



# USER INSTRUCTIONS

## **WORTHINGTON® LR, LRV, LLR and LR-S**

Horizontal, split case, volute type centrifugal pumps for water and general service

PCN=71569088 08-10 (E) (Based on C953KH013)  
Original instructions

**Installation  
Operation  
Maintenance**



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

***Experience In Motion***

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## 1 INTRODUCTION AND SAFETY

### 1.1 General



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

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

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

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



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

### 1.2 CE marking and approvals

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

Where applicable, the Directives and any additional Approvals, cover important safety aspects relating to machinery and equipment and the satisfactory provision of technical documents and safety instructions. Where applicable this document incorporates information relevant to these Directives and Approvals.

To confirm the Approvals applying and if the product is CE marked, check the serial number plate markings and the Certification. (See section 9, *Certification*.)

### 1.3 Disclaimer

**Information in these User Instructions is believed to be complete and reliable. However, in spite of all of the efforts of Flowserve Corporation to provide comprehensive instructions, good engineering and safety practice should always be used.**

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 the Flowserve warranty. In addition, any modification of Flowserve products or removal of original components may impair the safety of these products in their use.

### 1.4 Copyright

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

### 1.5 Duty conditions

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



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

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

## 1.6 Safety

### 1.6.1 Summary of safety markings

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



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



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



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



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



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



This symbol is used in safety instructions to remind not to rub non-metallic surfaces with a dry cloth; ensure the cloth is damp. 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 help prevent injury to personnel and damage to the environment and to equipment. For products used in potentially explosive atmospheres section 1.6.4 also applies.**



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



**GUARDS MUST NOT BE REMOVED WHILE THE PUMP IS OPERATIONAL**



**DRAIN THE PUMP AND ISOLATE PIPEWORK BEFORE DISMANTLING THE PUMP**

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



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



**HANDLING COMPONENTS**

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



**APPLYING HEAT TO REMOVE IMPELLER**


There may be occasions when the impeller has either been shrunk fit on to the pump shaft or has become difficult to remove due to products of corrosion.

If you elect to use heat to remove the impeller, it must be applied quickly to the impeller boss. **TAKE GREAT CARE!**

Before applying heat ensure any residual hazardous liquid trapped between the impeller and pump shaft is thoroughly drained out through the impeller keyway to prevent an explosion or emission of toxic vapour. This must be carried out with the shaft in the vertical position. On some pump sizes a cavity exists in the impeller bore so on occasions a significant volume of liquid may drain out.

 **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.

 **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 80 °C (175 °F) or below -5 °C (20 °F) in a restricted zone, or exceeds local regulations, action as above shall be taken.***


 **HAZARDOUS LIQUIDS**


When the pump is handling hazardous liquids care must be taken to avoid exposure to the liquid by appropriate 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.***

 **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 PARTLY 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 pump and mechanical 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.


**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. For ATEX, both electrical and non-electrical equipment must meet the requirements of European Directive 94/9/EC. Always observe the regional legal Ex requirements eg Ex electrical items outside the EU may be required certified to other than ATEX eg IECEx, UL.

**1.6.4.1 Scope of compliance**

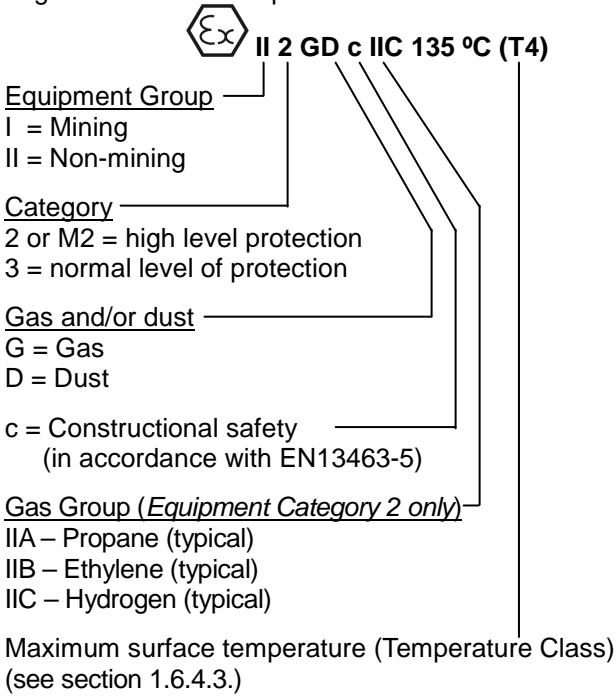
 Use equipment only in the zone for which it is appropriate. Always check that the driver, drive coupling assembly, seal and pump equipment are suitably rated and/or certified for the classification of the specific atmosphere in which they are to be installed.

