.6)	2.9	(2.1)	3.7	(2.7)
M8	17	(12.5)	27	(19.9)	15	(11.2)	7.1	(5.2)	9.1	(6.7)
M10	34	(25)	52	(38)	30	(22)	14	(10.3)	18.3	(13)
M12	59	(44)	91	(67)	51	(38)	24	(17.7)	31	(23)
M14	94	(69)	143	(105)	82	(60)	38	(28)	50	(37)
M16	145	(107)	222	(164)	126	(93)	58	(43)	76	(56)
M18	201	(148)	308	(227)	176	(130)	82	(60)	106	(78)
M20	283	(209)	434	(320)	247	(182)	115	(85)	150	(111)
M22	387	(285)	473	(349)	337	(249)	157	(116)	202	(149)
M24	487	(359)	595	(439)	426	(314)	198	(146)	257	(190)
M27	716	(528)	716	(528)	602	(444)	292	(215)	379	(280)
M30	968	(714)	968	(714)	817	(603)	397	(293)	515	(380)
M33	1315	(970)	1008	(744)	1112	(820)	536	(395)	697	(514)
M36	1692	(1248)	1297	(957)	1428	(1053)	690	(509)	897	(662)
M39	2187	(1613)			1849	(1364)	890	(656)	1160	(856)
M42	2714	(2002)			2287	(1687)	1067	(787)	1447	(1067)
M45	3375	(2489)							1800	(1328)
M48	4084	(3012)							2178	(1606)
M64	9750	(7192)							5201	(3836)
M68	11768	(8680)							6277	(4630)
M76										

Above mentioned torques are for all screwed unions, which works under dynamical load. For all other connections you can use a corresponding smaller torque.
Anchor bolts are usually made of 4.6 material. Tightening torques indicated in above table shall not be exceeded.

6.5.2 Tightening sequence

Stage 1: Torque the bolts, following the illustrated sequence below, using 30% of the tightening torque indicated in chapter 6.5.1.
Stage 2: Torque the bolts, following the illustrated sequence below, using 60% of the tightening torque indicated in chapter 6.5.1.
Stage 3: Torque the bolts, following the illustrated sequence below, using 100% of the tightening torque indicated in chapter 6.5.1.



6.6 Disassembly

Refer to section 1.6, *Safety*, 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.

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

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

CAUTION ***Remove the pipe plug(s) from the top of the bearing housing(s) and check to see that oil rings are riding free on the pump shaft and are not hung up. Failure to observe this caution could result in damage to or destruction of equipment.***

6.6.1 Pull Out Element Removal

This pump has a pull-out element, which consists of the pump shaft [2100], mechanical seal assembly, casing cover [1221], impeller [2200], and bearing housing assembly, as well as their attached parts. This pull-out element makes it unnecessary to remove the driver, bearing lantern [3140], or casing [1110] to service the bearing housing assembly, mechanical seal, impeller [2200], wear rings [2300.1/2300.2–1500.1/1500.2], stuffing box bushing [2430], and gaskets.
For an illustrative part reference, see the Pump Assembly drawing in the back of this manual.

a) Remove all seal piping, related instrumentation and electrical equipment that will interfere with disassembly. Drain pump casing.

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

When pump is handling "caustic" liquid extreme care must be taken to ensure safety of personnel when removing auxiliary piping or when draining pump. Protective devices of suitable protective materials must be worn when draining the pump.

b) Remove coupling guard [7450] from bearing lantern [3140] by removing bolts and washers.
c) Disassemble and remove coupling spacer in accordance with the manufacturer's instructions in the back of this manual.
d) In case of Oil Lubrication drain the bearing housing of oil. This can be done by removing the drain plug situated at the bottom of the bearing housing.

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

e) Remove the hex bolts clamping the casing cover [1221] to the casing [1110].
f) Use the jacking bolts provided on the casing cover [1221] flange to lift the cover from the casing [1110] and raise the cover above the lower flange of the bearing lantern [3140].
g) Attach the pullout element lifting tool to the pullout element, then lift the element out of the casing [1110]. (See figure 6.2).

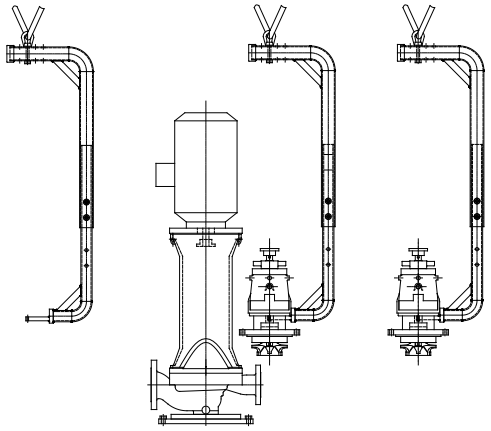


Figure 6.2

Note: *The lifting tool is not part of the pump. It must be ordered separately.*

h) Raise the pullout element upward until the impeller clears the lower flange of the bearing lantern [3140] and remove through the large opening.
i) Remove the casing cover gasket [4590] from the casing [1110] or casing cover [1221] and discard.
j) Move the pullout element to a safe, clean work area for further disassembly.

6.6.2 Pull Out Element Disassembly

CAUTION **All gaskets and O-rings removed during maintenance are to be discarded and replaced with new ones to ensure proper sealing during subsequent operation.**

Note: ***As a reminder of the orientation of the casing cover and the bearing housing you might match mark these parts before separating them; however, the OUTLINE drawing shows the factory orientation.***

To disassemble the pullout element, soft cable (or equivalent) and lifting equipment should be handy and used for heavy parts. Proceed as follows:

a) Secure bearing housing [3200] to workbench in a position that will allow impeller [2200] and casing cover [1221] to be pulled away from shaft [2100] and bearing housing [3200].
b) Secure shaft [2100] to prevent rotation.

