FLOWSERVE

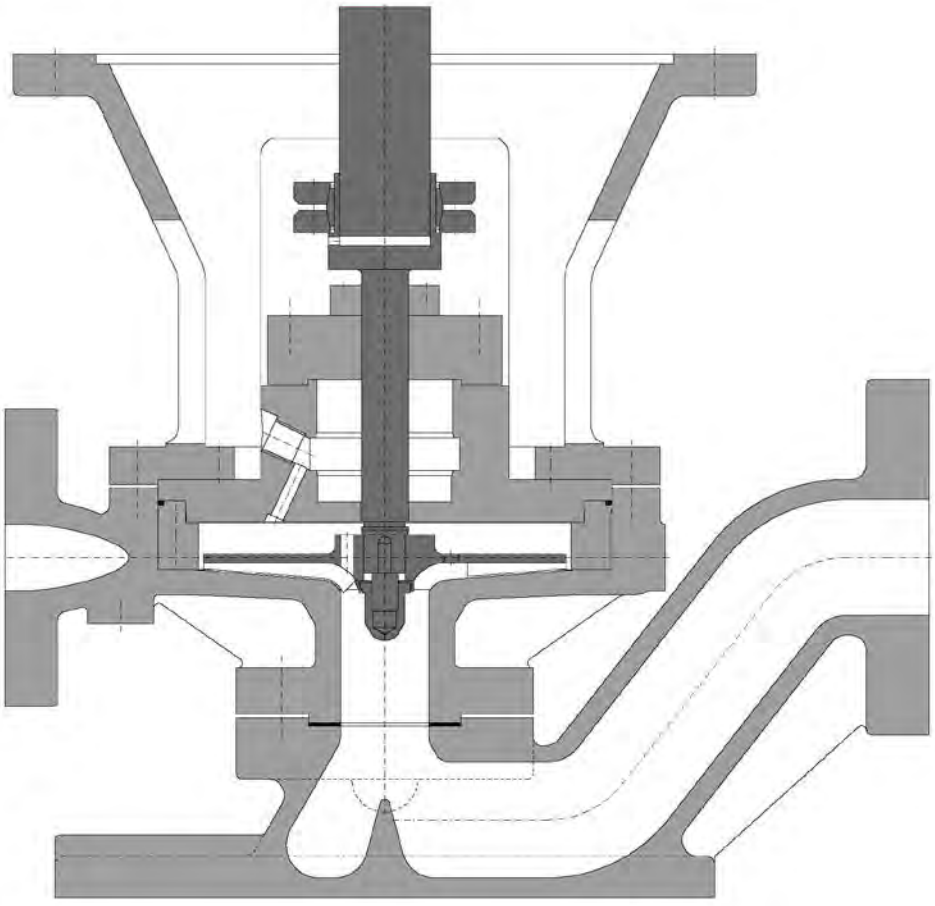
USER INSTRUCTIONS

Flowserve® MSP centrifugal pumps

Installation
Operation
Maintenance

Medium Speed, Vertical - Inline

PCN=71569268, 71569269 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

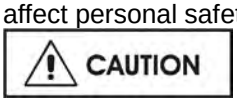
1.6.1 Summary of safety markings

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

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.

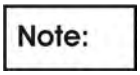


This symbol indicates safety instructions where non-compliance will involve some risk to safe operation and personal safety and would damage the equipment or property.

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.

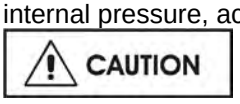
1.6.2 Personnel qualification and training

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.

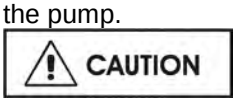
1.6.3 Safety action

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.

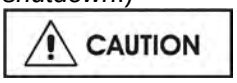
PREVENT EXCESSIVE EXTERNAL PIPE LOAD
Do not use pump as a support for piping. Do not mount expansion joints so that their force, due to internal pressure, acts on the pump flange.



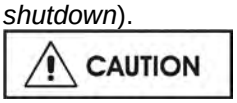
ONLY CHECK DIRECTION OF MOTOR ROTATION WITH COUPLING ELEMENT/ CLAMPING UNIT FASTENED
Starting in reverse direction of rotation will damage the pump.



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 wearing 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.

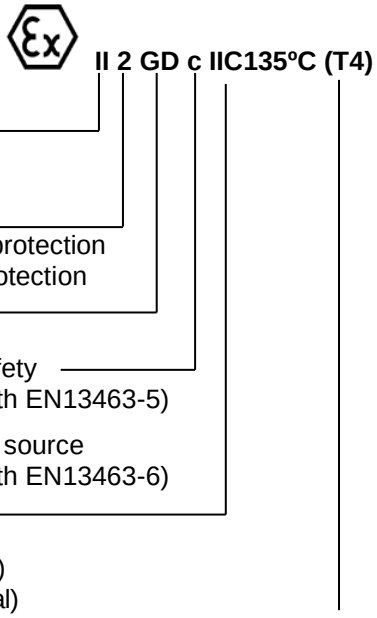
Where Flowserve has supplied only the bare shaft pump, the Ex rating applies only to the pump. The

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 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.