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

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

**1.6.4.2 Marking**

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



**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.

Temperature class to EN13463-1	Maximum surface temperature permitted	Temperature limit of liquid handled *
T6	85 °C (185 °F)	Consult Flowserve
T5	100 °C (212 °F)	Consult Flowserve
T4	135 °C (275 °F)	115 °C (239 °F)
T3	200 °C (392 °F)	180 °C (356 °F)
T2	300 °C (572 °F)	275 °C (527 °F)
T1	450 °C (842 °F)	400 °C (752 °F)

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

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

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

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

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

Where there is any risk of the pump being run against a closed valve generating high liquid and casing external surface temperatures, 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, make regular checks and remove dirt from areas around close clearances, bearing housings and motors.

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

ENSURE THE PUMP IS PROPERLY FILLED AND VENTED AND DOES NOT RUN DRY  
Ensure the pump and relevant suction and discharge pipeline system is totally filled with liquid at all times during the pump operation, so that an explosive atmosphere is prevented. In addition it is essential to make sure that seal chambers, auxiliary shaft seal systems and any heating and cooling systems are properly filled.

If the operation of the system cannot avoid this condition fit an appropriate dry run protection device (for example 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.

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

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

For ATEX application the coupling must be selected to comply with 94/9/EC. Correct coupling alignment must be maintained.

### Additional requirement for metallic pumps on non-metallic baseplates

When metallic components are fitted on a non-metallic baseplate they must be individually earthed.

### 1.6.4.6 Preventing leakage

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

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

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

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

If leakage of liquid to atmosphere can result in a hazard, install a liquid detection device.

### 1.6.4.7 Maintenance to avoid the hazard

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

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

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

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

## 1.7 Safety labels summary

### 1.7.1 Nameplate

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

### 1.7.2 Safety labels

		<b>WARNING</b>	J218JZ250
ESSENTIAL PROCEDURES BEFORE STARTING:			
INSTALL AND OPERATE EQUIPMENT IN ACCORDANCE WITH THE INSTRUCTION MANUAL SUPPLIED SEPARATELY.	ENSURE ALL EXTERNAL CONNECTIONS TO THE PUMP / SHAFT SEALING AND DRIVER ARE CONNECTED AND OPERATIONAL.	FULLY PRIME UNIT AND SYSTEM. DO NOT RUN UNIT DRY.	
ENSURE GUARDS ARE SECURELY IN PLACE.	FAILURE TO FOLLOW THESE PROCEDURES MAY RESULT IN PERSONAL INJURY AND / OR EQUIPMENT DAMAGE		
ENSURE CORRECT DIRECTION OF ROTATION.			
J218/268			
ENSURE UNIT ON A FIRM FOUNDATION AND THAT COUPLING FACES ARE IN CORRECT ALIGNMENT PRIOR TO AND AFTER BOLTING BASEPLATE DOWN AND FIXING PIPEWORK. SEE MANUAL FOR TOLERANCES.	PUMP MUSS AUF FESTEM FUNDAMENT STEHEN. KUPPLUNGSHÄLFTEN KORREKT AXIAL AUSRICHTEN, DANN PUMPE AUF GRUNDPLATTE FESTSPANNEN UND ANSCHLUSSLEITUNGEN BEFESTIGEN. TOLERANZEN S. BEDIENUNGSANLEITUNG.		
S'ASSURER QUE LE GROUPE ELECTROPOMPE EST FERMEMENT INSTALLE SUR SON MASSIF. VERIFIER LE LIGNAGE DE L'ACCOUPLLEMENT AVANT ET APRES FIXATION DU SOCLE ET DE LA TUYAUTERIE. VOIR LES TOLERANCES D'ALIGNEMENT SUR LA NOTICE	ZORG DAT POMPEENHEID OP EEN STEVIGE ONDERGROND OGESTELD STAAT EN DAT KOPPELING CORRECT UITGELIJT IS ZOWEL VOOR-ALS NADAT DE GRONDPLAAT MET BOUTEN IS VASTGEZET EN DE LEIDINGEN GEINSTALLEERD ZIJN. ZIE HANDLEIDING VOOR TOELAABARE SPELINGEN.		
CDC: 603 604 610 612 621 623 624			

### Oil lubricated units only:

J218JZ262	
<b>WARNING</b>	<b>THIS MACHINE MUST BE FILLED WITH OIL BEFORE STARTING</b>
<b>ATTENTION</b>	<b>CETTE MACHINE DOIT ÊTRE REMPLIE D'HUILE AVANT LA MISE EN MARCHÉ</b>
<b>ACHTUNG</b>	<b>DIESE MASCHINE IST VOR DEM STARTEN MIT ÖL ZÜ FÜLLEN</b>
<b>WAARSCHUWING</b>	<b>DEZE MACHINE MOET VOOR HET STARTEN MET OLIE GEVULD WORDEN</b>
CDC: 603 604 610 612 621 623 624	

## 1.8 Specific machine performance

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



### 1.9 Noise level

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

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

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

Similarly the motor noise assumed in the “pump and motor” noise is that typically expected from standard and high efficiency motors when on load directly driving the pump. Note that a motor driven by an inverter may show an increased noise at some speeds.

