Pump Division

Type: FRBHJC
VERTICAL CANTILEVER CENTRIFUGAL PUMPS

USER INSTRUCTIONS:
INSTALLATION, OPERATION, MAINTENANCE

PCN=71569179 11-04

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

CONTENTS

PAGE

INDEX

1 INTRODUCTION AND SAFETY

1.1 General

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

Flowserve'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.

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

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

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

1.2 CE marking and approvals

It is a legal requirement that machinery and equipment put into service within certain regions of the world shall conform with the applicable CE Marking Directives covering Machinery and, where applicable, Low Voltage Equipment, Electromagnetic Compatibility (EMC), Pressure Equipment Directive (PED) and Equipment for Potentially Explosive Atmospheres (ATEX).

Where applicable, the Directives and any additional Approvals, cover important safety aspects relating to machinery and equipment and the satisfactory provision of technical documents and safety instructions. Where applicable this document incorporates information relevant to these Directives. To establish approvals and if the product itself is CE marked, check the serial number plate and the Certification. (See section 9, *Certification*.)

1.3 Disclaimer

Information in these User Instructions is believed to be reliable. In spite of all the efforts of Flowserve 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 you/the user seek our written agreement before start up.

1.6 Safety

1.6.1 Summary of safety markings

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

DANGER This symbol indicates electrical safety instructions where non-compliance would affect personal safety.

This symbol indicates safety instructions where non-compliance would affect personal safety.

This symbol indicates safety instructions where non-compliance would affect protection of a safe life environment.

CAUTION This symbol indicates safety instructions where non-compliance would affect the safe operation or protection of the pump or pump unit.

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

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

1.6.2 Personnel qualification and training

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

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

1.6.3 Safety action

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

CAUTION PREVENT EXCESSIVE EXTERNAL PIPE LOAD

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

CAUTION ENSURE CORRECT LUBRICATION

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

CAUTION START THE PUMP WITH OUTLET VALVE PART OPENED

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

This is recommended to minimize the risk of overloading and damaging the pump motor at full or zero flow. Pumps may be started with the valve further open only on installations where this situation cannot occur. The pump outlet control valve may need to be adjusted to comply with the duty following the run-up process. (See section 5, *Commissioning start-up, operation and shutdown*.)

CAUTION NEVER RUN THE PUMP DRY

CAUTION INLET VALVES TO BE FULLY OPEN WHEN PUMP IS RUNNING

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

DANGER NEVER DO MAINTENANCE WORK WHEN 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 siting of the pump, limiting personnel access and by operator training. If the liquid is flammable and/or explosive, strict safety procedures must be applied.

Gland packing must not be used when pumping hazardous liquids.

DRAIN THE PUMP AND ISOLATE PIPEWORK BEFORE DISMANTLING THE PUMP

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

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

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

GUARDS MUST NOT BE REMOVED WHILE THE 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 and persons entering the immediate area action must be taken to avoid accidental contact. If complete protection is not possible, the machine access must be limited to maintenance staff only, with clear visual warnings and indicators to those entering the immediate area. Note: bearing housings must not be insulated and drive motors and bearings may be hot.

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

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

1.6.4.2 Marking

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

II 2 GD c IIC 135 ºC (T4)

Equipment Group
I = Mining
II = Non-mining

Category
2 or M2 = High level protection
3 = normal level of protection

Gas and/or Dust
G = Gas; D= Dust

c = Constructional safety
(in accordance with En13463-5)

Gas Group (*Equipment Category 2 only*)
IIA – Propane (typical)
IIB – Ethylene (typical)
IIC – Hydrogen (typical)

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

1.6.4.3 Avoiding excessive surface temperatures

ENSURE THE EQUIPMENT TEMPERATURE CLASS IS SUITABLE FOR THE HAZARD ZONE

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

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

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

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

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

Temperature classification "Tx" is used when the liquid temperature varies and 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.

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

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

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

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

1.6.4.4 Preventing the build up of explosive mixtures

ENSURE 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 for Category 2.

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 avoid the hazard

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

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

To avoid potential explosion hazards during maintenance, the tools, cleaning and painting materials used must not give rise to sparking or adversely affect the ambient conditions. Where there is a risk from such tools or materials, maintenance must be conducted in a safe area.

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

1.7 Nameplate and warning labels

1.7.1 Nameplate

For details of nameplate, see the *Declaration of Conformity*.

1.7.2 Warning labels

WARNING
BEFORE STARTING THE PUMP ON SERVICE, CHECK TO ENSURE CORRECT ROTATION OF MOTOR. FAILURE TO DO THIS COULD RESULT IN SERIOUS DAMAGE TO THE EQUIPMENT.

ROTATION WARNING
P/N 2113932-001

WARNING
BEFORE GROUTING, REALIGN THIS UNIT. RECHECK ALIGNMENT BEFORE STARTING, FAILURE TO DO THIS COULD RESULT IN SERIOUS DAMAGE TO THE EQUIPMENT. REFER TO INSTALLATION MANUAL AND, OR COUPLING INSTRUCTIONS FOR METHOD OF CHECKING ALIGNMENT.

GROUT WARNING
P/N 2113934-001

1.8 Specific machine performance

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

1.9 Noise level

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

Pump noise level is dependent on a number of factors - the type of motor fitted, the operating capacity, pipework design and acoustic characteristics of the building. The levels specified in the table below are estimated and not guaranteed.

The dBA values are based on the noisiest ungeared electric motors that are likely to be encountered. They are Sound Pressure levels at 1 m (3.3 ft) from the directly driven pump, for "free field over a reflecting plane". For Estimating Lwa sound power level (re 1pW) add 14Dba to the sound pressure value.

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

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

FRBH pump size	Sound Pressure dBA @ 1 m (3 ft)	Sound Power dBA	Pump speed -rpm
2 FRBH-121	75	89	1780
3 FRBH-121	75	89	1780
3 FRBH-101	75	89	1780
3 FRBH-141	77	91	1780
4 FRBH-111	77	91	1780
4 FRBH-141	78	92	1780
6 FRBH-111	80	93	1780
6 FRBH-142	81	95	1780
8 FRBH-182	83	98	1180
8 FRBH-152	85	99	1780
10 FRBH-182	85	99	1180
6FRBH-183	85	100	1780
8FRBH-183	86	101	1780

2 TRANSPORT AND STORAGE

2.1 Consignment receipt and unpacking

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

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

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

2.2 Handling

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

The pump should be lifted with suitably sized and located slings. Do not use the shaft for lifting and take special care to prevent the pump from rotating in the slings due to unbalanced weight distribution.

2.3 Lifting

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

2.4 Storage

2.2.1 ⚠ CAUTION Short-Term Storage

When it is necessary to store a pump for a short time before it can be installed, place it in a dry, cool location. Protect it thoroughly from moisture and condensation. Protective flange covers should not be removed until the pump is being installed.

Wrap the exposed portions of the shaft and coupling to protect against sand, grit or other foreign matter. Oil lubricated units should be lubricated (refer to Section III) to protect the bearings. Grease lubricated units are lubricated at the factory during assembly. Turn the rotor over by hand at least once a week to maintain a protective film on the bearing components.

2.4.2 LONG-TERM STORAGE

More than precautions are required if long-term storage in excess of 90 days from factory shipment is unavoidable.

The internal surfaces of the pump should be sprayed with a rust preventative such as a water soluble oil or other suitable alternative. Particular attention should be given to the impeller, wear plate and stuffing box.

An optional method of protection is to suspend bags of desiccant material inside casing and completely seal all openings from the surrounding atmosphere. The stuffing box should be packed with clean. dry rags. Use of this method requires that the casing be initially free of liquid. The desiccant material should be checked at regular intervals to ensure that it has not absorbed excessive water vapour. A warning instruction, advising that the desiccant must be removed prior to installation should be wired to the pump.

A rust inhibitor should be added to the lubricating oil of oil lubricated units to give additional protection without destroying the lubricating properties of the oil. For specific recommendations, consult your lubrication dealer. Grease lubricated units, which can be identified by the grease fitting at each bearing location, should be well lubricated prior to placing in storage. Small amounts of additional grease should be added at regular intervals during storage. Refer to Section III for additional information related to grease lubrication.

Storage of pumps in areas of high ambient vibration should be avoided to prevent bearing damage due to brinelling. The risk of such damage can be reduced by frequent rotation of the shaft.

The pump half coupling and key should be removed from the shaft, coated with rust preventative and wrapped to prevent metal-to-metal contact. Exposed surfaces of the pump shaft should be protected with a rust preventative. All dismantled parts should be wrapped and tagged according to pump serial number and a record kept of their location.

⚠ CAUTION **Pumps covered with plastic should not be stored in a cool environment because resulting condensation can cause rusting**.

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 in accordance with local regulations. If the product contains substances that are harmful to the environment, these should be removed and disposed of in accordance with current local regulations. This also includes the liquids and/or gases that may be used in the "seal system" or other utilities.

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

3 PUMP DESCRIPTION

3.1 Configurations

Flowserve "FRBH" pumps are single stage, end suction centrifugal pumps specifically designed for the pulp and paper industry and consequently are ideally suited to many process fluids. A volute type casing with integrally cast feet and top centerline discharge nozzle is standard. The semi-open impeller with rear pump-out vanes is capable of passing pulpy material and solids of a limited size. A rigid steel sump cover plate supports the pump and drive system. The three point thrust bearing housing support permits precision bearing alignment and impeller clearance setting.