Note: ***The impeller cap nut [2912] is left-hand threaded. To remove the impeller cap nut, turn it to the right (clockwise) while facing the impeller.***

c) Untight the security dowel of the cap nut [2912] and remove it from shaft.
d) Use heat, if necessary, on impeller [2200] and remove it from shaft.
e) Remove impeller key [6700.1].
f) Install the mechanical seal spacers to lock the shaft sleeve to the seal plate. Then loosen the set screws which hold the shaft sleeve to the shaft.
g) Unscrew cap screws that hold bearing housing [3200] to casing cover [1221] and tap casing cover and bearing housing with mallet to break cover loose from housing.

Note: ***The impeller cap nut [2912] is left-hand threaded. To remove the impeller cap nut, turn it to the right (clockwise) while facing the impeller.***

h) Hold shaft sleeve in place and carefully slide casing cover [1221] with sleeve and mechanical seal parts off shaft and clear of bearing housing [3200].

Note: ***The stuffing box bushing [4133] is pressed into the casing cover [1221] and should not be removed unless worn or badly scratched or gouged, in which case the old bushing must be pressed out and a new one pressed in***.

i) Set casing cover [1221] on workbench with bearing-housing side up.

To disassemble a mechanical seal follow the seal manufacturer's instructions in the Appendix.

j) Remove the seal plate nuts and the mechanical seal.

Note: k) ***If no pumpage has got into bearing housing and you plan to replace just the mechanical seal, omit the remaining steps; otherwise continue to disassemble pump as outlined.***

l) Evenly heat pump half-coupling using a welding torch with a Rosebud head until you are able to pull half-coupling off with a coupling puller, then remove half-coupling and key [6700.4].
m) Remove outboard fan [if applicable 8161.1] and screws [6577.4]. Loosen screw [6579.4] on vent ring [2500] and slide off shaft.
n) Unscrew bearing housing end cover cap screws and slide end cover [1220] off shaft. If your pump is oil lubricated, remove and retain the cover plate [3260].

Note: ***Although not necessary, it may be worthwhile to lift the bearing housing and block it in a vertical position with the thrust bearing up to facilitate removal of the shaft and bearings. Support shaft as it is moved out of bearing housing by soft cables and hoist or wood blocks.***

o) Remove shaft [2100], with thrust bearings [3013] and radial bearing [3010] installed, from bearing housing [3130].
p) Proceed as follows:
   - Loosen the set screws which hold the screw pump to the shaft, then slide the screw pump [4223] off of the shaft.
q) Place shaft in a vice which is covered with a soft material such as copper to prevent marring; then clamp it just enough to keep it from turning when thrust bearing lock nut [3712] is broken loose.
r) Bend back tab on thrust bearing lock washer [6541]. Unscrew thrust bearing lock nut [3712]. Facing the bearing nut, turn it clockwise to loosen. Remove lock nut and lock washer from shaft.
s) Remove shaft from vice and press bearings [3013 – 3010] off shaft with hydraulic press, if available; otherwise, leave shaft in vice and pull bearings off shaft with a bearing puller.
t) If your pump is oil lubricated: The grease catcher [3865] should only be removed if there is evidence of leakage. If the cover is to be removed, remove the cap screws and slide the cover out of the bearing housing.

6.7 Examination of parts

CAUTION **Used parts must be inspected before assembly to ensure the pump will subsequently run properly.**

In particular, fault diagnosis is essential to enhance pump and plant reliability.

To perform a good visual inspection and to obtain the highest degree of cleanliness, which is essential to the correct fit and balance of all rotating parts, the shaft must be stripped of all parts. The visual inspection consists of examining the following parts for those conditions that commonly impair pump operation. Where the corrective action may not be apparent to a journeyman millwright or a more extensive examination is required, the inspection item is cross-referenced to a detailed procedure. Unless noted below, all damaged parts should be replaced rather than repaired.

6.7.1 Cleaning Agents

When the pump is used in the steam generator feed, the boiler feed, the reactor feed, or other such steam (or water) circuit, all internal metal parts of the pump including the case should be cleaned with a non-petroleum-base cleaning agent such as alcohol or acetone or a steam cleaner that uses steam from demineralised water. The basic concern should be to insure that the solvent is compatible with the pumpage. Petroleum-base agents such as dry cleaning solvent and kerosene may be used for cleaning internal parts when such agent will dissolve in the liquid being pumped without inducing an ill effect. Petroleum-base agents should be used to clean the bearings and their housings.

Fumes from alcohol, acetone, petroleum solvents and other such chemicals are injurious to health and may ignite from a spark; make certain that the area where they are used is well ventilated and have a fire extinguisher handy.

6.7.2 Casing, seal housing and impeller

a) Inspect for erosion, foreign object damage and cracks; erosion and damage must be corrected before final assembly.
b) Inspect impeller cap nut [2912] and impeller [2200] for nicks, gouges, galling and rust.
c) Inspect impeller bore for correct fit with shaft (See Section 6.8.2 ”Checking Fit Between Impeller Bore and Shaft”).
d) Inspect running surfaces of stuffing box bushing [4133], shaft [2100], case wear ring [1500.1], casing cover wear ring [1500.2], and impeller wear ring [2300.1–2300.2] for nicks, burrs, scratches, scouring and excessive wear. Concentric and smooth surfaces are required (See Section 6.8.1 “Wear Rings”).
e) Replace as necessary.

6.7.3 Mechanical seal

a) Mechanical seal stationary and rotating faces should be inspected for signs of wear or cracks and replaced as necessary.
b) It is recommended that when reassembling mechanical seal new "O" rings and gaskets be used.
c) Refer to manufacturers drawing for assembly of mechanical seal. Refer to mechanical seal section within this manual for further details.

6.7.4 Throat Bush (If fitted)

a) Check the throat bush and replace if required. Note that the bush outside diameter should be the same diameter as the adjacent impeller wear ring.