If a pump unit only has been purchased for fitting with your own driver then the “pump only” noise levels in the table should be combined with the level for the driver obtained from the supplier. Consult Flowserve or a noise specialist if assistance is required in combining the values.

It is recommended that where exposure approaches the prescribed limit, then site noise measurements should be made.

The values are in sound pressure level  $L_{pA}$  at 1 m (3.3 ft) from the machine, for “free field conditions over a reflecting plane”.

For estimating sound power level  $L_{WA}$  (re 1pW) then add 17 dBA to the sound pressure value.

Motor size and speed kW (hp)	Typical sound pressure level $L_{pA}$ at 1 m reference 20 $\mu$ Pa, dBA							
	3 550 r/min		2 900 r/min		1 750 r/min		1 450 r/min	
	Pump only	Pump and motor	Pump only	Pump and motor	Pump only	Pump and motor	Pump only	Pump and motor
<0.55(<0.75)	72	72	64	65	62	64	62	64
0.75 (1)	72	72	64	66	62	64	62	64
1.1 (1.5)	74	74	66	67	64	64	62	63
1.5 (2)	74	74	66	71	64	64	62	63
2.2 (3)	75	76	68	72	65	66	63	64
3 (4)	75	76	70	73	65	66	63	64
4 (5)	75	76	71	73	65	66	63	64
5.5 (7.5)	76	77	72	75	66	67	64	65
7.5 (10)	76	77	72	75	66	67	64	65
11(15)	80	81	76	78	70	71	68	69
15 (20)	80	81	76	78	70	71	68	69
18.5 (25)	81	81	77	78	71	71	69	71
22 (30)	81	81	77	79	71	71	69	71
30 (40)	83	83	79	81	73	73	71	73
37 (50)	83	83	79	81	73	73	71	73
45 (60)	86	86	82	84	76	76	74	76
55 (75)	86	86	82	84	76	76	74	76
75 (100)	87	87	83	85	77	77	75	77
90 (120)	87	88	83	85	77	78	75	78
110 (150)	89	90	85	87	79	80	77	80
150 (200)	89	90	85	87	79	80	77	80
200 (270)	①	①	①	①	85	87	83	85
300 (400)					87	90	85	86

① The noise level of machines in this range will most likely be of values which require noise exposure control, but typical values are inappropriate. **Note:** for 1 180 and 960 r/min reduce 1 450 r/min values by 2 dBA. For 880 and 720 r/min reduce 1 450 r/min values by 3 dBA.

## 2 TRANSPORT AND STORAGE

### 2.1 Consignment receipt and unpacking

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

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


Check any crates, boxes and wrappings for any accessories or spare parts 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.

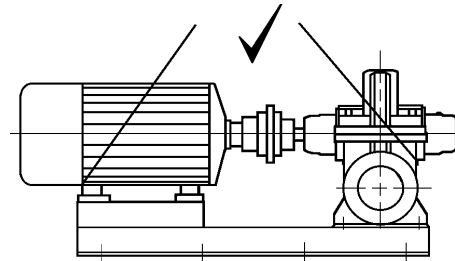
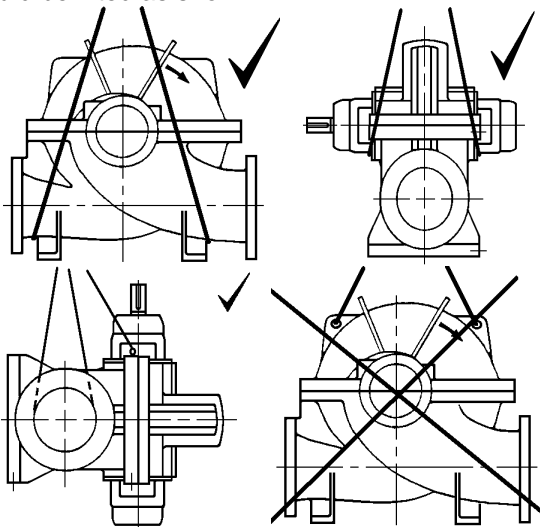
### 2.2 Handling

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

### 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.


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



When there are no specific lifting points on the baseplate

Before lifting the driver alone, refer to the manufacturer's instructions.