1.6.4.6 Preventing leakage

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

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

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

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

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

1.6.4.7 Maintenance to 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.

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.

		Octave MID_BAND Frequency, HZ							
	dB(A) Value	63	125	250	500	1K	2K	4K	8K
4000 rpm	70	64	64	62	62	60	55	50	50
5000 rpm	72	62	66	66	64	64	64	62	57
6000 rpm	76	70	70	68	68	66	61	56	56
7000 rpm	78	68	72	72	70	70	70	68	63
8000 rpm	80	70	74	74	72	72	72	70	65

Sound pressure readings are for information only and are not subject to guarantee by Flowserve.
Decibel readings do not include driver or system noise.
Pump tested at 100% of the best efficiency point at max.impeller diameter with water.

dB correction for combining noises (pump+motor)

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

Note :

1) The values showed are measured at a distance of 1 mt. (horizontally) from major pump surfaces and 1.5 mt. above the floor.
2) The values shown are expressed in dB.
3) For Noise Test Procedure refer to Works Standard L-109-0
4) The values shown have been derived from actual noise-test data and are based on the following conditions:
   - Equipment is located in a free field above a reflecting plane in which the reductionin noise level in all directions is 6db in each octave band for each doubling of distance.
   - Background noise is 10dB minimum below all noise levels in each octave band.
   - The values shown are at a distance of 1 meter (horizontally) from the major pump surface and 1,5 meters above the floor, using a standard pressure reference of 0,00002 newton per square meter.
   - Overall noise level, dB(A) is determined at points of maximum noise level and the values of all mid-band frequences are basis A scale readings.

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

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

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.

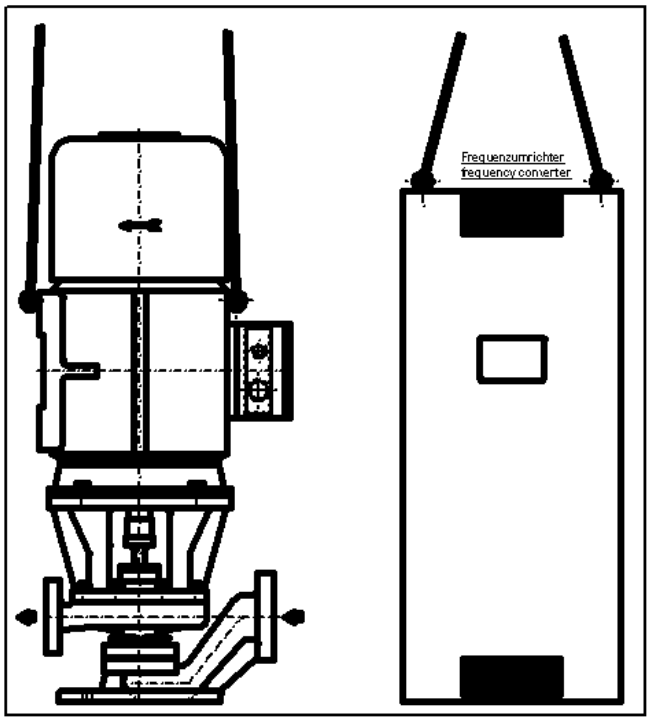
2.2 Handling

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 motor 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 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 model MSP belongs to Flowserves family of API 610 vertical inline pumps.
MSP pumps are directly coupled to a medium speed induction motor, which is driven by a VFD (Variable Frequency Drive). The pump unit is available in 5 motor sizes:

22 kW	max. 6000 rpm
37 kW	max. 6000 rpm
55 kW	max. 8000 rpm
80 kw	max. 8000 rpm
120kW	max. 8000 rpm

The hydraulics are designed for low flow at high heads and consist of:

- a semi open radial vaned impeller to guarantee optimum performance
- a circular volute with a single coned diffuser to minimize hydraulic forces

The pump unit is available in single stage or two stage opposed impeller configuration. Both versions are available with high and low flow hydraulics. For low NPSHA applications an inducer is available.

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

3.2 Nomenclature

Example:

MSP 22A-Ind ….1 stage

MSP2 22A-Ind ….2 stage

M S P	Medium Speed Pump
22/37/55/80/120	Motor power in kilowatts at maximum speed
A	Hydraulic for higher capacities
B	For lower capacities
C	For higher power

Options:

-Ind	Inducer

3.3 Design of major parts

3.3.1 Pump casing

Vertical inline design with flanged suction elbow and integrated baseplate. It is directly flanged to the motor stand, which itself is flanged to the motor. Back pull out design for easy maintenance, so the casing remains on its foundation in case of repair.

3.3.2 Hydraulics

A circular volute in combination with a single coned diffuser is inserted into the pump casing. A radial vaned semi open impeller is used to ensure optimal performance.

3.3.3 Motor

Medium speed induction motor for vertical arrangement. The bearings are grease lubricated and designed to take the pump hydraulic forces.