The pump liquid end is fitted with a non-flush restriction bushing that also acts as a bearing for start-up conditions.

All pumps are carefully inspected and prepared for shipment. All exterior machined surfaces are coated with a rust preventative compound and openings are provided with covers or plugs. The axial impeller running clearance is preset at the factory but should be checked prior to final alignment in case of tampering.

3.2 Name nomenclature

The pump size will be engraved on the nameplate. The following example explains how the pump name identifies the construction features and options.

8FRBH-182

Nominal discharge branch size.

Configuration – see below.

Nominal maximum impeller diameter.

Frame size

JC is added for vertical cantilever

3.3 Design of major parts

3.3.1 Pump casing

The pump casing is a volute type casing with integrally cast feet (for horizontal configuration) and centerline discharge nozzle. It is a one piece pressure retaining casting with gasket connections to the stuffing box head and the suction and discharge flanges.

3.3.2 Impeller

The impeller is semi-open design, keyed to the shaft and secured with a contoured impeller nut.

3.3.3 Shaft

The large diameter stiff shaft, mounted on bearings, has a keyed drive end.

3.3.4 Pump bearings and lubrication

Ball bearings are fitted as standard and grease lubricated. The inboard bearing located just above the top plate is pregreased and is sealed for life. Greasing if necessary will only be required for the lip seal that seals the bearing housing. The outboard bearing cover has a grease fitting accessible through the motorstand.

3.3.5 Stuffing box housing

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

3.3.6 Driver
The driver is normally an electric motor driving via couplings, belts, gearboxes, drive shafts etc.

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

3.4 Performance and operating limits
This product has been selected to meet the specifications of your purchase order see section 1.5. The following data is included as additional information to help with your installation. It is typical, and factors such as temperature, materials, and seal type may influence this data. If required, a definitive statement for your particular application can be obtained from Flowserve.

3.4.1 Operating limits

Pumped liquid temperature limits	up to+177 ºC (350 ºF)
Maximum ambient temperature	up to +50 ºC (122 ºF)
Maximum soft solids in suspension	up to 7 % by volume
Maximum pump speed	Refer to the nameplate

3.4.2 Speed torque curves
To bring a centrifugal pump up to rated speed, the driver must be capable of providing more torque at each speed than required by the pump. The margin between the available and required torque affects the time it takes the unit to reach full speed. If the torque required by the pump exceeds the torque capability of the drive at any run-up speed, the unit will not accelerate to full speed. Normally, this is not a problem with standard induction or synchronous motors provided the proper voltage is supplied at the motor.

For pumps started at shut valve conditions, 100 percent full speed torque can be calculated by using the formula:

$$\text{Torque (Nm)} = 9545 \frac{\text{Shutoff Power (kW)}}{\text{r/min}}$$

$$\text{Torque (lbfx ft)} = 5250 \frac{\text{Shutoff Power (hp)}}{\text{r/min}}$$

Torque required by the pump at any other speed during start-up can be determined from the curve above. Note that the driver manufacturer usually bases 100 percent torque on the design power of the driver and consequently the speed-torque curves should be plotted in torque units (e.g. Nm) instead of percentage torque to avoid confusion.

3.4.3 MAXIMUM WORKING PRESSURES -bar (psi).

CONSTRUCTION	CAST IRON AND C.I.S.S. FITTED			STAINLESS STEEL 316,317L, WORTHITE, ETC.	
TEMPERATURE ^{O}C (^{O}F)	UP TO 12” DISCHARGE	14 TO 16” DISCHARGE	18 TO 20” DISCHARGE	UP TO 16” DISCHARGE	18 TO 20” DISCHARGE
-30 to 38 (-20 to100)	10.3 (150)	10.3 (150)	6.2 (90)	13.8 (200)	8.3 (120)
65 (150)	10.3 (150)	9.7 (140)	6.2 (90)	13.8 (200)	8.3 (120)
95 (200)	10.3 (150)	9.3 (135)	6.2 (90)	13.4 (195)	8.3 (120)
120 (250)	10.3 (150)	9.0 (130)	6.2 (90)	12.6 (185)	8.3 (120)
150 (300)	**CONSULT FACTORY FOR APPLICATIONS IN THIS RANGE. CASTIRON NOT RECOMMENDED DUE TO THERMAL SHOCK RISKS.**			12.1 (175)	8.3 (120)
175 (350)				11.0 (160)	7.6 (110)

TABLE OF ENGINEERING DATA

(FRAMES 1 & 2 - LIQUID END)

ENGINEERING DATA	2FRBH-121	3FRBH-121	3FRBH-101	4FRBH-111	6FRBH-111	3FRBH-141	4FRBH-141	6FRBH-142	8FRBH-152	3FRBH-182	4FRBH-182	8FRBH-182	10FRBH-182
PUMP DATA													
SUCTION DIA. mm (in.)	76 (3)	102 (4)	152 (6)	152 (6)	203 (8)	152 (6)	152 (6)	203 (8)	254 (10)	152 (6)	203 (8)	153 (10)	305 (12)
DISCHARGE DIA. mm (in.)	51 (2)	76 (3)	76 (3)	102 (4)	152 (6)	76 (3)	102 (4)	152 (6)	203 (8)	76 (3)	102 (4)	203 (8)	153 (10)
CASING THICKNESS mm (in.) C.I.	11.2 (.44)	11.2 (.44)	11.2 (.44)	11.2 (.44)	11.2 (.44)	11.2 (.44)	11.2 (.44)	17.5 (.69)	17.5 (.69)	16 (.63)	16 (.63)	20.8 (.82)	20.8 (.82)
CASING THICKNESS mm (in.) S.S.	9.7 (.38)	9.7 (.38)	9.7 (.38)	9.7 (.38)	9.7 (.38)	9.7 (.38)	9.7 (.38)	14.2 (.56)	16 (.63)	12.7 (.50)	12.7 (.50)	16 (.63)	17.5 (.69)
CASING TYPE	SV - SINGLE VOLUTE								DV	SV		DV	
GAUGE CONNECTION	1 / 4 NPT							1 / 2 NPT					
DRAIN CONNECTION	3 / 8 NPT		1 / 2 NPT							3 / 4 NPT			1" NPT
NO. OF VANES	4												
IMP. EYE AREA cm^2 ($in.^2$)	34 (5.2)	61 (9.5)	93 (14.4)	137 (21.3)	214 (33.2)	127 (19.7)	182 (28.2)	247 (38.3)	361 (56)	183 (28.3)	200 (31.0)	359 (55.6)	555 (86.0)
MAX. SPHERE DIA. mm (in.)	12.7 (.5)	17.8 (.7)	25.4 (1.0)	30.5 (1.2)	43.2 (1.7)	25.4 (1.0)	35.6 (1.4)	38.1 (1.5)	55.9 (2.2)	19.1 (.75)	27.9 (1.1)	55.9 (2.2)	68.6 (2.7)
WK^2 kg x m^2 (lb x ft^2)	.07 (1.7)	.08 (1.9)	.07 (1.6)	.08 (1.9)	.12 (2.8)	.19 (4.6)	.27 (6.5)	.34 (8.2)	.48 (11.5)	.51 (12.0)	.53 (12.5)	.88 (20.8)	1.19 (28.2)
*PUMP WEIGHT kg (lb.)													
IMPELLER AXIAL CLEARANCE mm (in.)	.38 - .76 (.015 - .030)							.38 - .76 (.015 - .030)					
MAXIMUM TEMPERATURE	121°C (250°F)							121°C (250°F)					
MAX. HYDRO PRESSURE C.I.	12.1 bar (175 psi)							15.5 bar (225 psi)					
MAX. HYDRO PRESSURE S.S.	20.7 bar (300 psi)							20.7 bar (300 psi)					
STUFFING BOX DATA													
O.D. SLEEVE mm (in.)	50.80 (2.000)							76.20 (3.000)					
STUFF. BOX BORE mm (in.)	69.85 (2.750)							101.60 (4.000)					
DEPTH OF BOX mm (in.)	77.5 (3.05)							99.1 (3.90)					

TABLE OF ENGINEERING DATA
(FRAMES 1 & 2 - FRAME DETAILS)

ENGINEERING DATA	2FRBH-121	3FRBH-121	3FRBH-101	4FRBH-111	6FRBH-111	3FRBH-141	4FRBH-141	6FRBH-142	8FRBH-152	3FRBH-182	4FRBH-182	8FRBH-182	10FRBH-182
SHAFT AND BEARING DATA													
DIA. AT IMPELLER mm (in.)	28.58 (1.125)		34.93 (1.375)					50.80 (2.000)					
DIA. UNDER SLEEVE mm (in.)	41.27 (1.625)							66.68 (2.625)					
DIA. BETWEEN BEARINGS mm (in.)	104.65 (4.12)												
DIA. AT COUPLING mm (in.)	63.50 (2.500)												
LINE BEARING	6321 2RS1 C3												
THRUST BEARING	7318 BECBY												
BEARING SPAN mm (in.)	691 (27.2)												
B10 BEARING LIFE	MINIMUM 3 YEARS												
BEARING SEALS													
THRUST BEARING LIP SEAL (1)	NATIONAL 417191												
LINE BEARING LIP SEAL (1)	C / R 49929							NATIONAL 417511					

(1) LIP SEAL MAY BE REPLACED BY APPROPRIATE LABRYNTH SEALS

TABLE OF ENGINEERING DATA
(FRAME 3 - LIQUID END)