### 2.4 Storage

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

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

### 2.5 Recycling and end of product life

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

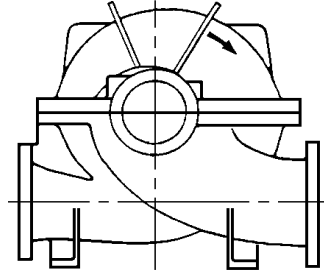
 Make sure that hazardous substances are disposed of safely and that the correct personal protective equipment is used. The safety specifications must be in accordance with the current regulations at all times.

### 3 PUMP DESCRIPTION

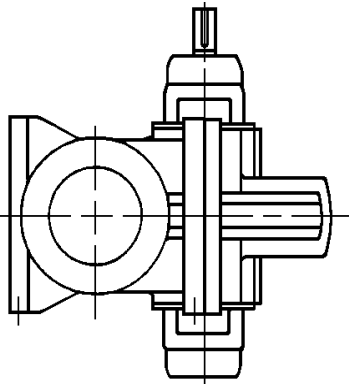
#### 3.1 Configurations

The LR range of pumps are horizontal split casing volute type centrifugal pumps designed for water works, drainage, general service and circulating applications. They can be used with motor, steam turbine and gasoline or diesel engine drives.

The range can have the following configurations:



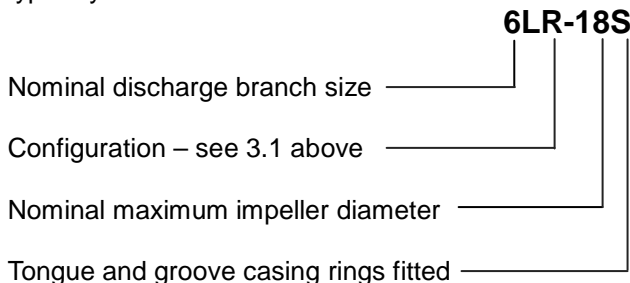
LR single-stage horizontal suction and discharge nozzles.  
 LLR two-stage horizontal suction and discharge nozzles.  
 LR-S single stage horizontal suction and discharge nozzles.



LRV single-stage LR horizontal suction/discharge nozzles, with vertical pump shaft.

#### 3.2 Name nomenclature

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



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

#### 3.3 Design of major parts

##### 3.3.1 Pump casing

The pump has its main casing gasket axial to the shaft allowing maintenance to the rotating element by removing the top half casing. Suction and discharge branches are in the bottom half and therefore remain undisturbed.

##### 3.3.2 Impeller

The impeller is fully shrouded and may be fitted with optional hub rings.

##### 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 may be either oil or grease lubricated.

Oil lubrication is only available where the pump shaft is horizontal.

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

The LRV as standard has a liquid lubricated journal bearing fitted at the non-drive end. This bearing is lubricated by pumped product or from an external clean source.

##### 3.3.5 Bearing housing

Two grease nipples enable grease lubricated bearings to be replenished between major service intervals.

LR-S pumps have sealed for life bearings and cannot be re-greased.

For oil lubricated bearings, a constant level oiler is fitted.

##### 3.3.6 Seal housing

The design enables one of a number of sealing options to be fitted.

##### 3.3.7 Shaft seal

The mechanical seal(s), attached to the pump shaft, seals the pumped liquid from the environment. Gland packing may be fitted as an option on the LR, LR-S, and LLR.

##### 3.3.8 Driver

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

### 3.3.9 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 *	-20 to +150 °C (-4 to +302 °F)
Maximum ambient temperature *	-20 to +40 °C (-4 to +104 °F)
Maximum soft solids in suspension *	up to 3 % by volume (refer for size limits)
Maximum pump speed	refer to the nameplate

\* Subject to written agreement from Flowserve.

## 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.

Refer to the general arrangement drawing for the pump set.

### 4.2 Part assemblies

Motors may be supplied loose on LRV pumps, typically on frame sizes 250 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



There are many methods of installing pump units to their foundations. The correct method depends on the size of the pump unit, its location and noise vibration limitations. Non-compliance with the provision of correct foundation and installation may

lead to failure of the pump and, as such, would be outside the terms of the warranty.