3.3.4 VFD

The VFD allows to operate the connected motor with variable speed. Generally we supply the converter as a completely wired unit including all contactors and fuses. A RFI (radio frequency interference) - filter is included to meet the requirements of the public electricity supplier. All necessary safety features are included, so that the unit needs only be connected to the electrical power supply.

3.3.5 Coupling

The pump is rigid coupled to the motor. So the motor bearings take all the load from the hydraulic forces. The shaft of an electric motor must be a magnetic material, so no stainless steels can be used. To overcome this material restriction the impeller is located on a separate shaft which is clamped to the motor shaft via an annular spring clamping device. Therefore also all kind of stainless steels and higher Alloy can be used for pump shaft.

The coupling has the following design data:

Max. transm. torque of coupling = 1040 Nm (767 ft-lbs]
Max. transm. axial force = 59 kN (13275 lbs)

3.3.6 Control Circuit

The control circuit control, protect and adjust the main circuit within the VFD cabinet.
Two filter-fan's (12M1, 12M2) situated in the front door obtain constantly the temperature
of the cabinet to avoid electronics damage and keep pure from dirty air in the environment.
They start normally after switched-on the main switch of the cabinet.
The PTC-thermistor's tripping device (12K1) observe the winding temperature of the main motor. When the temperature exceeds the max. allowable value the auxiliary contact (NC)

which is in line with the control circuit fuse (10F2) and the auxiliary contact of the external motor fan (13Q1) interrupt the safety loop requested by international regulations. This cause an immediately stop of the VFD itself.

For commissioning connect the PTC-thermistor's from the main terminal box of the main motor onto terminals 1X1:27/28
For your convenience the implemented insulation amplifier transform all incoming reference values into a suitable current signal for the control board (11U1). To adjust the insulation amplifier turn the screw into the right position (see wiring diagram, page 12).
The motor-starter (13Q1) includes a thermal and over-current protection to protect the external fan cooling only. The motor has to be connected onto terminals 1X1:29/30/31. It is necessary for commissioning to switch on the starter otherwise the VFD occur an external fault and it isn't possible to start the drive !
The transformer (10T1) is implemented to provide 230V~, 50Hz suitable for customer connection's.

- What to do when the filter-fan's don't run ?
  Check the Neozed fuses (10F1)
  Check the Fuse C-Characteristic (10F2)
  Check the power supply to the VFD cabinet
- Are reference values preset by the factory ?
  No, only if we had detailed data from client.
- What's wrong when the VFD tripped and it isn't possible to restart ?
  Please check refer to point 1 and measure resistance value of PTC
  Check parameter for RO1 "RUN"

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

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 with the motor. Also the shaft seal is in the correct position. 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.

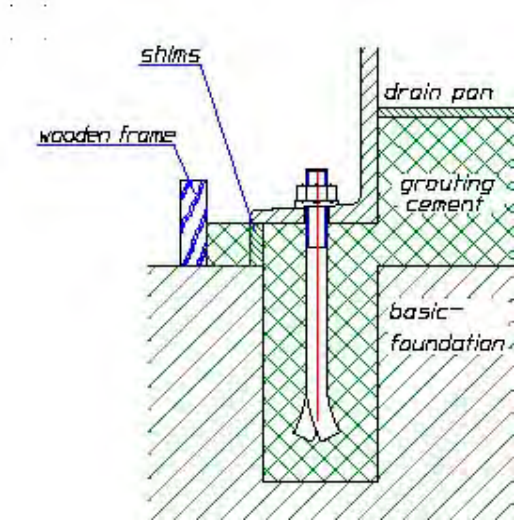
4.3.2 Steel foundation

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 Piping

4.4.1 General

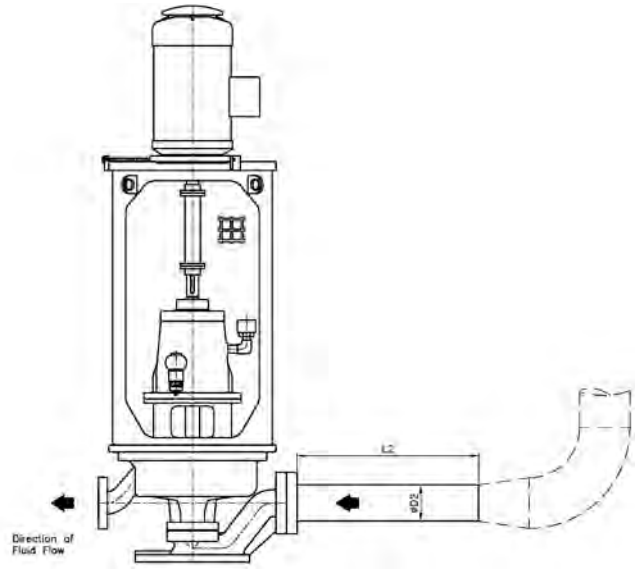
Protective covers are fitted to the pipe connections to prevent foreign particles entering during transportation and installation. Ensure that these covers are removed from the pump before connecting any pipes.
Maximum forces and moments allowed on the pump flanges vary with the pump size and type. To 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.