ENGINEERING DATA		6FRBH-183	12FRBH-183	14FRBH-183	16FRBH-183	6FRBH-223	8FRBH-223	18FRBH-223						
PUMP DATA														
SUCTION DIAMETER	mm (in.)	254 (10)	356 (14)	356 (14)	406 (16)	254 (10)	305 (12)	457 (18)						
DISCHARGE DIA	mm (in.)	152 (6)	305 (12)	356 (14)	406 (16)	152 (6)	203 (8)	457 (18)						
CASING THICKNESS	C.I. mm (in.)	17.5 (.69)	19.0 (.75)	20.8 (.82)	20.8 (.82)	19.0 (.75)	20.8 (.82)	17.3 (.68)						
	S.S. mm (in.)	14.2 (.56)	15.7 (.62)	17.5 (.69)	17.5 (.69)	16.0 (.63)	17.5 (.69)	14.2 (.56)						
CASING TYPE		SV	DV			SV		DV - DUAL VOLUTE						
GAUGE CONNECTION		1 / 2 NPT												
DRAIN CONNECTION		1 NPT	1 - 1 / 4 NPT			1 NPT		1.5						
NO. OF VANES		4		6	5	4		5						
IMPELLER EYE AREA	cm^2 ($in.^2$)	292 (45.2)	755 (117)	839 (130)	1090 (169)	352 (54.4)	564 (87.4)	1510 (234)						
MAX. SPHERE DIA.	mm (in.)	48.3 (1.9)	96.5 (3.8)	40.6(1.6)	40.6 (1.6)	50.8 (2.0)	61 (2.4)	61 (2.4)						
WK^2	kg x m^2 (lb x ft^2)	.83 (19.8)	.93 (22.0)	1.57 (37.2)	1.39 (33.0)	1.64 (38.8)	1.88 (44.5)	3.91 (92.9)						
PUMP WT.	kg (lb.)													
IMPELLER AXIAL CLEARANCE	mm (in.)	.38 - .76 (.015 - .030)												
MAXIMUM TEMPERATURE		121°C (250°F)												
STUFFING BOX DATA														
O.D. SLEEVE	mm (in.)	95.25 (3.750)												
STUFFING BOX BORE	mm (in.)	127.00 (5.000)												
DEPTH OF BOX	mm (in.)	122.2 (4.81)												

TABLE OF ENGINEERING DATA
(FRAMES 3 & 4 - FRAME DETAILS)

ENGINEERING DATA	6FRBH-183	12FRBH-183	14FRBH-183	16FRBH-183	6FRBH-223	8FRBH-223	18FRBH-223						
SHAFT AND BEARING DATA													
DIA. AT IMPELLER mm (in.)	69.85 (2.750)												
DIA. UNDER SLEEVE mm (in.)	82.55 (3.250)												
DIA. BETWEEN BEARINGS mm (in.)	104.65 (4.12)												
DIA. AT COUPLING mm (in.)	63.50 (2.500)												
LINE BEARING	6321 2RS1 C3												
THRUST BEARING	7318 BECBY												
BEARING SPAN mm (in.)	952.5 (37.5)												
B10 BEARING LIFE	MINIMUM 3 YEARS												
BEARING SEALS													
THRUST BEARING LIP SEAL	NATIONAL 417191												
LINE BEARING LIP SEAL	NATIONAL 417511												

MATERIALS OF CONSTRUCTION
(LIQUID END)

BASIC CONSTRUCTION	ALL IRON AIF	ALL 316 SS (SS)	IRON CASING SS FITTED (SSF)	317 SS	317L SS	WORTHITE W
CASING,LOWER HOUSING AND WEAR PLATE	ASTM A48 CL35	ASTM A743 CF8M	ASTM A48 CL35	ASTM A743 CG8M	ASTM A743 CG3M	ASTM A743 CN7MS
IMPELLER	ASTM A48 CL30	ASTM A743 CF8M	ASTM A743 CF8M	ASTM A743 CG8M	ASTM A743 CG3M	ASTM A743 CN7MS
IMPELLER NUT	ASTM A743 CG3M	ASTM A743 CG3M	ASTM A743 CG3M	ASTM A743 CG3M	ASTM A743 CG3M	ASTM A743 CN7M
SHAFT SLEEVE	ASTM A743 CG3M *	ASTM A743 CG3M *	ASTM A743 CG3M *	ASTM A743 CG3M *	ASTM A743 CG8M *	ASTM A743 CN7M
SHAFT	AISI 1045	AISI 316	AISI 1045	AISI 317L	AISI 317L	AISI A20
PIPE PLUGS (LIQUID END)	C.I.	AISI 316	C.I.	A-20	A-20	A-20
IMPELLER KEY	AISI 1045	AISI 316	AISI 1045	A-20	A-20	A-20
WEAR PLATE STUDS & NUTS	AISI 316			A-20		
GASKETS	SYNTHETIC FIBRE					
O-RINGS (LIQUID END)	BUNA-N (120^{o} C MAX.)**					
MISC. FASTNERS, PARTS	STEEL					

*   Nickel-Chrome-Boron Coated, except for units with mechanical seals.
** Viton will be used for all applications operating above 120^{o}C.

4 INSTALLATION

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

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. Allow sufficient room to facilitate the back pull-out feature on V-belt driven units.

Refer to the general arrangement drawing for the pump set.

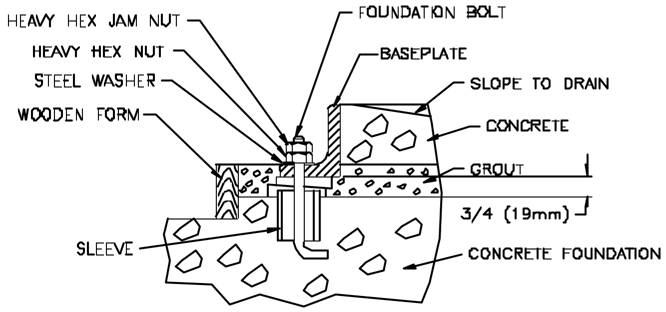
4.2 Part assemblies

Motors may be supplied loose on FRBH pumps, typically on frame sizes 400 and above. It is the responsibility of the installer to ensure that the motor is assembled to the pump and lined up as detailed in section 4.5.2.

4.3 Foundation

CAUTION The foundation may consist of any material that will afford permanent, rigid support to the full area of the pump or driver supporting member. It should be of sufficient size and mass to absorb expected strains and shocks that may be encountered in service. Concrete foundations built on solid ground are desirable.

The purpose of foundation bolts is to anchor the pump unit securely to the foundation such that the foundation and pump assembly become a single structural unit. High strength steel foundation bolts (SAE Gr. 5 or equal) of the specified diameter should be located according to the elevation drawing provided. Each bolt should be surrounded by a pipe sleeve two or three times the diameter of the bolt.The sleeves should be securely anchored and designed to allow the bolts to be moved to conform with the holes in the baseplate. The bolts should be sufficiently long to allow for wedges or shims or levelling nuts under the baseplate, and a washer, heavy hex nut and hex jam nut for retention. Since baseplate levelling is performed after the foundation has cured, it is best to use extra long bolts that can be shortened after the installation is complete.



4.4 Baseplate installation

Position the baseplate and pump next to the foundation and clean the foundation surface thoroughly. Remove the rag packing from the pipe sleeves and place wedges or ships as close to the foundation bolts as possible. These may be omitted if a jacking nut on the foundation anchor bolts is preferred for levelling. Initial levelling should be within 0.75 mm (.030 inches).

Remove the flange covers and check inside the pump nozzles for cleanliness. Kerosene is recommended as the best solvent for removing factory applied rust preventative. Ensure that all traces of rust preventative are removed from the discharge and suction flange faces, the exposed shafting and all coupling surfaces. Flush the pump internals of any rust preventative applied for long-term storage.

Lift the baseplate assembly, remove the shipping skids and clean the underside of the baseplate. Position the baseplate over the foundation and lower the unit over the foundation bolts and onto the wedges, shims or jacking nuts.

With the aid of a machinist's level, adjust the wedges, shims or jacking nuts to level the pump and driver mounting pads in each direction. Check to ensure that the suction and discharge flanges are plumb, level, and at the correct elevation. It is normal practice to set the mounting pads slightly low in order to permit lowering of units which may be required to suit future piping or minor changes. Place washers over the foundation bolts and install nuts. Tighten finger tight only.

Check the impeller axial clearance and that the rotor turns freely by hand.

Note: Grout is not poured until an initial alignment of the pump and driver has been performed.

4.5 Initial alignment

4.5.1 Thermal expansion

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

4.5.2 Alignment methods

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

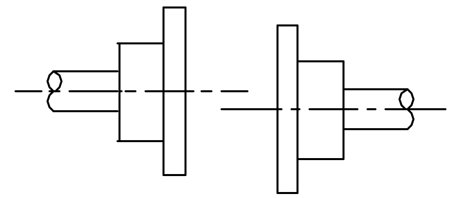
CAUTION The alignment MUST be checked. Although the pump will have been aligned at the factory it is most likely that this alignment will have been disturbed during transportation or handling. If necessary, align the motor to the pump, not the pump to the motor.

Direct Driven Units:
The importance of accurate alignment of pump and driver shafts cannot be overemphasized. IMPROPER ALIGNMENT IS THE PRIMARY CAUSE OF VIBRATION PROBLEMS AND REDUCED BEARING LIFE.