### 3.4.2 Pump and impeller data

Pump size	Impeller minimum passage size mm (in.)	Nominal wear ring diameter mm (in.)	Mean radial wear ring clearance mm (in.) *	Approx. oil capacity, both bearings litres (fl. oz.)
1.5LLR-7	6 (0.24)	95.25 (3.75)	0.19 (0.007)	0.16 (5.4)
1.5LLR-10	9 (0.35)			
2LLR-9	7.5 (0.29)	103.2 (4.06)	0.22 (0.009)	0.19 (6.4)
2LLR-11		124.0 (4.88)		
3LLR-11	10.5 (0.41)	139.9 (5.51)		
4LLR-11	17 (0.67)	157.3 (6.19)		
2.5LR10	9 (0.35)	95.25 (3.75)	0.19 (0.007)	0.16 (5.4)
2.5LR-13	13 (0.51)	123.8 (4.88)	0.22 (0.009)	0.17 (5.8)
3LR-9	8 (0.31)	103.2 (4.06)		0.16 (5.4)
3LR-12	14.5 (0.57)	123.8 (4.88)		
4LR-10	16.5 (0.65)			
4LR-11	18 (0.71)			
4LR-12	12 (0.47)			
4LR-14	16 (0.63)	139.7 (5.5)		0.16 (5.4)
5LR-10	16.5 (0.65)			
5LR-13	15 (0.59)	168.4 (6.63)		0.17 (5.8)
5LR-15	17 (0.67)			
5LR-19	17 (0.67)	157.2 (6.19)		0.19 (6.4)
6LR-10	21 (0.83)			
6LR-13	17.5 (0.69)	157.2 (6.19)		0.16 (5.4)
6LR-16				
6LR-18	23.5 (0.93)	190.5 (7.5)	0.19 (6.4)	
8LR-12	22 (0.87)			
8LR-14	27 (1.06)	228.6 (9.0)	0.21 (7.1)	
8LR-20				
10LR-14	44.5 (1.75)	278 (10.95)	0.19 (6.4)	
10LR-16	39 (1.54)			
10LR-17	41 (1.61)	278 (10.95)	0.21 (7.1)	
10LR-18	22 (0.87)			
6LR-18S	26.5 (1.04)	215.9 (8.5)	0.13 (0.005)	0.47 (15.9)
8LR-18S	38 (1.50)	247.7 (9.75)		
8LR-23S	23 (0.91)	235 (9.25)		
10LR-14S	42.5 (1.67)	247.7 (9.75)		
10LR-18S	57.5 (2.26)	273.1 (10.75)		
12LR-14S	58.5 (2.30)			

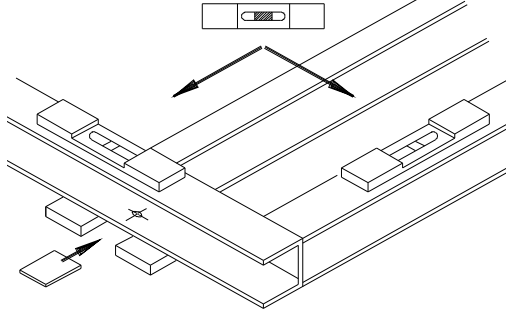
\* May be up to 0.13 mm (0.005 in.) larger if casing ring and impeller have a tendency to gall.

**Note:**

Clearances for non-metallic wear rings are smaller, typically 50 - 65% of those for the standard metallic rings shown above.

Ensure the following are met:

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



- c) Level with shims between baseplate and packing pieces.
- d) The pump and driver have been aligned before dispatch however the alignment of pump and motor half coupling must be checked. If this is incorrect, it indicates that the baseplate has become twisted and should be corrected by re-shimming.
- e) Vertical pumps should be mounted following the practices outlined for baseplate mounted pumps. (Larger sizes may need the motor fitting after installing the pump - refer to section 4.5.2.)
- f) If the pump is driven via a universal joint drive shaft there may be a requirement to offset the pump shaft with respect to the driver to optimize the universal joint drive shaft bearing life. This offset will typically be in the range 0 to 4 degrees depending on shaft design. Please consult the separate User Instructions before installation.
- g) Any support for the universal joint drive shaft plummer blocks must not exhibit resonant frequencies in the range 0.8 to 1.2 N where N = pump running speed.
- h) If not supplied, guarding shall be fitted as necessary to meet the requirements of ISO 12100 and EN953 and or any applicable local safety regulations.

#### 4.4 Grouting

Where applicable, grout in the foundation bolts.

After adding pipework connections and rechecking the coupling alignment, the baseplate should then be grouted in accordance with good engineering practice. Fabricated steel, cast iron and epoxy baseplates can be filled with grout. Folded steel baseplates should be grouted to locate their packing pieces. If in any doubt, please contact your nearest service centre for advice.

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

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

#### 4.5 Initial alignment

##### 4.5.1 Thermal expansion



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



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



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.