4.4.2 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

4.4.3 Vent

All MSP pumps are provided with a vent connection in the seal gland.

4.4.4 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.

4.5 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.

DANGER
The VFD must be wired up in accordance with the VFD manufactures instruction book (normally supplied within the front door of the electrical cabinet)

A device to provide emergency stopping must be fitted.

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

CAUTION The parameters of the VFD are preset. Check it before initial start up.

4.6 Final shaft rotation 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.

5.0 COMMISSIONING START-UP, OPERATION AND SHUTDOWN

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

5.1 Precommissioning procedure

a) The pump must be completely filled with liquid to avoid running dry and to guarantee a correct performance of the pump.
b) During filling the pump shall reach the specified temperature, so pumps for hot liquids (T > 100 °C (212 °F)) shall be warmed up by preflushing.
c) Check the sense of rotation of the pump. Sense of rotation is clockwise viewed to the drive end of the pump. Coupling shall be coupled for this test. VFD shall be set up for slow rotation (refer to VFD IOMl).
d) The pump rotor and the shaft seal must be in correct axial position. Mounting plates of mechanical seal must be locked at the seal gland in open position. Drive-collar of the mechanical seal sleeve must be tightened.
e) Check the readiness of all auxiliary systems (seal sys., lubrication sys.,...) for start up.
f) All pipe work, including the internal and the auxiliary pipe work, must be connected correctly and must be absolutely tight. Check the tightness of all connections of the auxiliary pipe work. The suction valve must be open, the discharge valve shall be closed.
g) Turn the pump by hand, if required with the help of a lever, to check the free rotation of the rotor. The rotor must turn uniformly and noiselessly. Some resistance may be felt due to friction in bearings and seals.
h) Check the readiness of the driver for start up. Refer to the manual of the driver (preheating for explosion proof E-motor).

CAUTION As MSP pump is rigidly coupled, motor solo run test shall not be performed.

5.2 Pump Lubricants

5.2.1 Lubrication

Bearings are within the motor and grease lubricated. Refer to motor manufacturer´s instruction for quantity and type of grease, regreasing, intervalls ect.

5.2.2 Lubrication Table

	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 Impeller clearance

No axial adjustment of the rotor is necessary.

5.4 Direction of rotation

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

The rotation of the driver shall be checked at minimum speed with coupled pump.

5.5 Guarding

Be sure that all guards are mounted correctly prior to start up.

5.6 Priming and auxiliary supplies

The pump must be completely primed prior to start up.

a) The pump casing must be vented via the vent connection [V] in the seal gland.
b) Auxiliary systems, e.g. barrier /buffer fluid systems, cooling circuits, shall be filled according to the user instructions.

5.7 Starting the pump

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

Note: Usually the initial start up is done by "hand". Control via the VFD panel or remote control. It is good practice to program a time ramp for soft start. (Use 10s to speed up the unit completely) After checking the sense of rotation and several operation parameters like suction and discharge pressure, speed, mechanical seal operation, temperatures, the unit can be switched to automatic mode (if a pump control system is installed).

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 5mm/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 special coupling 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.

Due to the coupling design, motor solo run test is strictly forbidden.

5.8 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 105 °C (221 °F)and is observed by an integrated PT100. If the bearing temperatures reaches 105 °C (221 °F) the VFD control gives an alarm and shuts down the unit.

CAUTION Alarm or shut down are selectable options and must be verified.

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.

5.9 Stopping and Shutdown

a) Close the outlet valve, but ensure that the pump runs in this condition for no more than a few seconds.

b) Stop the pump. It is good practice to stop the pump against a time ramp controlled by the VFD. (Use 10s to 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 5.6, 5.7, 5.8 and 5.9 are implemented in the control logic.

5.10 Hydraulic, mechanical and electrical duty

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

5.10.1 Specific gravity (SG)

Pump capacity and total head in 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.

5.10.2 Viscosity

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

5.10.3 Pump speed

Changing pump speed effects flow, total head, power absorbed, NPSH**R**, noise and vibration. Flow varies in direct proportion to pump speed. Head varies as speed ratio squared. 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.

5.10.4 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.

5.10.5 Pumped flow

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

6.0 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) Check for any leaks from gaskets and seals. The correct functioning of the shaft seal must be checked regularly.
c) Check bearing lubricant level, and if the hours run show a lubricant change is required.
d) Check that the duty condition is in the safe operating range for the pump.
e) Check vibration, noise level and surface temperature at the bearings to confirm satisfactory operation.
f) Check dirt and dust is removed from areas around close clearances, bearing housings and motors

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 MSP pump:
MSP 37A-Ind, 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.