6.7.5 Shaft

Shaft [2100] for scratches, nicks, burrs, and distortion; absolutely smooth surfaces and a straight shaft are required.
After the shaft is inspected for damage as described above, it must be checked for straightness before reassembling the rotating parts. When making the check do not turn the shaft in its lathe centers. It is possible for the lathe centers of a straight shaft to be off center slightly, resulting in a false indication of a bent shaft.

1. Set shaft in soft-faced V-blocks, precision rollers (or equivalent).
2. Check straightness by taking dial indicator readings all along the shaft while it is rotated; total runout of shaft must not exceed 0.04 mm (0.0015 in). If runout is exceeded shaft must be cold-straightened or replaced.

CAUTION **Application of heat to straighten shaft will cause more distortion.**

Note: ***The term "soft-faced V-blocks" refers to V-blocks faced with metal that is softer than the shaft, for example, V-blocks faced with copper.***

6.7.6 Gaskets and O-rings

After dismantling, discard and replace.

6.7.7 Bearings

a) It is recommended that bearings are not re-used after any removal from the shaft. In any case the bearings must be replaced not after 25000 operating hours.
b) If the bearing cannot be removed with the tools available never use a torch under any circumstances. Split the outer ring with a small hand grinder, saw through the ball/roller retainer, and split the inner ring about three quarters through with a grinder and break with a cold steel chisel.

Note: ***Do not attempt to inspect condition of bearings until they have been cleaned.***

c) Solvent for cleaning bearings should be in a clean container. Place bearings in solvent and let soak for a short time. Agitate the bearing around near the top of the container, giving it a turn now and then until it is clean. Rinse in a clean container of fresh solvent.

Note: ***Do not spin dirty bearings. Rotate them slowly while washing.***

d) Dry thoroughly cleaned bearings. If an air hose is used for drying, make sure it is clean dry air.

Note: ***Do not allow the bearings to spin by force of air. Hold the inner and outer rings to prevent bearing from spinning.***

e) Inspect bearings immediately. If there is any question as to the condition of a bearing do not hesitate to replace it. There are many conditions that contribute to the deterioration of the bearings. A qualified bearing representative should be consulted if there is any question of bearing condition.

f) Inspected bearings which will be reused should be packed with new grease or dipped in clean lubricating oil, covered with clean lint free rags or other suitable covering and placed in a clean box or carton until ready for installation.

Note: ***Under no circumstances the bearings are to be left exposed.***

6.7.8 Labyrinths or bearing isolators (if fitted)

a) The lubricant, bearings and bearing housing seals are to be inspected for contamination and damage. If oil bath lubrication is utilised, these provide useful information on operating conditions within the bearing housing.

b) If bearing damage is not due to normal wear and the lubricant contains adverse contaminants, the cause should be corrected before the pump is returned to service.

c) Labyrinth seals and bearing isolators should be inspected for damage but are normally non-wear ring parts and can be re-used.

Bearing seals are not totally leak free devices. Oil from these may cause staining adjacent to the bearings.

6.8 Assembly

To assemble the pump consult the sectional drawings.
Ensure threads, gasket and O-ring mating faces are clean.

6.8.1 Wear rings

The impeller may be fitted with both front and rear wear rings or front ring only.

The impeller ring(s) are renewable and should be replaced when badly grooved, and/or when pump performance does not meet the system requirements. Whenever it becomes necessary to replace either wear ring, both rings involved (impeller and casing/casing cover) must be ordered and replaced as a set as they are furnished standard size only. Spare impeller wear rings are supplied with a material stock over outside diameter which has to be machined off after rings fitting on impeller. If an impeller with its wear rings is ordered as spare, it will be supplied fully machined, including wear rings outside diameter, to original dimensions. Casing wear rings are always supplied fully machined. Be sure to re-establish the original running clearance between the two wear rings involved by machining the fitted impeller ring.

Running clearance is determined by measuring the inside diameter of the stationary part and the outside diameter of the rotating part (for example, the inside diameter of the case wear ring and outside diameter of the related wear ring ring on the impeller), and taking their difference to get the running clearance; that is, the diameter of the stationary part minus the diameter of the rotating part equals the actual running clearance.

Measurement should be taken with a micrometer and each part should be checked for trueness or roundness by taking diametrical readings 90 degrees apart. To determine whether the actual running clearance has increased to a point where replacement of a part is advisable, compare the actual clearance with the design clearance that is given in the cross sectional drawing. Then consider the wear with respect to mechanical and hydraulic efficiency and decide whether to restore the design clearance.

Before final assembly, the trueness and the running clearance of the following should be checked:

1. Stuffing box bushing [4133].
2. Case wear ring [1500.1], casing cover wear ring [1500.2], and impeller wear rings [2300.1–2300.2]; restore running clearance that is given in cross sectional drawing and roundness as outlined in section 6.8.1.1 and 6.8.1.2.

6.8.1.1 Impeller wear rings

a) To remove impeller wear rings, mutually remove wear ring set screws or ground off tack weld. Rings can be machined off or grind two slots diametrically opposite across the width of the ring so it can be split apart. Use caution if ring is removed by grinding so as not to damage impeller hubs.