##### *Horizontal pumps – LR, LLR and LR-S*

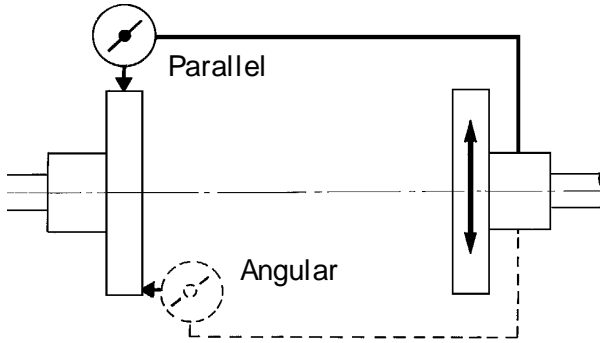
Alignment is achieved by adding or removing shims under the motor feet and also moving the motor horizontally as required. In some cases where the alignment cannot be achieved it will be necessary to move the pump before recommencing the above procedure.

##### *Vertical pumps – LRV*

Adding or removing shims between the motor stool and the pump casing achieves alignment. The motor/motor stool assembly may also have to be moved horizontally at the interface with the pump casing, as required.

It should be noted that the motor has a spigot (rabbet) fit into the motor stool and it is therefore not possible to achieve any horizontal movement at this interface.

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



Maximum permissible misalignment at working temperature:

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

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

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

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

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

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



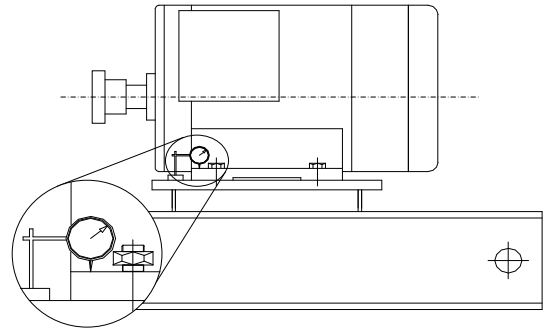
Refer to the motor manual for details.

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



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

#### 4.5.3 Check for soft foot

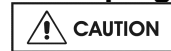


This is a check to ensure that there is no undue stress on the driver holding down bolts; due to non-level baseplate or twisting. To check, remove all shims and clean surfaces and tighten down driver to the baseplate. Set a dial indicator as shown in sketch and loosen off the holding down bolt while noting any deflection reading on the dial test indicator - a maximum of 0.05 mm (0.002 in.) is considered acceptable but any more will have to be corrected by adding shims, for example, if the dial test indicator shows the foot lifting 0.15 mm (0.006 in.) then this is the thickness of shim to be placed under that foot. Tighten down and repeat the same procedure on all other feet until all are within tolerance



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

#### 4.6 Piping



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

##### 4.6.1 Suction and discharge pipework

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

Take into account the available NPSH 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 4.6.3 summarizes the maximum forces and moments allowed on horizontal shaft pump casings. Refer to Flowserve when the pump shaft is vertical.

**CAUTION** Ensure piping and fittings are flushed before use.

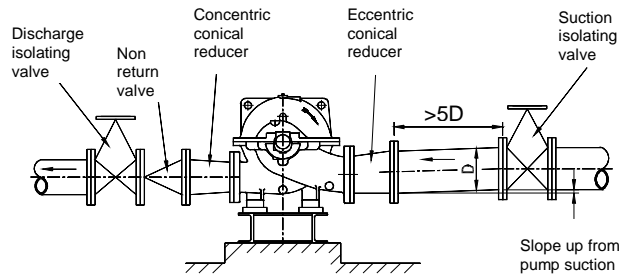
**!** Ensure piping for hazardous liquids is arranged to allow pump flushing before removal of the pump.

#### 4.6.2 Suction piping

- The inlet pipe should be one or two sizes larger than the pump inlet bore and pipe bends should be as large a radius as possible.
- Pipework reducers should be conical and have a maximum total angle of divergence of 15 degrees.
- On suction lift the piping should be inclined up towards the pump inlet with eccentric reducers incorporated to prevent air locks.
- On positive suction, the inlet piping must have a constant fall towards the pump.
- Flow should enter the pump suction with uniform flow, to minimize noise and wear. This is particularly important on large or high-speed pumps which should have a minimum of five diameters of straight pipe on the pump suction between the elbow and inlet flange. See section 10.3, *Reference 1*, for more detail.
- Inlet strainers, when used, should have a net 'free area' of at least three times the inlet pipe area.
- Do not install elbows at an angle other than perpendicular to the shaft axis. Elbows parallel to the shaft axis will cause uneven flow.
- Except in unusual circumstances strainers are not recommended in inlet piping. If considerable foreign matter is expected a screen installed at the entrance to the wet well is preferable.
- Fitting an isolation valve will allow easier maintenance.