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
Diffuser							1
Motor							1
Shaft (w/key)				1	1	2	1
Impeller				1	1	2	3
Mechanical seal complete (Cartridge)	1	2	3	1	2	3	3
Shaft sleeve and stage bushing (set) – only MSP 2	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

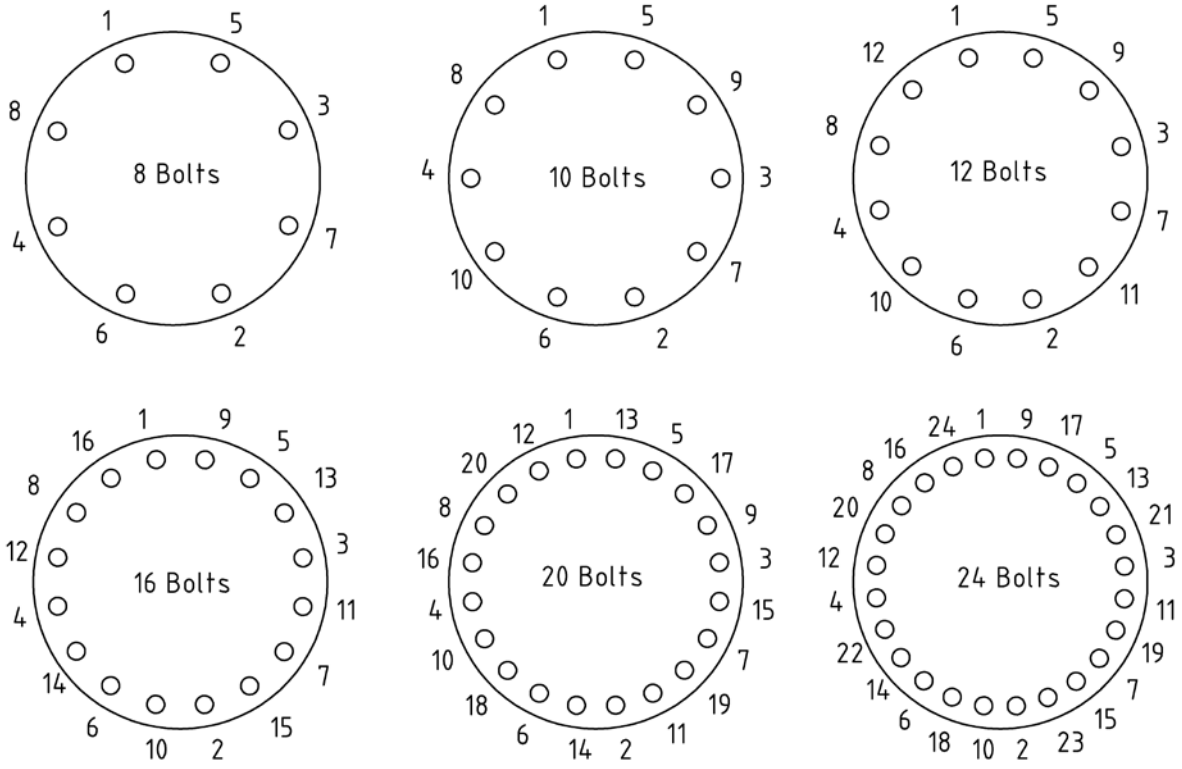
Tightening Torque M_A Nm (lbf.ft)										
	Carbon Steel									
Size of Screw	A193 B7M, A320 L7M (NACE)		A193 B7, A320 L7, 8.8		3.6		4.6		10.9	
	[Nm]	[lbf.ft]	[Nm]	[lbf.ft]	[Nm]	[lbf.ft]	[Nm]	[lbf.ft]	[Nm]	[lbf.ft]
M4	4.2	(3.1)	3	(2.2)	0.8	(0.6)	1.1	(0.8)	4.6	(3.4)
M5	8.3	(6.1)	5.9	(4.4)	1.6	(1.2)	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 Setting impeller clearance

No axial adjustment of the rotor is necessary, unless pump has been disassembled/rigid coupling opened (refer to chapter 6.9.2 point 2))

6.7 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.

6.7.1 Dismantling of pump – 1 stage

1) Completely drain the pump by using the drain connection. By pumping explosive or toxic media, flush your system with Nitrogen.
2) Disconnect the motor from the main electricity supply.
3) Secure the mechanical seal by putting the mounting plates into the groove of the shaft sleeve. Loose the clamping device, and disconnect the seal piping.

   Note: Refer to mechanical seal drawing for details.

   CAUTION Drain the seal system, if applicable.
4) Loose the hex nuts [6581.2] to disconnect the pump casing [1110] from the motor hydraulic assembly. Use hexagon head bolt [6577] to support this.
5) Pull out the motor hydraulic assembly and bring it to a workshop.
6) Unsecure lockwasher [6541] and loose impeller nut [2912] (right hand thread)

   Note: If the pump is equipped with an inducer [2215] loose inducer.
7) Pull off the impeller [2200] by using two studs screwed into the threads at the impeller shroud. Remove also key [6700].
8) Loose socket head cap screws [6579.2] and pull off the diffuser insert [1649].

   CAUTION Replace O-rings [4610.2], [4610.1] after each disassembly.
9) Loose socket head cap screws [6579.3] and pull off the casing cover [1221] together with the mechanical seal.
10) Loose hex nuts [6581.3] and pull out the mechanical seal.
11) Open the clamping ring [2542] and pull off the pump shaft [2100] with help of the jack screws.