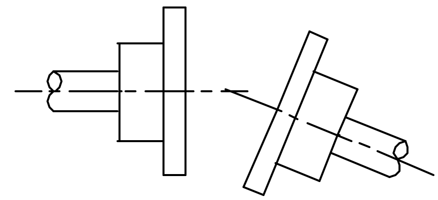
A flexible coupling is used to compensate for slight changes in alignment which occur during normal operation and is not used to correct for installation errors. Install the pump and driver half couplings in accordance with the coupling manufacturer's instructions. Note that the coupling hub faces are not always mounted flush with the ends of the shafts. Place the driver on the baseplate such that the correct spacing is obtained between the two half couplings. In the case of electric motors, such as those with sleeve bearings, it may be necessary to run the motor to establish the rotor magnetic center. Consult the manufacturer's instruction manual for details.

The purpose of the alignment procedure is to ensure that the pump and driver shafts are in parallel and angular alignment under the normal operating conditions of load and temperature. (See Fig. 2)

When the pump coupling and driver are assembled at the factory, the units are aligned prior to shipment. However, baseplates can be sprung or distorted during shipment or installation and the alignment must be checked before the unit is put in service. The coupling spacer must be removed to make this check.



PARALLEL MISALIGNMENT– Shafts with axis parallel but not concentric

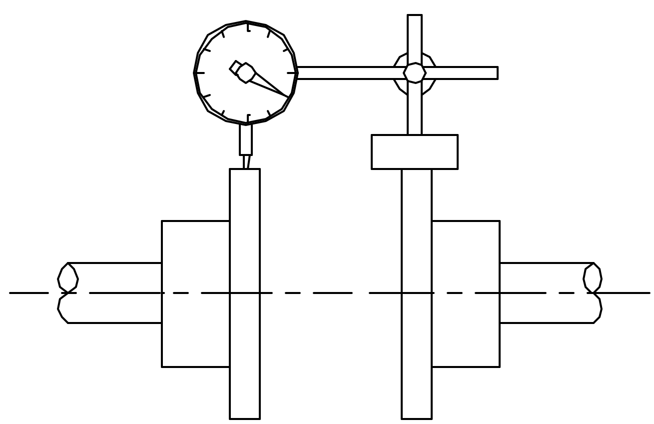


ANGULAR MISSALIGNMENT – Shafts with axis concentric but not parallel.

For pumps and drivers which operate at different temperatures compensation must be made at the initial alignment stage (when the units are at the same temperature) to allow for thermal expansion during operation. Consult the instruction manual supplied with the driver for the manufacturer's recommendations.

Shaft alignment is greatly simplified by the use of a dial indicator, or with extension rods and a magnetic base. Before taking readings, ensure that the pump and driver mounting bolts are secure, and that the thrust bearing housing is properly aligned in the bearing frame or cartridge. (See Section VII- Maintenance).

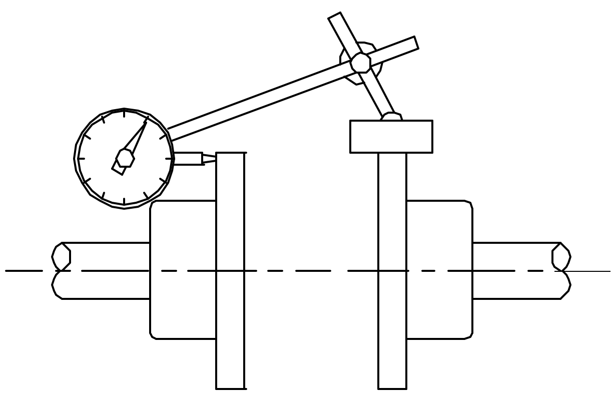
Parallel Alignment:



CHECKING PARALLEL MISALIGNMENT

Mount the magnetic base on the pump half coupling hub and place the dial indicator button on the outside diameter of the driver half coupling hub. Note that the length of extension rods should be kept at a minimum to reduce deflection. Rotate the pump shaft and record the dial reading at the top, bottom and each side. Correct the parallel alignment by adding or removing shims under the driver and/or moving the driver horizontally. Repeat this procedure until the maximum total indicator reading (T.I.R.) is within 0.076 mm (0.003 inch.)

Angular Alignment:
With the magnetic base mounted on the pump half coupling hub, move the dial indicator button to indicate on the face of the driver half coupling hub as close to the outside diameter as possible. Turn both shafts 360° and record the dial readings at 90° intervals. Adjust the shims under the motor as required and repeat the procedure until the angular alignment is within 0.0005 mm (T.I.R.) per mm (0.0005 inch per inch) of maximum hub diameter.



CHECKING ANGULAR MISALIGNMENT

Repeat the checks on parallel and angular alignment, ensuring the mounting bolts are secure, until the unit is properly aligned. Note that correction in one direction may affect the alignment in another direction. Re-check the gap between the coupling hubs.

If any difficulty is encountered in achieving the recommended alignment tolerances, the runout of the pump and driver shafts and each coupling hub diameter and face should be checked. Occasionally, due to practical and unavoidable manufacturing tolerance build-up associate with the pump, coupling and driver, it may be necessary to match up the two coupling hubs in the most advantageous relative angular position in order to achieve an acceptable alignment.

Do not install the coupling spacer or sleeve until grouting is complete and cured and the alignment is re-checked.

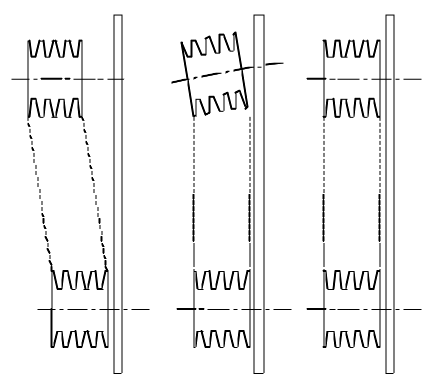
When the electric motor has sleeve bearings it is necessary to ensure that the motor is aligned to run on its magnetic centreline. A button (screwed into one of the shaft ends) is normally fitted between the motor and pump shaft ends to fix the axial position.

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

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

V-Belt Drive Units:

Check that both sheaves are free of grease, rust, nicks or burrs. Install the correct size sheave on the pump shaft and locate the sheave axially to minimize overhang. Re-check the impeller axial clearance and ensure that the pump is properly secured to the baseplate. Install the driver on the adjustable base provided and install the driver sheave in line with the pump sheave. Ensure that the sheaves are tight on the shafts. With a dial indicator, check the run-out on the periphery and face of each sheave to ensure that each is running true. Tighten the adjustable base and check that the driver rotation in the correct direction and that vibration levels are not unacceptable.



CHECKING V-BELT SHEAVE ALIGNMENT

Checking V-Belt Sheave Alignment

CAUTION Before starting the driver, refer to the manufacturer's instruction manual. The correct rotation of the pump shaft is marked on the pump casing or frame.

Check that all belts making up one drive set have matched code numbers. Loosen the adjustable base and install the belts in their proper grooves. Adjust the center distance between the sheaves to obtain proper belt tension. Check the alignment of the pump and driver sheaves with a taught string or straight edge. For proper alignment and the sheave faces must be parallel to each other and in line. Adjustments are made by slackening the belts, moving and retightening the drive or driver sheave, and repeating the above procedure.

When the sheaves are aligned that the shafts rotate freely by hand and install safety guard.

4.6 Grouting

The purpose of grouting is to provide rigid support to the pump and driver by increasing the structural rigidity of the baseplate and making it an integral mass with the foundation.

Clean the roughed foundation surface and build a wooden form around the baseplate (see Fig. 1). For initial grouting forms should be placed to isolate shims and levelling nuts. The foundation surface should be thoroughly saturated with water before grouting. A typical mixture for grouting-in a pump base is composed of one part pure Portland cement and two parts of clean building sand with sufficient water to provide the proper consistency. The grout should flow freely but not be so wet as to cause the sand and cement to separate.

Thoroughly puddle the grout while pouring to eliminate air pockets and low spots. Pour sufficient grouting to ensure that the bottom surface of the baseplate is completely submerged. Do not fill isolated areas around the shims or levelling nuts. Once the grout has set sufficiently, remove the wooden forms and finish off the sides and top as desired. At the same time, roughen the grout surface inside the baseplate. Cover with wet burlap and allow the grout to cure for at least 40 hours.

After grouting has cured, shims and levelling nuts should be removed or backed off. Tighten down baseplate to the new grout to put bolts in tension and ensure rigidity of structure. Install jam nuts and cut the bolts to the desired length. Finish grouting isolated areas. Fill the baseplate including pump and driver support pedestals with concrete. Trowel and slope the surface to give suitable drainage.

4.7 Piping

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

4.7.1 Suction and discharge pipework

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

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

CAUTION Never use the pump as a support for piping.

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

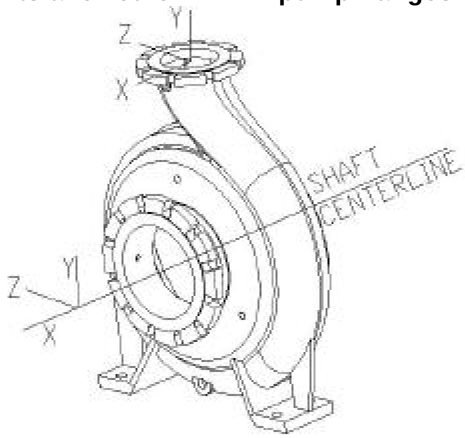
- Prevent excessive external pipe load
- Never draw piping into place by applying force to pump flange connections
- Do not mount expansion joints so that their force, due to internal pressure, acts on the pump flange

The table in 4.7.2 summarizes the maximum forces and moments allowed on FRBH pump casings. Refer to Flowserve for other configurations.