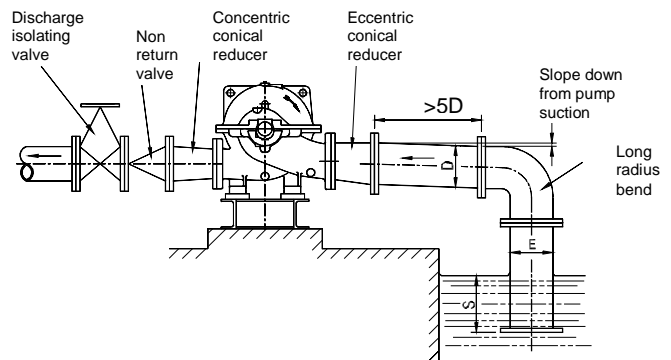
- Never throttle pump on suction side and never place a valve directly on the pump inlet nozzle.

#### Typical design – flooded suction



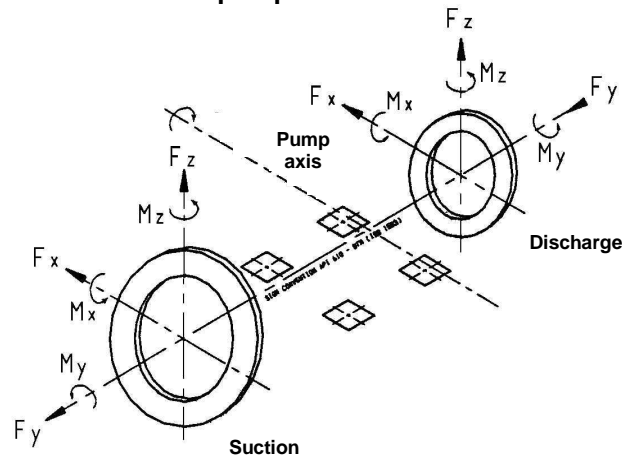
**Note:** Ideally reducers should be limited to one pipe diameter change, ie 150 mm (6 in.) to 200 mm (8 in.). Must have a maximum total angle of divergence of 15 degrees.

#### Typical design – suction lift



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

#### 4.6.3 Maximum forces and moments allowed on the pump suction and discharge flanges of horizontal shaft pumps



See table overleaf.