    Note: Pump shaft [2100] shall be pulled off only if required (see chapter 6.8) to keep axial clearance of impeller.

6.7.2 Dismantling of pump – 2 stage

1) Completely drain the pump by using the drain connection. By pumping explosive or toxic media, flush your system with Nitrogen.
2) Disconnect the motor from the main electricity supply.
3) Secure the mechanical seal by putting the mounting plates into the groove of the shaft sleeve. Loose the clamping device, and disconnect the seal piping.

   Note: Refer to mechanical seal drawing for details.

   CAUTION Drain the seal system, if applicable.
4) Loose the hex nuts [6581.2] to disconnect the pump casing [1110] from the motor hydraulic assembly. Use hexagon head bolt [6577] to support this.
5) Pull out the motor hydraulic assembly and bring it to a workshop.
6) Unsecure lockwasher [6541] and loose impeller nut [2912] (right hand thread)

   Note: If the pump is equipped with an inducer [2215] loose inducer.
7) Pull off impeller [2200] by using two studs screwed into the threads at the impeller shroud.
8) Loose socket head cap screws [6579.1] pull out the interstage plate [1471]

   Note: The interstage plate [1471] consist of two parts which are pressed together and cannot be disassembled.

   CAUTION Take care of the O-rings [4610.1].
9) Pull off the bearing sleeve [3400] and the second stage impeller [2200] from the shaft [2100]. Use two studs screwed into the threads at the impeller shroud. Remove also key [6700].
10) Now you can pull off the liner [1649]. Use hexagon head bolt [6577] to support this. Loose the socket head cap screws [6579.2] and pull off the liner [1649]
11) Loose socket head cap screws [6579.3] and pull off the casing cover [1221] together with the mechanical seal.
    Loose hex nuts [6581.3] and pull out the mechanical seal.

12) Open the clamping ring [2542] and pull off the pump shaft [2100] with help of the jack screws.

Note: Pump shaft [2100] shall be pulled off only if required (see chapter 6.8) to keep axial clearance of impeller.

6.8 Examination of parts

1) Pumps with semi open impeller have no wear rings. Check the wear plate and the impeller [2200] against any wear. Semi open and free flow impellers have back vanes, which shall be checked against any wear.
2) Check all parts against corrosion and erosion.
3) Carefully check the coupling against any wear.
4) Rotate the angular contact bearing by hand, to check against abnormal sound. Check the bearing cages against any wear and the outer and inner race against running marks. Check the runout of the shafts. TIR (Total Indicated Runout) shall not exceed 0.04 mm/m (0.0005 in./ft) of length. TIR shall not exceed 0.08 mm (0.003 in.) over total shaft length.

6.9 Assembly

To assemble the pump consult the sectional drawings.

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

6.9.1 Assembly of pump – 1 stage, 2 stage

If the pump shaft [2100] has not been pulled off, use reverse disassembly procedure.

6.9.2 Assembly of the hydraulic cartridge

This procedure shall be used, if the pump shaft [2100] has been pulled off.

1) Mount the mechanical seal into the casing cover [1221]. Tight hex nuts [6581.3] of studs [6572.3].
2) Insert carefully the pump shaft [2100] into the shaft seal assembly and install the tool into the foreseen shaft nut. Move the hydraulic assembly upwards until the tool touches the pump casing cover [1221]. Now the shaft needs to be fixed in this position by locking the clamping ring [2542].
3) Put the clamping ring [2542] to the pump shaft [2100] and slide the hydraulic cartridge consisting of mechanical seal, pump shaft [2100] and casing cover [1221] to the motor shaft.
4) Fix the hydraulic cartridge with the socket head cap screws [6579.3] to the bearing lantern [3140]. Now the pump shaft [2100] has reached its correct axial position.
5) Tight the clamping unit crosswise with the required torque of 7 Nm (5.2 lbf.ft)

CAUTION The clamping surfaces must be absolutely grease free.

6) Open the socket head cap screws and remove the tool .

Note: Store the tools outside the pump for better use.

7) Insert the O-ring [4610.2] and slip on the liner [1649] to the casing cover [1221]. Tight the socket head cap screws [6579.2].
8) Put in the key [6700] and slip on the 2nd stage impeller [2200]. Now put on the liner [1649] and push in the interstage plate [1471]. Fix the interstage plate [1471] with socket head cap screws [6579.1].

CAUTION Insert O-ring [4610.1] into the interstage plate [1471].

9) Slip on the bearing sleeve [3400] and the first stage impeller [2200] and the lockwasher [6541].Tight the assembly with the impeller nut [2912] (right hand thread) and secure it with the lockwasher [6541].

Note: If the pump is equipped with an inducer [2215] replaces the shaft nut.

x. Now the complete motor hydraulic assembly can be put into the pump casing [1110]. Tight hex nuts [6581.2] of the studs [6572.2].