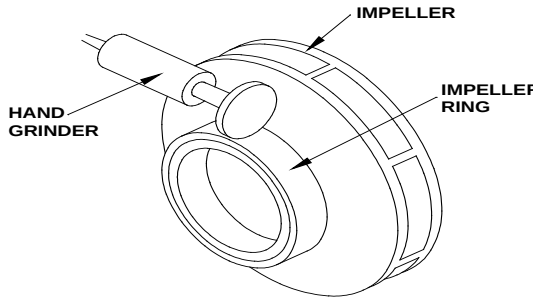


Figure 6.3

b) Determine that impeller has cooled to ambient temperature by feeling with hand; then heat wear ring using a torch until ring will slip into place on impeller.
c) Verify trueness of wear ring to impeller fit as outlined below or by an equivalent technique:
   - Make sure ring fits on impeller are free of nicks or burrs. Heat new ring to 107 °C (225 °F). Set impeller with wear ring face up on table of vertical lathe and parallel with face of table.
   - Align centerline of impeller (that is, centerline of impeller bore) with centerline of table using bore as true surface for dial indicator. Alignment should be within 0.03 mm (0.001 in.).
   - Clamp impeller in centered and parallel position.
   - Set up dial indicator to run outside diameter of wear ring ring and rotate table. Total runout must not exceed 0.04 mm (0.0015 in.).
d) Drill and tap new holes in impeller spaced half the circular distance from the previously used holes in the impeller. See sketch below (If tack welding ring, use ER308 or ER309 rod and gas-tungsten arc.

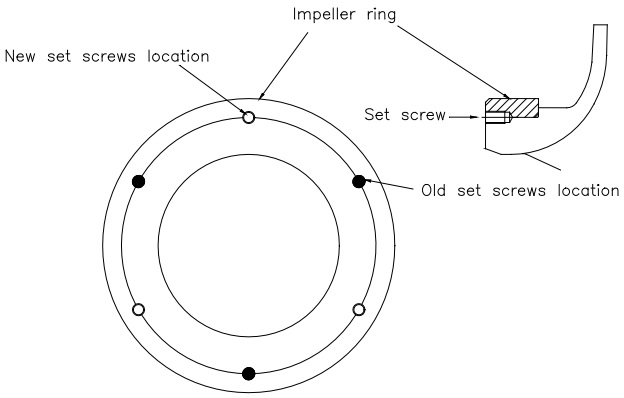


Figure 6.4

Note: ***Impeller wear rings when installed must be machined to establish original diameter and running clearance. Whenever an impeller has new wear rings fitted it must be dynamically balanced before being reassembled. Refer to the Cross Sectional drawing for the requested running clearance.***

6.8.1.2 Case wear rings (and casing cover wear ring when fitted)

Each wear ring is locked against rotation with a cylindrical pin.
a) To remove the wear ring, press it out. If this method does not easily effect removal of the ring, it can be split apart. First, however, drill one or more holes in the face of the worn ring.
b) New rings to be installed must be shrunk by freezing when installing in casing or casing cover. See that temperature of casing / casing cover is above 21 °C (70 °F).
c) Subcool new wear ring in dry ice to shrink it; then, bottom ring squarely in bore of parent part by using aluminium drift and mallet to strike evenly around circumference of wear ring ring.
d) Determine that wear ring ring and parent part have warmed to ambient temperature by feeling with hand.
e) Verify trueness of wear ring-ring-to-part fit as outlined below or by an equivalent technique:
   - Set up parent part in lathe or milling machine so that register face of part can be used as true side for dial indicator. The centreline of part must be aligned with centreline of machine's table and it must also be parallel with table within 0.03 mm (0.001 in).
   - Set up dial indicator to run on inside diameter of wear ring ring and rotate table (or chuck). Total runout must not exceed 0.04 mm (0.0015 in).
f) Fit and secure with a locking pin. Replacement wear rings are furnished standard size in the bore. Check the running clearance between impeller and casing ring against the appropriate value.

6.8.2 Checking Fit Between Impeller Bore and Shaft.

The fit between the impeller bore and the shaft must be correct or vibration is apt to occur.
To check the fit, proceed as follows:

a) Verify shaft straightness (See Section 6.7.5).

   Note: A three-point micrometer is the preferred instrument for measuring bore; a stick micrometer is its alternate. When measuring with the three-point micrometer, measure close to the keyway. With stick micrometer, measure three places at 120-degree intervals.

b) Determine nominal fit of impellers with shaft:
   - by using micrometers to measure diameter of bore under thickest metal near each end of keyway of impeller and the corresponding diameter of shaft,

- then by comparing diameter of bore of impeller with corresponding diameter of shaft. Diameter of bore of impeller should be 0.013 mm (0.0005 in.) to 0.38 mm (0.0015 in.) oversize of the corresponding diameter of shaft.

CAUTION ***The diameter of the impeller bore must never be oversize of its counterpart on shaft by more than the allowable tolerance. If the impeller bore is not within tolerance, you should contact the nearest FLOWSERVE Pump Sales Office for recommendations concerning your particular circumstance.***

6.8.3 Oil Thrower (if applicable)

In case of Oil Cascade Lubrication, install thrower onto shaft. Secure thrower to shaft by tightening set screws into the location groove in the shaft.

6.8.4 Bearings Housing

The ball bearings require correct handling and installation to ensure optimum performance. The following information is intended as a minimum to ensure that the bearings are handled and installed correctly. As you assemble the pullout element, keep soft cables or nylon lifting straps and hoist handy for heavy parts.

Note: If you have not match-marked the casing cover, the bearing housing, and seal plate to identify their orientation, you should determine their correction orientation by studying the OUTLINE drawing before commencing assembly of the pullout element.

If the intent is to replace only the Mechanical Seal Part proceed to section 6.8.4.1

1. Make certain that all visual inspection requirements have been met, including verification of shaft straightness, wear ring running clearance, stuffing box bushing running clearance, and fit between impeller and shaft (see Section 6.7 "*Examination of parts*").
2. Place shaft in a soft-faced vise (that is, a vise with faces covered with a soft material such as copper) to prevent marring; then clamp it so that the radial and thrust bearings can be slipped onto shaft.

6.8.4.1 Bearings handling

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

6.8.4.2 Bearing installation

Install the thrust and radial bearings in the same sequence and direction as removed.