CAUTION Ensure piping and fittings are flushed before use.

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

4.7.2 Maximum forces and moments allowed on FRBH pump flanges



Flange Size DN (in.)	Maximum forces (F) in N (lbf) and moments (M) in Nm (lbf•ft)											
	Suction						Discharge					
	Mx	My	Mz	Fx	Fy	Fz	Mx	My	Mz	Fx	Fy	Fz
50 (2)	460 (340)	230 (170)	350 (260)	890 (200)	710 (160)	5808 (130)	460 (340)	230 (170)	350 (260)	710 (160)	580 (130)	890 (200)
65 (2-1/2)	710 (520)	350 (260)	540 (400)	1110 (250)	890 (200)	760 (170)	710 (520)	350 (260)	540 (400)	890 (200)	760 (170)	1110 (250)
80 (3)	950 (700)	470 (350)	720 (530)	1330 (300)	1070 (240)	890 (200)	950 (700)	470 (350)	720 (530)	1070 (240)	890 (200)	1330 (300)
100 (4)	1330 (980)	680 (500)	1000 (740)	1780 (400)	1420 (320)	1160 (260)	1330 (980)	680 (500)	1000 (740)	1420 (320)	1160 (260)	1780 (400)
125 (5)	1830 (1340)	940 (690)	1450 (1070)	2450 (550)	1960 (440)	1600 (360)	1830 (1340)	940 (690)	1450 (1070)	1960 (440)	1600 (360)	2450 (550)
150 (6)	2300 (1700)	1180 (870)	1760 (1300)	3110 (700)	2490 (560)	2050 (460)	2300 (1700)	1180 (870)	1780 (1300)	2490 (560)	2050 (460)	3110 (700)
200 (8)	3530 (2600)	1760 (1300)	2580 (1900)	4890 (1100)	3780 (850)	3110 (700)	3530 (2600)	1760 (1300)	2580 (1900)	3780 (850)	3110 (700)	4890 (1100)
250 (10)	5020 (3700)	2440 (1800)	3800 (2800)	6670 (1500)	5340 (1200)	4450 (1000)	5020 (3700)	2440 (1800)	3800 (2800)	5340 (1200)	4450 (1000)	6670 (1500)
300 (12)	6100 (4500)	2980 (2200)	4610 (3400)	8000 (1800)	6670 (1500)	5340 (1200)	6100 (4500)	2980 (2200)	4610 (3400)	6670 (1500)	5340 (1200)	8000 (1800)
350 (14)	6370 (4700)	3120 (2300)	4750 (3500)	8900 (2000)	7120 (1600)	5780 (1300)	6370 (4700)	3120 (2300)	4750 (3500)	7120 (1600)	5780 (1300)	8900 (2000)
400 (16)	7320 (5400)	3660 (2700)	5420 (4000)	10230 (2300)	8450 (1900)	6670 (1500)	7320 (5400)	3660 (2700)	5420 (4000)	8450 (1900)	6670 (1500)	10230 (2300)
450 (18)	8200 (6050)	4200 (3100)	6100 (4500)	11570 (2600)	9650 (2170)	7560 (1700)	8200 (6050)	4200 (3100)	6100 (4500)	9610 (2160)	7560 (1700)	11570 (2600)
500 (20)	9080 (6700)	4750 (3500)	6780 (5000)	12900 (2900)	10720 (2410)	8450 (1900)	9080 (6700)	4750 (3500)	6780 (5000)	10760 (2420)	8450 (1900)	12900 (2900)
550 (24)	10850 (8000)	5830 (4300)	8130 (6000)	15480 (3480)	13120 (2950)	10230 (2300)	10850 (8000)	5830 (4300)	8130 (6000)	13080 (2940)	10230 (2300)	15660 (3520)

Notes:

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

4.7.2 Suction piping

a) Drop pipes may be used to extend the pump setting yet maintain cantilever design. All designs are reviewed for shaft deflection and critical speeds.

b) Inlet strainers, when used, should have a net `free area' of at least three times the inlet pipe area.

4.7.3 Discharge piping

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

Pipework reducers should have a maximum total angle of divergence of 15 degrees. Fitting an isolation valve will allow easier maintenance.

4.7.5 Final checks

Check the tightness of all bolts in the suction and discharge pipework. Check also the tightness of all foundation bolts.

4.8 Final shaft alignment check

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

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

4.9 Electrical connections

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

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

4.9.3 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.

4.9.4 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.

4.9.5 A device to provide emergency stopping must be fitted.

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

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

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

4.10 Protection systems

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

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

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

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

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

5 COMMISSIONING, START-UP, OPERATION AND SHUTDOWN

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

5.1 Pre-commissioning procedure

5.1.1 Lubrication

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

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

When fitted with a constant level oiler, the bearing housing should be filled by unscrewing or hinging back the transparent bottle and filling the bottle with oil. Where an adjustable body Trico oiler is fitted this should be set to the proper height.

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

Approximate oil volumes are shown in section 3.4.2, *Pump and impeller data*.

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

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

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

5.2 Pump lubricants

5.2.1 Recommended grease lubricants

Grease	Grease nipples	
	NLGI 2 *	**NLGI 3 ****
Temp. range ºC (ºF)	-20 to +100 (-4 to +212)	-20 to +100 (-4 to +212)
Designation according to DIN	K2K-20	K2K 30
BP	Energrease LS2	Energrease LS3
DEA	Glissando 20	Glissando 30
Elf	Elfmulti 2	Elfmulti 3
Esso	Beacon 2	Beacon 3
Mobil	Mobilux 2	Mobilux 3
Q8	Rembrandt 2	Rembrandt 3
Shell	Alvania Fett G2 Alvania Fett R2	Alvania R3
Texaco	Multilak 20 Multilak EP2	Multilak 30 Multilak EP3
Wintershall (BASF Group)	Wiolub LFK 2	-
SKF	LGMT 2	LGMT 3
Silkolene	G55/T	G56/T

* NLGI 2 is an alternative grease and is not to be mixed with other grades

** Factory packed bearings for the temperature range with grease nipples

5.2.2 Recommended fill quantities

Refer to section 3.4.2, *Pump and impeller data*.

5.2.3 CAUTION Lubrication schedule

5.2.3.1 Grease lubricated bearings

When grease nipples are fitted, one charge between grease changes is advisable for most operating conditions, ie 2 000 hours interval.

Normal intervals between grease changes are 4 000 hours or at least every 6 months.
The characteristics of the installation and severity of service will determine the frequency of lubrication. Lubricant and bearing temperature analysis can be useful in optimising lubricant change intervals.

The bearing temperature may be allowed to rise to 55 ºC (131 ºF) above ambient but should not exceed 95 °C (204 °F). For most operating conditions a quality grease having a lithium soap base and NLGI consistency of No 2 or No 3 is recommended. The drop point should exceed 175 ºC (350 ºF).

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

5.3 Direction of rotation

CAUTION Ensure the pump is given the same rotation as the pump direction arrow cast on the pump casing.

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

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

5.4 Guarding

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

5.5 Priming and auxiliary supplies

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

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

5.6 Starting the pump

a) CAUTION Ensure flushing and/or cooling/ heating liquid supplies are turned ON before starting the pump.
b) CLOSE the outlet valve.
c) OPEN all inlet valves.
d) Prime the pump.
e) Ensure all vent connections are closed before starting.
f) Start motor and check outlet pressure.
g) If the pressure is satisfactory, slowly OPEN outlet control valve.
h) CAUTION Do not run the pump with the outlet valve closed for a period longer than 30 seconds.

i) If NO pressure, or LOW pressure, STOP the pump. Refer to section 7, *Faults; causes and remedies*, for fault diagnosis.

5.7 Running the pump

5.7.1 Venting the pump

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

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

5.7.4 Bearings

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

If bearing temperatures are to be monitored it is essential that a benchmark temperature is recorded at the commissioning stage and after the bearing temperature has stabilized. Record the bearing temperature (t) and the ambient temperature (ta). Estimate the likely maximum ambient temperature (tb). Set the alarm at (t+tb-ta+5)°C [(t+tb-ta+10)°F] and the trip at 100 °C (212 °F) for oil lubrication and 105 °C (220 °F) for grease lubrication.

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

5.7.5 Normal vibration levels, alarm and trip

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

CAUTION Alarm and trip values for installed pumps should be based on the actual measurements (N) taken on the pump in the fully commissioned as new condition. Measuring vibration at regular intervals will then show any deterioration in pump or system operating conditions.

Vibration velocity – unfiltered **mm/s (in./s) r.m.s.**		**FRBHJC**
Normal	**N**	≤ 7.1 (0.28)
Alarm	**N** x 1.25	≤ 9.0 (0.35)
Shutdown trip	**N** x 2.0	≤ 14.2 (0.56)

5.7.6 Stop/start frequency

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

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

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

5.8 Stopping and shutdown

a) CAUTION Close the outlet valve, but ensure that the pump runs in this condition for no more than a few seconds.
b) Stop the pump.
c) Switch off flushing and/or cooling/heating liquid supplies at a time appropriate to the process.
d) CAUTION For prolonged shut-downs and especially when ambient temperatures are likely to drop below freezing point, the pump and any cooling and flushing arrangements must be drained or otherwise protected.