CAUTION Take care of the cylindrical pin [6811] to ensure correct position of the motor hydraulic assembly in the casing.

7.0 AUXILIARIES

7.1 Seal and seal systems

7.1.1 Single Mechanical Seal with API – Plan 01

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 6.7.1 *Dismantling MSP.*

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. Flushing of primary mechanical seal is performed according to API 610 flushing plan 01. Plan 01 is similar to a Plan 11 except that internal porting is used to direct flow to the seal chamber from an area behind the impeller near the discharge. The product is led internally through a bore of a small diameter (reduction of quantity) from the seal chamber to flush the primary seal.

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 11

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 6.7.1 *Dismantling MSP.*

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.

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 Single Mechanical Seal with API – Plan 23

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 6.7.1 *Dismantling MSP.*

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 desirable in many hydrocarbon and chemical services where it is necessary to cool the fluid establish the required margin between fluid vapour 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.

CAUTION For cooling flow and pressure refer to GA-drawing.

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 Dual Mechanical Seal unpressurized with API–Plan 01+52

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

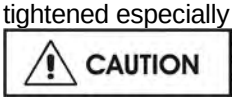
CAUTION Try to turn the rotor by hand.If the rotor cannot be turned, the pump must be

disassembled, refer to section 6.7.1 *Dismantling MSP.*

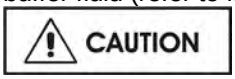
The mechanical seal requires no adjustment anymore. Check if the mounting plates are already swung out.

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.

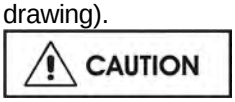
The faces of the inner mechanical seal are flushed by the product (API Plan01). In Plan 01, product is routed from the pump discharge via an internal port to the seal chamber to provide cooling for the seal and to vent air or vapors from the seal chamber. Fluid then flows from the seal cavity back into the process stream. Between the inner mechanical seal and the outer (atmospheric) mechanical seal is a liquid buffer fluid, which is unpressurized (API Plan 52). The buffer fluid is contained in a seal pot (refer to drawing of the seal pot), which is vented to a vent system, thus maintaining the buffer fluid pressure close to atmospheric.
Inner seal leakage will be product leakage into the buffer fluid. There will always be some leakage (max.5 ml/hour).
Plan 52 is used for flashing liquids, which have a vapour pressure higher then the buffer fluid pressure. So the product will flash in the seal pot and the vapour can escape to the vent system.
All screw / flange connections have to be proofed. Straight screw joints made of stainless steel have to be tightened especially carefully.



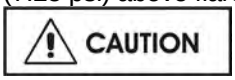
Fill the seal system with a suitable buffer fluid (refer to lubrication table).



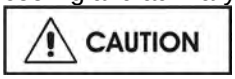
Ensure that the valve GV for the connection V is open (Barrier/buffer fluid vessel drawing).



Open the Block & Bleed valve to allow proper function of the PSH (set point 0.5 bar (7.25 psi) above flare pressure).

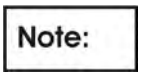


Open all necessary valves in the cooling and auxiliary piping and check the flow.



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.

7.1.5 Dual Mechanical Seal unpressurized with API–Plan 11+52



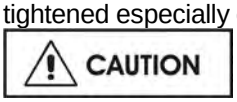
Refer to mechanical seal drawing and auxiliary piping drawing.
The pump is equipped with a dual mechanical seal. The cartridge design allows to change the mechanical seal without taking it apart.

Try to turn the rotor by hand.If the rotor cannot be turned, the pump must be disassembled, refer to section 6.7.1 *Dismantling MSP.*

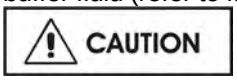
The mechanical seal requires no adjustment anymore. Check if the mounting plates are already swung out.

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.

The faces of the inner mechanical seal are flushed by the product (API Plan11). 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. Between the inner mechanical seal and the outer (atmospheric) mechanical seal is a liquid buffer fluid, which is unpressurized (API Plan 52). The buffer fluid is contained in a seal pot (refer to drawing of the seal pot), which is vented to a vent system, thus maintaining the buffer fluid pressure close to atmospheric.
Inner seal leakage will be product leakage into the buffer fluid. There will always be some leakage (max.5 ml/hour).
Plan 52 is used for flashing liquids, which have a vapour pressure higher then the buffer fluid pressure. So the product will flash in the seal pot and the vapour can escape to the vent system.
All screw / flange connections have to be proofed. Straight screw joints made of stainless steel have to be tightened especially carefully.



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



Ensure that the valve GV for the connection V is open (Barrier/buffer fluid vessel drawing).

CAUTION Open the Block & Bleed valve to allow proper function of the PSH (set point 0.5 bar (7.25 psi) above flare pressure).

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.

7.1.6 Dual Mechanical Seal pressurized with API–Plan 53a

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 6.7.1 *Dismantling MSP.*

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 53 pressurized dual seal systems are used in services where no leakage to atmosphere can be tolerated. A Plan 53a system consists of dual mechanical seals with a liquid barrier fluid between them. The barrier fluid is contained in a seal pot which is pressurized to a pressure of approximately 1.5 bar (23 psi) greater than the pump seal chamber. 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.