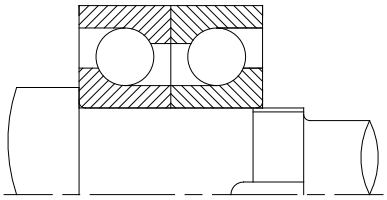


Figure 6.5 - Oil Cascade and Oil Mist Lubrication -

There are two simple methods of providing a heat source for expanding the inner race of the bearings to facilitate mounting.

a) In the first method, bearings still wrapped in their original intimate wrap are placed on a shelf in a temperature controlled oven, or in an enclosure lined with foil and heated with electric light bulbs. A temperature of 66 °C (150 °F) for one half hour should be sufficient.
b) A second method consists of locating a light bulb 100 to 150 Watt (0.13 to 0.15 hp) in the bore of the bearing. The light bulb will heat, primarily, the inner ring and the bearing can usually be handled by the outer ring without special gloves. Care must be taken to keep the bearing clean and uncontaminated.

Note: ***The old and once popular method of heating bearings in an oil bath is DEFINITELY DISCOURAGED. HEATING INNER RING WITH A GAS TORCH IS PROHIBITED. In either case, it is difficult to control the heating rate and final temperature and even more difficult to keep the oil and/or bearing clean.***

c) When bearings are installed on the shaft make sure the bearing is installed squarely and is firmly seated. Hold bearing in place until it has cooled sufficiently so that it will not move from position. Cover bearings to protect them from dirt.

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

Note: ***Inner thrust bearing must be assembled against shoulder on shaft with the***

wide flange of the outer race towards the coupling. The outer thrust bearings is to be placed on the shaft with the wide flange of the outer race towards the inner bearing.

d) When installing bearings on shaft, heat thrust bearing, radial bearing and screw pump (oil cascade lubricated bearing housing) to 200-230°F (95-110°C) and slide them up against their shoulders on shaft (thrust bearing on coupling end of shaft and radial bearing and screw pump on impeller end). Heat for approximately 20 - 30 minutes.

e) Install the lock washer and locknut as per figure 6.6 (oil cascade and oil mist lubrication).

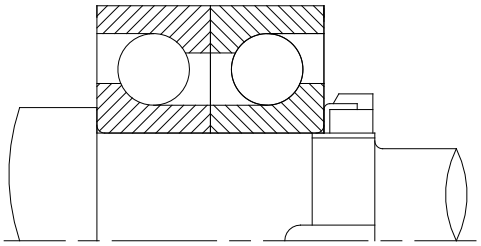


Figure 6.6 - Oil Cascade and Oil Mist Lubrication -

- Slide thrust bearing lock washer onto shaft, then thread lock nut onto shaft hand tight.
- Spin outer races of thrust bearing several times, then tighten the lock nut. The lock nut should be tightened such that the outer races of the thrust bearing do not turn independently when spun, but can be moved independently by hand.
- Allow the thrust bearings to cool to ambient temperature.
- Loosen the thrust bearing lock nut to hand tight, then re-torque the lock nut to 122 Nm (90 ft-lb).
- Mount a dial indicator on the shaft to read on the outer thrust bearing races. Runout on the outer thrust bearing races should not exceed 0.04 mm (0.0015 in.). Tap the bearing races into place with a soft-faced mallet if necessary.
- When bearing nut has been properly tightened and runout are within specification, bend a lock washer tab into a slot on the lock nut.

f) Remove shaft from vise.

g) Place the bearing housing in a vertical position on blocks in preparation for installation of shaft assembly. Make sure blocking is of sufficient height so that shaft will not contact the floor. There should be 0.03 mm (0.001 in.) diametrical clearance between outer race of each bearing and its bore in the bearing housing.

h) Suspend shaft vertically for installation into bearing housing.

i) If your pump is oil lubricated, and the inner bearing housing cover [3260] has been removed, then install a new O-ring, or coat the mating surfaces of the bearing housing [3200] and cover with Loctite Gasket Eliminator 504 sealant (or equivalent], as indicated in the Cross Sectional Drawing in the back of this manual. Install bearing housing end cover and evenly tighten cap screws.

j) Lubricate outer races of thrust bearings [3013] and radial bearing [3010]; then slide the shaft with bearings installed into the bearing housing [3200]. Push or tap on the outer thrust bearing race with a soft brass or plastic rod to position bearings in their bores in bearing housing.

k) Install the bearing isolator [4330] in the bearing housing end cover [3260.2].

l) Coat the mating surfaces of the bearing housing [3200] and bearing housing end cover [1220] with Loctite Gasket Eliminator 504 sealant (or equivalent]. If your pump is oil lubricated, then coat and install the cover plate [3260] as well. Install bearing housing end cover (and cover plate, if applicable) and evenly tighten cap screws.

m) Determine thrust bearing axial play as follows:
   - Mount a dial indicator to read on end of shaft. Push on coupling end of shaft until shaft is all the way toward impeller end; then set the dial indicator to "0".
   - Thrust shaft toward coupling end and read indicator: Repeat the procedure to confirm reading.
   - Clearance is correct if dial indicator is between 0.05 mm (0.002 in.) and 0.100 mm (0.004 in.).
   - If dial indicator indicates play less than 0.05 mm (0.002 in.) or more than 0.100 mm (0.004 in.), correct by machining end cover or installing appropriate gasket between bearing housing and end cover gasket.

n) Install inboard fan [2540] and tighten cap screw. Install vent ring [2500] and secure it with screws [6579.4]. Mount the fan [8161] on the vent ring [2500] with screw [6577.4]

o) Determine shaft and impeller wear ring runout as follows:
   - With bearing housing clamped in position, fix dial indicator to bearing housing [3200] and touch dial indicator button to shaft [2100]. Indicator must be fixed tightly to housing.
   - Slowly, rotate shaft and record readings at 12, 3, 6, and 9 o'clock points. Total indicated reading (TIR) shall not exceed 0.04 mm (0.0015 in.). If readings are excessive, set up may not be rigid.