5.9 Hydraulic, mechanical and electrical duty

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

5.9.1 Specific gravity (SG)

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

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

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

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

NPSH required ($NPSH_R$) is a measure of the head required in the pumped liquid, above its vapour pressure, to prevent the pump from cavitating. It is important that $NPSH_A > NPSH_R$. The margin between $NPSH_A > NPSH_R$ should be as large as possible.

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

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

6 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 5.8.

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

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

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

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

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

Do not spray air or compressed inert gas on skin.

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

Never use air or compressed inert gas to clean clothes.

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

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

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

6.2 Maintenance schedule
Ex 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.
g) Check coupling alignment and re-align if necessary.

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

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

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

6.2.1 Routine inspection (daily/weekly)

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

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

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

6.2.2 Periodic inspection (six monthly)

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

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

6.2 3 Re-lubrication

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

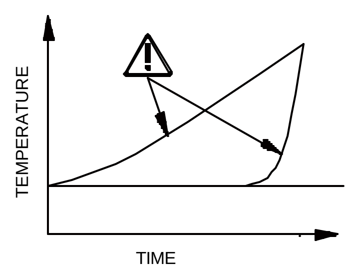
6.2.3.1 Grease lubrication

CAUTION See section 5.2.2 for grease recommendations.

Regrease - via grease nipples every 2 000 hours or sooner depending on the severity of the application.

It is important not to under or over grease the bearings as this will lead to over heating and premature failure.

a) Grease lubricated bearing housings have grease nipples fitted in the bearing covers.
b) Move the axial seal ring back so the gap between the pump shaft and bearing cover can be seen.
c) Connect grease gun to the nipple.
d) Press grease into the bearing housing until the first signs of it appear in the gap between the housing and shaft, then stop greasing.
e) V-rings should be seated at the proper distance from the sealing surface to avoid overheating.
f) The maximum allowable operating temperatures for anti friction bearings will vary from unit to unit, depending on ambient and fluid temperature. The rise above ambient should not normally exceed 55 °C (131 °F) or a combined maximum of 95 °C (204 °F).
g) A continuously rising temperature or an abrupt temperature rise indicates a problem. If these symptoms occur, stop the pump immediately and investigate the cause.



Grease change - every 4 000 hours or sooner depending on the severity of the application.

a) Remove the bearing housing from the rotor assembly.
b) Brush the bearing housing with hot kerosene (100 to 115 °C/212 to 240 °F) or other non-toxic solvent.
c) Clean and flush out the housing with a light mineral oil.
d) Do not use waste oil to clean the housing.

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

To remove badly oxidized grease which refuses to come off:
a) Support the rotor in a vertical position and immerse the bearing in hot kerosene or a mixture of alcohol and light mineral solvent.
b) Gently spin the bearing outer ring.
c) Dry and reflush the bearing with clean light oil.
d) It is important not to under or over grease the bearings as this will lead to over heating and premature failure. It is recommended that the bearings be filled with grease using a suitable spatula. In addition the housings should be no more than half filled.

6.3 Spare parts

6.3.1 Ordering of spares

Flowserve keep records of all pumps that have been supplied. When ordering spares the following information should be quoted:
1) Pump serial number
2) Pump size
3) Part name – taken from section 8
4) Part number – taken from section 8
5) Number of parts required

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

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

6.3.2 Storage of spares

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

6.4 Recommended spares and consumable items

For start up purposes:
1 - restriction bushing
2 - shaft sleeves
1 - set of gaskets and seals

For 2 years operation:
1 - set of bearings (line and thrust)
2 – restriction bushings
2 - shaft sleeves
2 - sets of gaskets and seals
1 - casing wear plate

For 4 years operation:
1 - set of bearings (line and thrust)
2 – restriction bushings
2 - shaft sleeves
2 - sets of gaskets and seals
2 - casing wear plate
1 - impeller

6.5 Tools required

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

Readily available in standard tool kits, and dependent on pump size:
- Open ended spanners (wrenches) to suit up to M 48 screws/nuts
- Socket spanners (wrenches), up to M 48 screws
- Allen keys, up to 10 mm (A/F)
- Range of screwdrivers
- Soft mallet

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

6.6 Fastener torques

Bolt size	Torque Nm (lb•ft)	
	Pump feet fasteners	All other fasteners
M10 (3/8 in.)	23 (17)	23 (17)
M12 (1/2 in.)	54(40)	54 (40)
M 16 (? in.)	170 (125)	84 (62)
M 20 (¾ in.)	340 (250)	165 (120)
M 24 (? in.)	590 (435)	285 (210)
M 27 (1 in.)	770 (570)	375 (275)
M 30 (1? in.)	1 100 (810)	540 (400)
M 36 (1? in.)	1 840 (1 350)	900 (660)
M 42 (1? in.)	2 000 (1 475)	1 410 (1 040)

6.7 Renewal clearances

As wear takes place between the impeller and wear ring the overall efficiency of the pump set will decrease. To maintain optimum efficiency it is recommended that rings are replaced and the impeller renovated when the radial clearance detailed in section 3.4.2 has doubled to 1.0 to 1.5 mm (0.040 to 0.060 in.), depending on pump size.

6.8 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.

6.8.1 Pump unit

a) Isolate motor and lock off electrical supply in accordance with local regulations.
b) Isolate discharge valves.
c) Remove coupling guards and disconnect the coupling halves.
d) On units with larger drivers it is recommended to remove the motor. If the bearing frame will be dismantled it is suggested that the motor be left connected to the motor. Unfasten the motorstand from the top plate and remove.
e) Unscrew and remove discharge pipe flange bolts. remove spool sections to allow pump to be removed from well.
f) Unscrew and remove top plate mounting bolts.
g) Install eyebolts in top plate.
h) Using overhead crane or hoist, remove pump from well.
i) Place the pump assembly in a horizontal position, preferably on a V-block fixture.

CAUTION

Adequate support must be provided to support columns and liquid end to eliminate bending stresses imposed on the shaft and column support pipes.

6.8.2

a) With casing [1] adequately supported by a hoist unscrew and remove bolts holding casing [1]. Remove casing [1] away from support pipe [101].
b) Inspect wear plate [181] and casing [1], if replacement of either component is required loosen wear plate nuts and remove wear plate [181].
c) Remove impeller nut [24], application of heat may be required to break bond of resinous sealant on threads [heat evenly).
d) Remove impeller [2]. For ease of removal, the impeller hub is slotted to accept a standard bearing puller.
e) Remove impeller key [32] and sleeve stop [82].

6.8.3 Stuffing Box Head

a) Remove stuffing box head [33A] from the support pipe [101].
b) Inspect lower bushing [39], if replacement is required carefully press bearing out.
c) Remove the support pipe [101].
d) Inspect shaft sleeve [6] for excessive wear. Remove shaft sleeve only if replacement is necessary. The sleeve is a hook type that is normally held in place with an anaerobic sealant.

6.8.4 Bearing Frame

a) If the motor stool was not removed with the motor it should be unfastened from the bearing frame now.
b) Unfasten and remove the line bearing cover from the bearing frame.
c) Loosen and remove jacking stud nuts and bolts from the thrust bearing housing [33]
d) Remove the shaft assembly from the bearing frame [19], set on wooden V-blocks.

6.8.5 Thrust bearings

a) Loosen cap screws from thrust bearing cover [37]; remove cover.
b) Slide thrust bearing housing [33] towards the inboard line bearing to expose bearings.
c) To remove the bearings first bend the locking tab of the bearing lock washer [22A] from lock nut [22].
d) Using a hook type wrench unscrew the lock nut from the shaft.
e) The bearings may be removed from the shaft by using a puller or cutting torch.

CAUTION

If a torch is used caution is required to prevent damage to the shaft.

f) The thrust bearing housing may be removed from the shaft.

6.8.6 Line Bearing

a) The line bearing is secured in place using a snap ring as well as an interference fit on the shaft. Remove the snap ring.
b) The bearing may be removed by using a bearing puller or can be cut from the shaft using a cutting torch.

CAUTION

Caution should be used with the cutting torch to prevent damaging the shaft and sleeve.

6.8.7

a) Remove the shaft sleeve from the shaft. The sleeve has a locational fit and may be held in place with an anaerobic sealant.
b) If required, remove bearing frame [19] from the top plate [23].

6.9 Examination of parts

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

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

6.9.1 Casing, wear plate, stuffing box head and impeller

a) Inspect for excessive wear, pitting, corrosion, erosion or damage and any sealing surface irregularities.
b) Replace as necessary.

6.9.2 Shaft and sleeve

Replace if grooved, pitted or worn.

6.9.3 Gaskets and O-rings

a) After dismantling, discard and replace.
b) Clean and inspect all gasket surfaces.

6.9.4 Bearings and Stuffing Box Bushing

a) It is recommended that bearings are not re-used after any removal from the shaft.
b) The plain liquid lubricated bearings may be re-used if both the stuffing box bush and bearing sleeve show no sign of wear, grooving or corrosion attack. [It is recommended that both the bush and sleeve are replaced at the same time.]

6.9.5 Bearing isolators, labyrinths or lip seals [if fitted]

a) The lubricant, bearings and bearing housing seals are to be inspected for contamination and damage.
b) If bearing damage is not due to normal wear and the lubricant contains adverse contaminants, the cause should be corrected before the pump is returned to service.
c) Labyrinth seals and bearing isolators should be inspected for damage but are normally non-wearing parts and can be re-used.
d) Inspect all bearing lip seals [47 & 49] and replace move if worn, damaged or in doubt.