7.1.7 API Plan M

Note: Refer to auxiliary piping drawing.
The pump is equipped with an API plan M, cooling to seal heat exchanger.
Open all the valves in the cooling line before start up the pump.

CAUTION Check cooling flow at the installed flow indicator. If required adjust flowrate with the flow control valve.

CAUTION Refer to the GA - drawing for the required cooling flow and pressure.

7.1.8 Dual Mechanical Seal pressurized with API–Plan 32+54

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 6.7.1 *Dismantling MSP.*

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 32 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.
Plan 32 is used in services containing solids or contaminants where a suitable cleaner or cooler extern flush will improve the seal environment. It is also used to reduce flashing or air intrusion (in vacuum services) across the seal faces by providing a flush that has a lower vapor pressure or that will raise the seal chamber pressure to an acceptable level. The external flush shall be continuous and reliable even during non-standard situations such as start-up or shutdown. The external flush shall also be compatible with the process stream because it will leak from the seal chamber into the process fluid.
In Plan 32, the flushing product is brought from an external source to the seal. This plan is almost always used in conjunction with a close-clearance throat bushing as barrier to isolate the pumped product from the seal chamber.

Plan 54 pressurized dual seal systems are used in services where no leakage to atmosphere can be tolerated. A Plan 54 system consists of dual mechanical seals with a liquid barrier fluid between them. The barrier fluid is supplied from an external source, which is pressurized to a pressure of approximately 1.5 bar (23 psi) greater than the pump seal chamber. Inner seal leakage will be barrier fluid leakage into the product. There will always be some leakage (max.5 ml/hour).
The barrier fluid pressure must not be less than the sealed pressure. If it were, the failure of one inner seal could contaminate the entire barrier fluid system and cause additional seal failures.

CAUTION Carefully consider the reliability of the barrier fluid souce. If the souce is interrupted or contanuinded, the resulting seal failures are very expensive.

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

CAUTION Refer to the GA - drawing for the required flushing fluid, 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.

7.1.9 Dual Mechanical Seal unpressurized with API – Plan 01+76

Note: Refer to mechanical seal drawing and auxiliary piping drawing.

The pump is equipped with a dual 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 6.7.1 *Dismantling MSP.*

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. Flushing of primary mechanical seal is performed according to API 610 flushing plan 01.
Plan 01 is similar to a Plan 11 except that internal porting is used to direct flow to the seal chamber from an area behind the impeller near the discharge.
The product is led internally through a bore of a small diameter (reduction of quantity) from the seal chamber to flush the primary seal.

Plan 76 is suitable only for fluids, where no condensation of the inner seal leakage or from the collection system will occur.
Leakage from the inner mechanical seal is restricted from escape by the containment seal and goes out the containment seal vent. An orifice in the outlet line of the collector restricts flow such that high leakage of the inner seal will cause a pressure increase and trigger the PSH set at a gauge pressure of 0,7 bar (10 psi). The block valve in the outlet serves to isolate the system for maintenance. It may also be used to test the inner seal by closing while the pump is in operation and noting the time/pressure build up relationship in the collector. If specified, drain connection on the piping harness may be used to inject nitrogen or other gas for the purpose of testing the containment seal as well as for checking for any liquid build up.

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.

7.1.10 Dual Mechanical Seal pressurized with API–Plan 32+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 6.7.1 *Dismantling MSP.*

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. 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 32 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.

Plan 32 is used in services containing solids or contaminants where a suitable cleaner or cooler extern flush will improve the seal environment. It is also used to reduce flashing or air intrusion (in vacuum services) across the seal faces by providing a flush that has a lower vapor pressure or that will raise the seal chamber pressure to an acceptable level. The external flush shall be continuous and reliable even during non-standard situations such as start-up or shutdown. The external flush shall also be compatible with the process stream because it will leak from the seal chamber into the process fluid.
In Plan 32, the flushing product is brought from an external source to the seal. This plan is almost always used in conjunction with a close-clearance throat bushing as barrier to isolate the pumped product from the seal chamber.

CAUTION Refer to the GA - drawing for the required flushing fluid, pressure and flow.

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.

7.2 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. Loose the clamping device, and disconnect the seal piping.
   CAUTION Drain the seal system, if applicable.
3) For disassembly refer to section 6.7.1, *Dismantling of pump*.
4) For assembly refer to section 6.9.1, *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
					●		●	●		Wearing 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
			●	●	●					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	m^2 cm^2	10.764 0.155	square feet square inch	ft^2 $in.^2$
Capacity or Flow rate	Cubic meter/hour	m^3/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	$kg.m^2$	23.73	pounds square feet	$lb.ft^2$
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/mm^2	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	m^3 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

OUR ADDRESS

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Mail: flowserve-brunn@flowserve.com

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

Telefon: +43 2236 31530
Fax: +43 2236 33430
E.mail: flowserve-brunn@flowserve.com

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