     Note: If runout (i.e., TIR) at any surface is excessive, check all parts for burrs, dirt and rough surfaces; register face of bearing housing for squareness, and its bore for roundness; bearings for bottoming against shaft shoulders.

If you disassemble bearing housing, reassemble it in accordance with the procedure outlined above

- Remove the dial indicator.
- Install the impeller key [6700.1] and impeller [2200].

Note: As you face the impeller end of the shaft, thread the impeller cap screw by turning it counter-clockwise.

- Remove the dial indicator.
- Install impeller washer [2430] and impeller lock washer against impeller [2200] and screw impeller cap screw [2912] tightly against washer, but do not bend a lock washer tab. The impeller must be tight against the shaft shoulder with no play.
- Fix dial indicator to bearing housing register face or another point so that it is rigid and touch indicator button to either wear ring [2300.1 – 2300.2].
- Slowly, rotate shaft and record readings at 12, 3, 6, and 9 o'clock points; TIR shall not exceed 0.04 mm (0.0015 in).
- Repeat the two steps above to verify concentricity of other wear ring.

Note: If runout is excessive, check fit of impeller on shaft (see Section 6.9.2) and wear ring installations (see Section 6.9.1). Should you be unable to determine the cause of excessive runout, contact the nearest FLOWSERVE Pump Sales Office.

- Remove impeller cap screw [2912], impeller lock washer, impeller washer, and impeller [2200].

6.8.5 Shaft seal

6.8.5.1 Shaft seal – mechanical seal

a) Install, mechanical seal, and seal plate nuts. Tighten nuts evenly, then turn casing cover [1221] over, placing impeller-side up.
b) Use heat, if necessary, on impeller and slide it over key [6700.1] and against shaft shoulder.
c) Secure shaft [2100] so that it will not move.
d) Install impeller washer and impeller lock washer against impeller and tightly screw impeller cap screw [2912] against washer to hold impeller on shaft without any play. Bend a tab of the lock washer against a face of the cap screw to secure it in place.
e) Rotate the mechanical seal setting washers which hold the shaft sleeve to the seal plate out of the way and secure them for future use.
f) Heat half-coupling in dry heat convection oven to 300°F (149°C). Install the coupling key [6700.4] on shaft, then slide the half-coupling onto the shaft until it is positioned as shown by the Outline Drawing.
g) Wrap soft cables or nylon lifting strap around casing cover [1221] and bearing housing [3200], then raise pullout element and transport it to pump casing [1110].

Refer to any special instructions supplied with the mechanical seal.

***6.8.6* Pullout Element Installation**

a) Install a new casing cover gasket [4590] in the casing [1110].
b) Attach the pullout element lifting tool to the pullout element, then install rigging gear to lift the element.

Note: ***Ensure that the pullout element is properly aligned with the casing and auxiliary equipment in accordance with the Outline Drawing.***

c) Raise the pullout element upward until the impeller clears the lower flange of the bearing lantern [3140] and install through the large opening in the support head.
d) Install the hex bolts clamping the casing cover [1221] to the casing [1110]. Torque the bolts evenly in a star pattern to the torque value specified on Section 6.5.
e) Turn shaft by hand to ensure that rotor turns freely without binding or rubbing.

CAUTION ***Use of odd size bolts and nuts to couple half-couplings and spacer will cause imbalance; use only bolts and nuts specified by the coupling manufacturer.***

f) Install coupling spacer in accordance with the manufacturer's instructions in the back of this manual.
g) Install all seal piping, related instrumentation, and electrical equipment that was removed prior to disassembly.
h) Perform an alignment check of the pump in accordance with Section 4.5, "Initial Alignment"

Ensure that bearing lubrication is provided prior to operating the pump in accordance with Section 5.2, "Pump Lubricants".

7.0 AUXILIARIES

7.1 Seal and seal systems

7.1.1 Single Mechanical Seal with API–Plan 11+61

Note: Refer to mechanical seal drawing and auxiliary piping drawing.
The pump is equipped with a single mechanical seal. The cartridge design allows to change the mechanical seal without taking it apart.

CAUTION Try to turn the rotor by hand.If the rotor cannot be turned, the pump must be disassembled, refer to section 6.6 *Dismantling HWX.*

Actions after start up:
Check all connections to the seal gland and the mechanical seal itself against leakage. It is usual that at the seal faces a small leakage occurs after start up, which decreases with the time of operation and should stop after the seal is run in. Check the temperature of the seal gland. I slight increase of temperature may be observed during the run in period. The mechanical seal is flushed by an API Plan 11 and the temperature at the seal gland should be max. 10 °C (18 °F) above the pumped liquid temperature, unless otherwise specified by mechanical seal supplier.

In Plan 11, product is routed from the pump discharge via an orifice to the seal chamber to provide cooling for the seal and to vent air or vapors from the seal chamber. Fluid then flows from the seal cavity back into the process stream.

API Plan 61 has tapped and plugged connections for the purchaser´s use. Typically this plan is used when the purchaser is to provide fluid (such as steam, gas, or water) to an external sealing device.

CAUTION Refer to the GA - drawing for the required quench medium, pressure and flow.

CAUTION Disassembly of the seal cartridge is only allowed by authorized personal. Contact Flowserve for any service of the mechanical seal. We recommend to have a spare cartridge seal on stock for easy replacement.

7.1.2 Single Mechanical Seal with API–Plan 23+62

Note: Refer to mechanical seal drawing and auxiliary piping drawing.
The pump is equipped with a single mechanical seal. The cartridge design allows to change the mechanical seal without taking it apart.

CAUTION Try to turn the rotor by hand.If the rotor cannot be turned, the pump must be disassembled, refer to section 6.6 *Dismantling HWX.*

Actions after start up:
Check all connections to the seal gland and the mechanical seal itself against leakage. It is usual that at the seal faces a small leakage occurs after start up, which decreases with the time of operation and should stop after the seal is run in. Check the temperature of the seal gland. I slight increase of temperature may be observed during the run in period. The mechanical seal is flushed by an API Plan 23 and the temperature at the seal gland should be below the pumped liquid temperature (refer to mechanical seal drawing for temperature limit).