6.9.6 Bearing frame and housing

a) Clean and flush bearing housing internal surfaces.

6.10 Assembly

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

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

The following consumable material are required for pump assembly.

- high strength thread locking compound equivalent to Loctite *680 + primer T.
- medium strength thread locking compound equivalent to Loctite *A.
- anti-seize compound

*Loctite Corporation, Newington, Conn. USA>

CAUTION Care must be taken during assembly to avoid contamination of the parts with dirt, or other foreign matter.

6.10.1 Preparation

a) Inspect all new parts. Remove all nicks, burrs, etc, that may have been caused by handling.
b) Lubricate internal bores of bearing frame [19] with same grease used to lubricate bearings.
c) Install the thrust bearing housing [33] into the applicable bore of the bearing frame [19] to ensure a good sliding fit, then remove.
d) Clean shaft free of grease at the spacer sleeve [78] location. Spray the area with Loctite Primer T. The primer acts as a catalyst to ensure optimum bond strength and rapid cure of the Loctite compound.

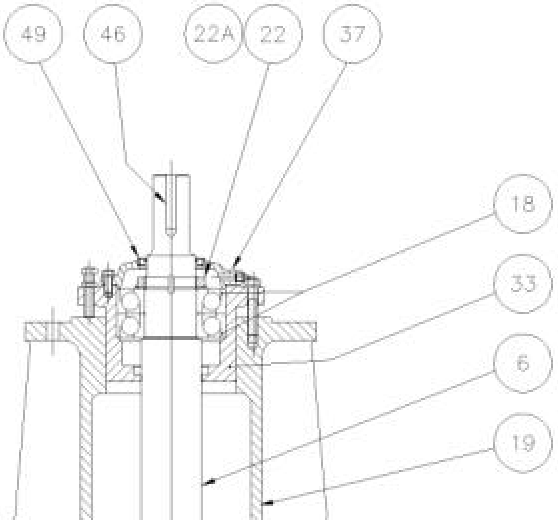
6.10.2 Line Bearings

a) Apply Loctite 680 to the shaft and install the sleeve [79] at the line bearing against the shaft shoulder.

b) Lightly lubricate the shaft [6] at the bearing position.
c) Use an induction heater or oil bath to first heat up the line bearing [16] to 100°C (210^{0}F). Press the bearing on the shaft with the aid of a sleeve designed to push the inner race only.

CAUTION
Note that the inner race must seat on the shaft sleeve shoulder.

d) After the bearing has cooled, protect the bearing by wrapping with a clean lint free cloth.
e) Slide the retaining ring [706] over the shaft and place in groove.
f) The bearings are sealed for life and do not need greasing.



6.10.3 Thrust Bearings

a) Slide the thrust bearing housing [33] onto the shaft [6] between the line bearing [16] and thrust bearing [18] Location.
b) Lightly lubricate the shaft [6] at the bearing position.
c) Use and induction heater or not oil bath to heat the bearings to 100 °C (210^{0}F). Install the thrust bearings [18] as noted below.

CAUTION
Note that the angular contact bearings are mounted back-to-back, commonly called the "O" arrangement. The inner race must seat on the shaft shoulder.

d) Slide the bearing lockwasher [22A] on the shaft and fit the bearing locknut [22]. Tighten the locknut snugly and allow to cool. Check the tightness and bend one lockwasher tab over to lock the nut.
e) Pack the thrust bearings [18] with grease.
f) Slide the thrust bearing housing [33] over the bearings.
g) Install the grease fitting into the thrust bearing cover [37].
h) Carefully install the lip seal [49] or labyrinth seal into the thrust bearing cover [37] by pressing squarely into the bore.
i) Slide the thrust bearing cover over the shaft.

CAUTION Care must be taken to ensure that the lip seal is not damaged on the shaft keyway.

j) Secure to the thrust bearing housing using the capscrews and lockwashers, tighten in accordance with Table in section 6.6.

6.10.4 Bearing Frame

a) Place the top plate [23] in a vertical position and block in place with angle plates.
b) Bolt the bearing frame [19] to the top plate [23]. Use Loctite A on the capscrew threads - tighten in accordance to Table 6.6.
c) Slide the shaft assembly through Bearing Cartridge [19] from the drive end and align to the adjusting bolt holes.
d) Assemble adjusting bolts and hardware.

6.10.5 Lower Column

6.10.5.1 Integral line bearing cover

In some designs the line bearing cover is integral with the column support pipe [101]

a) Place the support pipe [101] in a horizontal position on a V-block arrangement and install lip seal [47] with the primary sealing lip away from the bearings.
b) Lubricate the shaft/sleeve for the line bearing seal.
c) Lift the support pipe and carefully install over the shaft and to the top plate/bearing frame assembly.

CAUTION
The sealing lip could be damaged during the assembly if adequate precaution not taken.

d) Fasten the support pipe to the top plate/bearing frame assembly. Use Loctite "A", thread locking compound on all capscrew threads. Tighten in accordance with Table 6.6.

6.10.5.2 Loose line bearing cover

a) Install the lipseal [47] or labyrinth seal in the line bearing cover [37]. Place the lipseal with the primary sealing lip away from the bearings. For labyrinth seals the shoulder is outside and away from the bearings.
b) Lubricate the shaft/sleeve for the line bearing seal.
c) Install the line bearing cover to the bearing frame [19] and fasten in place with appropriate fasteners.
d) Lift the support pipe and carefully install over the shaft and to the line bearing cover.

6.10.6 Grease Fitting, frame 3

a) Install the appropriate grease fitting to the bearing frame at the line bearing.
b) Charge grease fitting with grease

6.10.7 Bearing Frame Vent

a) Install street elbow in bearing frame and orientate elbow to towards drive end of shaft.
b) Install Inpro vent valve

6.10.8 Stuffing Box area

a) Clean the shaft where the shaft sleeve [14] will be located.
b) Prepare shaft and sleeve with Loctite Primer
c) Apply Loctite A to shaft.
d) Install the shaft sleeve [14] onto the shaft [6] while turning the sleeve to spread the Loctite sealant over the inside surface of the sleeve.
e) Assemble the throat bushing [63] into the lower housing [33A].
f) Apply Loctite A to periphery of elastomeric bushing [39] at one end and slide into housing [33A] using a twisting motion. Wipe away excess compound. If provided, install studs and fit clamp plate to hold bushing in place.
g) Slide the lower housing [33a] over shaft and into spigot to support pipe [101]. Clamp into position using 'C' clamps.
h) Using adjusting bolts on thrust bearing housing [33] adjust shaft forward so that the end of the sleeve protrudes slightly beyond the face of the lower housing [11].
i) Install impeller key [32], smear anti-seize compound onto the shaft at the impeller location.
j) Slide impeller [2] onto the shaft [6].
k) Apply Loctite A to shaft threads and install the impeller nut [24]. Torque impeller nut as indicated in table below:

TABLE 6.10.8

MINIMUM IMPELLER NUT TIGHTENING TORQUE		
FRAME	**Ft. lbs.**	**Nm.**
1	**100**	**140**
2	**300**	**400**
3	**300**	**400**

6.10.9 Casing

a) Place the casing on the suction nozzle.
b) Screw the wear plate studs into the wear plate. Apply Loctite A to threads.
c) Place sealing washers over the studs. A small amount of grease may be used to hold them into position during assembly of wear plate.
d) Lower the wear plate [181] studs first into the casing [1], align the studs with the casing holes.
e) Fasten the wear plate [181] to the casing using the washers, nuts and Loctite A on nuts. Tighten in accordance with Table 6.6.
f) Remove 'C' clamp from housing. Smear the casing gasket [73] with a grease and position on lower cover [33A].
g) Release thrust bearing housing hold down bolts.
h) Lift the casing [1] and slide over the impeller and onto the lower housing [33].
i) Align discharge of casing [1] with slot in top plate [23]
j) Bolt casing [1] into position using Loctite 242 on threads. Tighten bolts in accordance with Table 6.6.

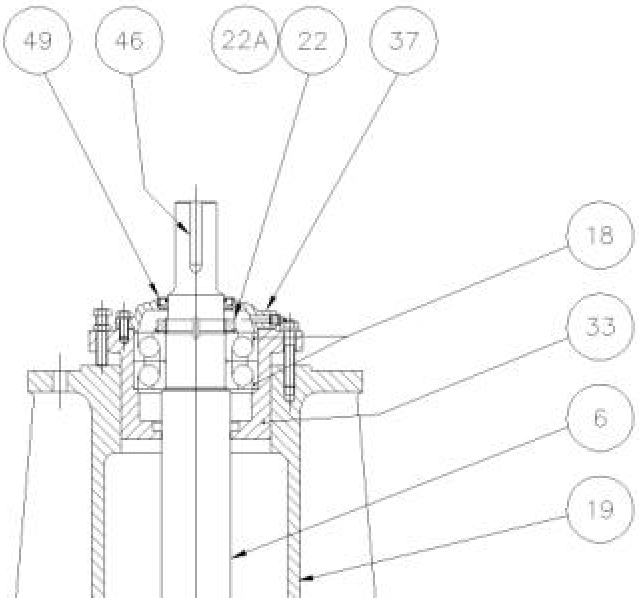
6.11 Setting Impeller Clearance

CAUTION

Never attempt to change the clearance when the pump is running.

If the coupling has limited axial adjustment capability, the pump and driver must be uncoupled prior to adjusting the clearance in order to permit free movement.

a) Loosen the thrust bearing housing jam nuts and back off the three jacking screws at least 1.5 mm (0.06 in.).
b) Move the rotor towards the wear plate [181] by tightening the three hold-down capscrews evenly and uniformly until the impeller [2] just touches the wear plate [181]. This can be best established by rotating the shaft and stopping the forward motion at the first sign of rubbing. If the shaft cannot be rotated, back off the bearing housing with the jacking screws until a just detectable rub is obtained.
c) Set a dial indicator on the end of the shaft or the flange of the bearing housing [33]. Set dial to "0".
d) Determine the required impeller axial running clearance from Engineering Tables of Section 3.4
e) Loosen the thrust bearing housing hold down capscrews slightly and tighten the jack screws to achieve the clearance reading on the dial indicator.
f) Alternately and gradually tighten the hold down capscrews and jack screws while maintaining the reading on the dial indicator. The gap between the housing and the bearing frame should be even within 0.08mm (0.003 in.). .
g) While preventing the jack screws from rotating, tighten
h) the jam nuts to lock them in position.
i) Manually rotate the shaft to ensure that there is no rubbing or binding.
j) On belt driven units, adjust the pump or driver sheave to maintain belt alignment. (Section 4.5).
k) Check the alignment on direct driven units (refer to Section 4.5) and reassemble the coupling components.
l) Replace any safety guards that may have been removed.



7 FAULTS; CAUSES AND REMEDIES

FAULT SYMPTOM

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

FAULT SYMPTOM

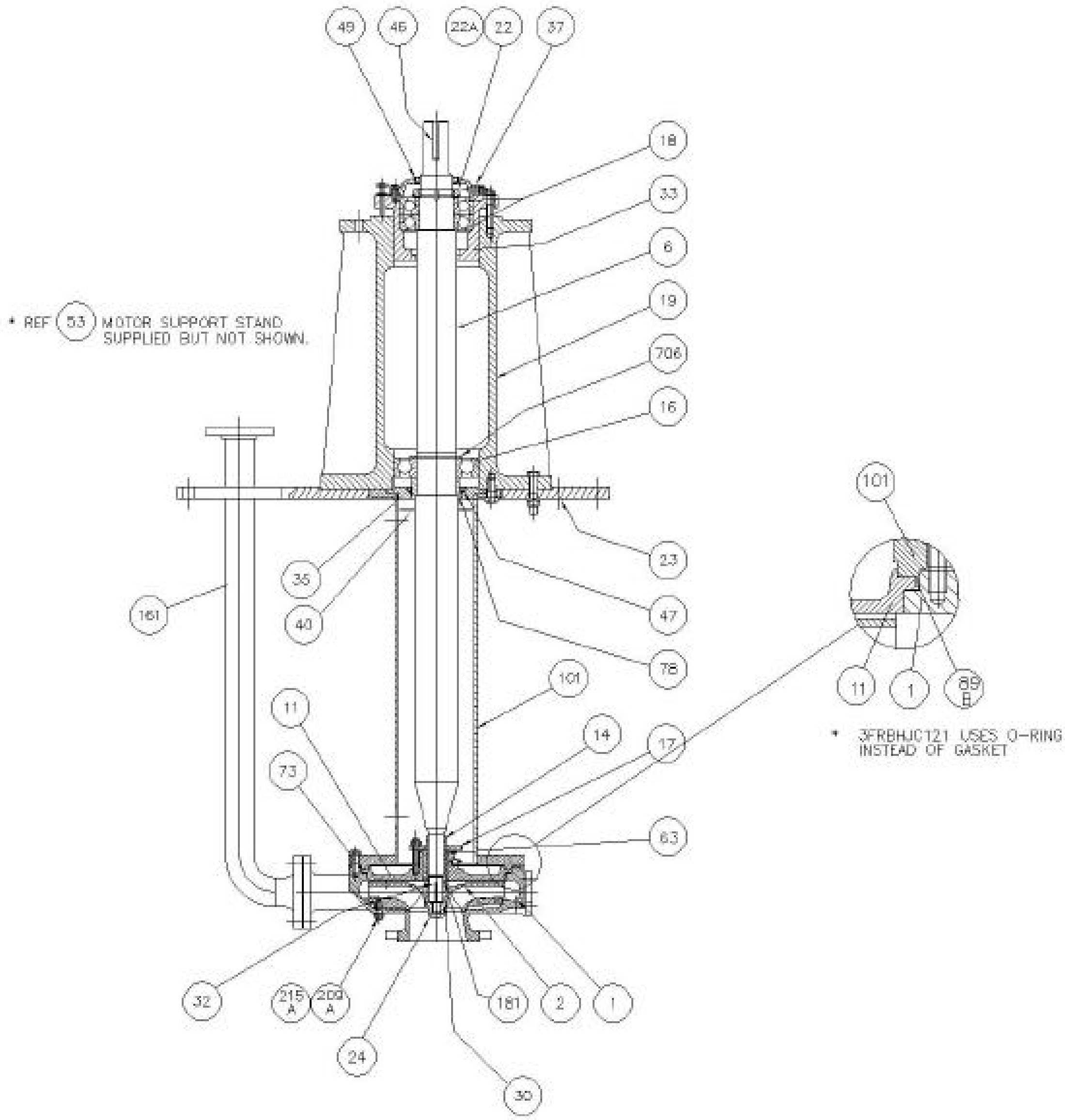
Pump overheats and seizes	Bearings have short life	Pump vibrates or is noisy	Mechanical seal has short life	Mechanical seal leaks excessively	Pump requires excessive power	Pump loses prime after starting	Insufficient pressure developed	Insufficient capacity delivered	Pump does not deliver liquid	PROBABLE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

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
										C. MOTOR ELECTRICAL PROBLEMS	
		●			●		●	●		Wrong direction of rotation.	Reverse 2 phases at motor terminal box.
					●			●		Motor running on 2 phases only.	Check supply and fuses.
	●	●						●		Motor running too slow.	Check motor terminal box connections and voltage.

8 PARTS LIST AND DRAWINGS

8.1 FRBHJC Sectional drawing



ITEM	DESCRIPTION	ITEM	DESCRIPTION	ITEM	DESCRIPTION	ITEM	DESCRIPTION
1	Casing	19	Bearing Frame	35	Cover – Line Bearing	78	Sleeve-Bearing
2	Impeller	22	Bearing Lock Nut	37	Thrust Bearing Cover	89B	O-ring
6	Shaft	22A	Bearing Lock Washer	40	Deflector	101	Column Pipe
11	Stuffing Box Head	23	Top Plate	46	Drive Key	161	Discharge Pipe
14	Shaft Sleeve	24	Impeller nut	47	Seal - Inboard	181	Wearplate
16	Line Bearing	30	O-ring, Impeller Nut	49	Seal – Outboard	209A	Stud – Wearplate
17	Bushing Cover	32	Impeller Key	53	Motorstand	215A	Nut – Wearplate
18	Thrust bearing (set)	33	Housing - Thrust bearing	73	Gasket-Casing		

8.5 General arrangement drawing

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

9 CERTIFICATION

Certificates, determined from the contract requirements will be provided with this manual. Examples are certificates for CE marking and ATEX marking. If required, copies of other certificates sent separately to the Purchaser should be obtained from Purchaser for retention with the User Instructions. See section 1.9, *Noise level*, for details of typical noise certification.

10 OTHER RELEVANT DOCUMENTATION AND MANUALS

10.1 Supplementary User Instruction manuals

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

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

10.2 Change notes

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

10.3 Additional sources of information

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

Reference 2:
Pumping Manual, 9th edition, T.C. Dickenson, Elsevier Advanced Technology, United Kingdom, 1995.

Reference 3:
Pump Handbook, 2nd edition, Igor J. Karassik et al, McGraw-Hill Inc., New York, 1993.

Reference 4:
ANSI/HI 1.1-1.5
Centrifugal Pumps - Nomenclature, Definitions, Application and Operation.

Reference 5:
ANSI B31.3 - Process Piping.

Notes

Notes:

FLOWSERVE
REGIONAL SALES OFFICES:

USA and Canada
Flowserve Corporation (Pump Division)
5215 North O'Connor Blvd. Suite 2300
Irving, Texas 75039, USA

Tel +1 972 443 6500
Toll free 800 728 PUMP (7867)
Fax +1 972 443 6800

Latin America and Caribbean
Flowserve Corporation (Pump Division)
6840 Wynnwood Lane
Houston, Texas 77008, USA

Tel +1 713 803 4434
Fax +1 713 803 4497

Europe, Middle East & Africa
Flowserve Limited (Pump Division)
Harley House, 94 Hare Lane
Claygate, Esher, Surrey KT10 0RB
United Kingdom

Tel +44 (0)1372 463 700
Fax +44 (0)1372 460 190

Asia Pacific
Flowserve Pte Ltd (Pump Division)
200 Pandan Loop, 06-03/04
Pantech 21, Singapore 128388

Tel +65 775 3003
Fax +65 779 4607

Visit our web site at: www.flowserve.com

Your Flowserve factory contact:

Flowserve Pump Division
15 Worthington Drive,
PO Box 40,
Brantford,
Ontario,
Canada N3T 5M5

Telephone +1 (519) 753 7381
Fax +1 (519) 753 0845

Your local Flowserve representative:

In Europe:

Flowserve Pumps Limited
PO Box 17, Newark
Notts NG24 3EN United Kingdom

Telephone (24 hours) +44 (0)1636 494 600
Sales & Admin Fax +44 (0)1636 705 991
Repair & Service Fax +44 (0)1636 494 833

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