Plan 23 is the plan of choice for all hot water services, and it is also disirable in many hydrocarbon and chemical services where it is necessary to cool the fluid establish the required margin between fluid vapor pressure (at the seal chamber temperature) and seal chamber pressure. In a Plan 23, the cooler only removes seal face-generated heat plus heat soak from the process.
Additionally the mechanical seal is equipped with a Plan 62.
The mechanical seal is mounted as a complete unit in the casing cover [1221] (Cartridge design).
The lubrication of the sealing faces and the cooling is done from top of the sealing chamber through a pipe with an orifice back to the suction side (API Plan 11).
Next to the mechanical seal is a quenching chamber with a throttle bushing the quenching chamber has to be flushed with water or steam (API Plan 62).

CAUTION Refer to the GA - drawing for the required quench medium, pressure and flow.

CAUTION Disassembly of the seal cartridge is only allowed by authorized personal. Contact Flowserve for any service of the mechanical seal. We recommend to have a spare cartridge seal on stock for easy replacement.

7.1.3 Dual Mechanical Seal pressurized with API–Plan 02+53b

Note: Refer to mechanical seal drawing and auxiliary piping drawing.
The pump is equipped with a dual mechanical seal in face to back configuration, back to back configuration or face to face configuration.

CAUTION Try to turn the rotor by hand.If the rotor cannot be turned, the pump must be disassembled, refer to section 6.6 *Dismantling HWX.*

The mechanical seal requires no adjustment anymore. Check if the mounting plates are already swung out.
Actions after start up:
Check all connections to the seal gland and the mechanical seal itself against leakage. Check the temperature of the seal gland. I slight increase of temperature may be observed during the run in period.

Plan 02 is a dead ended seal chamber with no flush fluid circulation. Flushing is not necessary because the seal is not exposed to the pumped liquid.

Plan 53 pressurized dual seal systems are used in services where no leakage to atmosphere can be tolerated. A Plan 53b system consists of dual mechanical seals with a liquid barrier fluid between them. The barrier fluid is contained in a seal pot and is pressurized by using a bladder type accumulator. Inner seal leakage will be barrier fluid leakage into the product. There will always be some leakage (max.5 ml/hour).
The leakage rate is monitored by monitoring the seal pot level. The product must be able to accommodate a small amount of contamination from the barrier fluid. The seal pot pressure must be maintained at the proper level. If the seal pot pressure drops, the system will begin to operate like a Plan 52, or unpressurized dual seal, which does not offer the same level of sealing integrity. Specifically, the inner seal leakage direction will be reversed and the barrier fluid will, over time, become contaminated with the process fluid with the problems that result, including possible seal failure.

CAUTION Fill the seal system with a suitable barrier buffer fluid (refer to lubrication table).

CAUTION Open all necessary valves in the cooling and auxiliary piping and check the flow.

CAUTION Disassembly of the seal cartridge is only allowed by authorized personal. Contact Flowserve for any service of the mechanical seal. We recommend to have a spare cartridge seal on stock for easy replacement.

7.1.4 Single Mechanical Seal with API–Plan 13+61

Note: Refer to mechanical seal drawing and auxiliary piping drawing.
The pump is equipped with a single mechanical seal. The cartridge design allows to change the mechanical seal without taking it apart.

CAUTION Try to turn the rotor by hand.If the rotor cannot be turned, the pump must be disassembled, refer to section 6.6 *Dismantling HWX.*

Actions after start up:
Check all connections to the seal gland and the mechanical seal itself against leakage. It is usual that at the seal faces a small leakage occurs after start up, which decreases with the time of operation and should stop after the seal is run in. Check the temperature of the seal gland. I slight increase of temperature may be observed during the run in period. The mechanical seal is flushed by an API Plan 13 and the temperature at the seal gland should be max. 10 °C (18 °F) above the pumped liquid temperature, unless otherwise specified by mechanical seal supplier.

In API Plan 13 product is routed from the seal chamber back to the pump suction to provide cooling for the seal and to vent air or vapors from the seal chamber. The seal chamber is subjected to discharge pressure.

API Plan 61 has tapped and plugged connections for the purchaser´s use. Typically this plan is used when the purchaser is to provide fluid (such as steam, gas, or water) to an external sealing device.

CAUTION Refer to the GA - drawing for the required quench medium, pressure and flow.

CAUTION Disassembly of the seal cartridge is only allowed by authorized personal. Contact Flowserve for any service of the mechanical seal. We recommend to have a spare cartridge seal on stock for easy replacement.

7.2 Changing of mechanical seal

1) Completely drain the pump by using the drain connection. By pumping explosive or toxic media, flush the system with Nitrogen.
2) Secure the mechanical seal by putting the mounting plates into the groove of the shaft sleeve [2450]. Loose the grub screws [6814.4], and disconnect the seal piping.
   CAUTION Drain the seal system, if applicable.
3) For disassembly refer to section 6.6, *Dismantling of pump*.
4) For assembly refer to section 6.8, *Assembly of pump*

8.0 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
		●				●		●	●	Pump or suction pipe not completely filled with liquid.	Check and complete filling
●		●				●		●	●	Suction lift too high or level too low.	Check NPSHa>NPSHr, proper submergence, losses at strainers / fittings
						●	●	●		Excessive amount of air or gas in liquid.	Check and purge from pipes
						●		●	●	Air or vapour pocket in suction line.	Check suction line design for pockets
						●		●		Air leaks into suction line.	Check airtight pipe then joints and gaskets
						●		●		Air leaks into pump through mechanical seal, sleeve joints, casing joint or pipe lugs.	Check airtight assembly then joints and gaskets
		●						●		Foot valve too small.	Investigate replacing the foot valve
		●						●		Foot valve partially clogged.	Clean foot valve
		●				●		●	●	Inlet of suction pipe insufficiently submerged.	Check cut out system design
							●	●	●	Total head of system higher than differential head of pump.	Check discharge head and head losses in discharge pipe at the valve settings. Check back pressure is not too high
					●					Total head of system lower than pump design head.	Throttle at discharge valve or ask Flowserve if the impeller can be trimmed
					●					Specific gravity of liquid different from design.	Consult Flowserve
					●		●	●		Viscosity of liquid differs from that for which designed.	Consult Flowserve
●		●								Operation at very low capacity.	Measure value and check minimum permitted
	●	●			●					Operation at high capacity.	Measure value and check maximum permitted
										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 within acceptable values
●	●	●			●					Rotating part rubbing on stationary part internally.	Check for signs of this and consult Flowserve if necessary
●	●	●	●	●						Bearings worn	Replace bearings
					●		●	●		Wear ring ring surfaces worn.	Replace worn wear ring/ surfaces
		●					●	●		Impeller damaged or eroded.	Replace impeller and check reason
				●						Leakage under sleeve due to joint failure.	Replace joint and check for damage
			●	●	●					Mechanical seal improperly installed.	Check alignment of faces or damaged parts and assembly method used

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**
			●	●	●					Incorrect type of mechanical seal for operating conditions.	Consult Flowserve
●	●	●	●	●						Shaft running off center because of worn bearings or misalignment.	Check misalignment and correct if necessary. If alignment satisfactory check bearings for excessive wear
●	●	●	●	●						Impeller out of balance resulting in vibration.	Check and consult Flowserve
			●	●	●					Abrasive solids in liquid pumped.	Check and consult Flowserve
			●	●						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
●	●	●								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	Check method of assembly, possible damage or state of cleanliness during assembly and type of bearing used
	●	●								Damaged bearings due to contamination.	Check contamination source and replace damaged bearings
										C. ELECTRICAL TROUBLES	
		●			●		●	●		Wrong direction of rotation.	Reverse 2 phases on motor terminal box
	●	●						●		Motor running too slow,	Check motor terminal box connections

9.0 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.

10.0 OTHER RELEVANT DOCUMENTATION AND MANUALS

10.1 Supplementary user instructions

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

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

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

10.2 Change notes

If any changes, agreed with Flowserve, 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:
Pump Handbook, 2nd edition, Igor J. Karassik et al, McGraw-Hill Inc., New York, 1993.

Reference 3:
ANSI/HI 1.1-1.5
Centrifugal Pumps - Nomenclature, Definitions, Application and Operation.

Reference 4:
ANSI B31.3 - Process Piping.

10.4 Abbreviations

Quantity	ISO unit	ISO unit abbreviation	Multiplication Factor [1]	US unit	US unit Abbreviation
Area	square meter square centimeter	m² cm²	10.764 0.155	square feet square inch	ft² in.²
Capacity or Flow rate	Cubic meter/hour	m³/h	4.4033	US Gallons/ minute	US gpm
Force	Newton	N	0.2248	Pound force	lbf
Head	meter	m	3.28084	feet	ft
Heat Energy	kilo joule	kJ	0.9478	British thermal unit	Btu
Length	meter millimeter micrometer	m mm µm	3.28084 0.03937 0.00003937	feet inch inch	ft in. in.
Mass	kilogram gram	kg g	2.20462 0.035274	pounds ounces	lb. oz.
Moment of Inertia	kilogram square meter	kg.m²	23.73	pounds square feet	lb.ft²
Noise [4]	decibel	dBA			
Power	kilowatt	kW	1.34102	horsepower	hp
Pressure [2]	bar	bar	14.5	pounds/in.²	psi
Rotational Speed	revs per minute	r/min			
Stress	Newton/square millimetre	N/mm²	145.0	pounds/in.²	psi
Temperature	degrees Celsius	°C	(1.8 x °C) + 32	degrees Fahrenheit	°F
Torque	Newton meter	Nm	0.7376	pound.feet	lbf.ft
Unbalance	gram millimeter	g.mm	0.001389	ounce-inch	oz-in.
Vibration [3]	millimetre/ second	mm/s	0.03937	inches/ second	in./sec
Velocity	meter/second millimeter/second	m/s mm/s	3.28084 0.03937	feet/second inches/second	ft/sec in./sec
Viscosity	square millimetre/ second or centiStoke	cSt			
Volume	cubic meter liter	m³ l	264.2 33.81	US Gallons fluid ounce	US gal. Fl.oz.

[1] multiply the ISO unit by the multiplication factor to obtain US units

[2] where pressure is not stated to be absolute it is gauge

[3] where not stated to be peak it is r.m.s.

[4] sound pressure level LpA, re 1m - 20microPa, or sound power level LwA re 1 pW when sound power is applicable

AFTERMARKET DIRECTORY

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MESSAGES CAN BE LEFT ALSO ON OUR ANSWERING MACHINE

IMPORTANT NOTES:

PLEASE NOTE, THAT WARRANTY EXPIRES:
- USE OF NON GENUINE FLOWSERVE AUSTRIA PARTS FOR MAINTENANCE AND REPAIRS
- NO USE OF OUR SERVICE PERSONAL IN CASE OF REPAIRS DURING WARRANTY PERIOD

RECOMMENDATION:

-PLEASE ASK FOR OUR SPECIAL RATES
- PLEASE ALSO ASK OUR SERVICE PERSONAL ABOUT REPAIRING AND SERVICING YOUR PUMPS AFTER THE WARRANTY PERIOD

Please quote your service:

Name of Company: ……
Contact person:……..
Telephone: ……..…….....
Fax: ...……....
e-mail: ……
Country: ……

Pumpdata:
Type: …….
Serialno.: ……....…….....

Your Flowserve factory contacts:

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Austria

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