Type and size	Maximum forces (F) in kN (lbf) and maximum moments (M) in kNm (lbf-ft)											
	Suction						Discharge					
	Fx	Fy	Fz	Mx	My	Mz	Fx	Fy	Fz	Mx	My	Mz
1.5LLR-7	1.47 (330)	1.15 (260)	1.34 (300)	0.85 (630)	0.45 (330)	0.6 (440)	0.77 (170)	0.88 (190)	0.64 (140)	0.44 (320)	0.24 (170)	0.32 (230)
1.5LLR-10	2.35 (520)	1.85 (410)	1.34 (300)	1.36 (1 000)	0.72 (530)	0.96 (700)	0.77 (170)	0.88 (190)	0.64 (140)	0.44 (320)	0.24 (170)	0.32 (230)
2LLR-9 to 2LLR-11	2.35 (520)	1.85 (410)	1.34 (300)	1.36 (1 000)	0.72 (530)	0.96 (700)	1.03 (230)	1.17 (260)	0.85 (190)	0.59 (430)	0.32 (230)	0.43 (310)
3LLR-11	2.94 (660)	2.31 (510)	1.68 (370)	1.70 (1 250)	0.90 (660)	1.20 (880)	1.54 (340)	1.76 (390)	1.28 (280)	0.88 (640)	0.48 (350)	0.64 (470)
4LLR-11	4.41 (990)	3.47 (770)	2.52 (560)	2.55 (1 880)	1.35 (990)	1.80 (1 320)	1.92 (430)	2.20 (490)	1.60 (360)	1.10 (810)	0.60 (440)	0.80 (590)
2.5LR-10	2.35 (520)	1.85 (410)	1.34 (300)	1.36 (1 000)	0.72 (530)	0.96 (700)	1.25 (280)	1.43 (320)	1.00 (230)	0.72 (530)	0.39 (280)	0.52 (380)
2.5LR-13	2.94 (660)	2.31 (510)	1.68 (370)	1.70 (1 250)	0.90 (660)	1.20 (880)	1.25 (280)	1.43 (320)	1.00 (230)	0.72 (530)	0.39 (280)	0.52 (380)
3LR-9	2.94 (660)	2.31 (510)	1.68 (370)	1.70 (1 250)	0.90 (660)	1.20 (880)	1.54 (340)	1.76 (390)	1.28 (280)	0.88 (640)	0.48 (350)	0.64 (470)
3LR-12	3.68 (820)	2.88 (640)	2.10 (470)	2.12 (1 560)	1.12 (820)	1.50 (1 100)	1.54 (340)	1.76 (390)	1.28 (280)	0.88 (640)	0.48 (350)	0.64 (470)
4LR-10	3.68 (820)	2.88 (640)	2.10 (470)	2.12 (1 560)	1.12 (820)	1.50 (1 100)	1.92 (430)	2.20 (490)	1.60 (360)	1.10 (810)	0.60 (440)	0.80 (590)
4LR-11 to 4LR-14	4.41 (990)	3.47 (770)	2.52 (560)	2.55 (1 880)	1.35 (990)	1.80 (1 320)	1.92 (430)	2.20 (490)	1.60 (360)	1.10 (810)	0.60 (440)	0.80 (590)
5LR-10 to 5LR-15	4.41 (990)	3.47 (770)	2.52 (560)	2.55 (1 880)	1.35 (990)	1.80 (1 320)	2.40 (540)	2.75 (610)	2.00 (450)	1.37 (1 010)	0.75 (550)	1.00 (730)
5LR-19	5.88 (1 320)	4.62 (1 030)	3.36 (750)	3.40 (2 500)	1.80 (1 320)	2.40 (1 770)	2.40 (540)	2.75 (610)	2.00 (450)	1.37 (1 010)	0.75 (550)	1.00 (730)
6LR-10 to 6LR-16	5.88 (1 320)	4.62 (1 030)	3.36 (750)	3.40 (2 500)	1.80 (1 320)	2.40 (1 770)	2.88 (640)	3.30 (740)	2.40 (540)	1.65 (1 210)	0.90 (660)	1.20 (880)
6LR-18 6LR-18S	7.35 (1 650)	5.78 (1 300)	4.20 (940)	4.25 (3 100)	2.25 (1 650)	3.00 (2 200)	2.88 (640)	3.30 (740)	2.40 (540)	1.65 (1 210)	0.90 (660)	1.20 (880)
8LR12/14	7.35 (1 650)	5.78 (1 300)	4.20 (940)	4.25 (3 100)	2.25 (1 650)	3.00 (2 200)	3.84 (860)	4.40 (990)	3.20 (720)	2.20 (1 620)	1.20 (880)	1.60 (1 180)
8LR18S 8LR-20	8.82 (1 980)	6.93 (1 550)	5.04 (1 130)	5.10 (3 760)	2.70 (1 990)	3.60 (2 650)	3.84 (860)	4.40 (990)	3.20 (720)	2.20 (1 620)	1.20 (880)	1.60 (1 180)
8LR-23S	7.35 (1 650)	5.78 (1 300)	4.20 (940)	4.25 (3 100)	2.25 (1 650)	3.00 (2 200)	3.84 (860)	4.40 (990)	3.20 (720)	2.20 (1 620)	1.20 (880)	1.60 (1 180)
10LR-14/16 10LR-14S	8.82 (1 980)	6.93 (1 550)	5.04 (1 130)	5.10 (3 760)	2.70 (1 990)	3.60 (2 650)	4.80 (1 080)	5.50 (1 230)	4.00 (900)	2.75 (2 020)	1.50 (1 100)	2.00 (1 470)
10LR-17/18 10LR-18S	10.30 (2 310)	8.09 (1 800)	5.88 (1 320)	5.95 (4 380)	3.15 (2 300)	4.20 (3 100)	4.80 (1 080)	5.50 (1 230)	4.00 (900)	2.75 (2 020)	1.50 (1 100)	2.00 (1 470)
12LR-14S	10.30 (2 310)	8.09 (1 800)	5.88 (1 320)	5.95 (4 380)	3.15 (2 300)	4.20 (3 100)	5.76 (1 300)	6.60 (1 480)	4.80 (1 080)	3.30 (2 430)	1.80 (1 320)	2.40 (1 770)

**Notes:**

- 1) F = External force (tension or compression).  
M = External moment, clockwise or counter-clockwise.  
Sign convention follows ISO1503 and ISO13709/API610.
- 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 Pumps.
- 5) Pumps must be on rigid foundations and baseplates must be fully grouted
- 6) Pump/baseplate should not be used as pipe anchor. Suction and discharge piping should be anchored as close as possible to the pump flanges to reduce vibration and prevent strain on the pump casing. Expansion joints are recommended. They must be properly tied and located on the side of the pipe anchor away from the pump.
- 7) The pump mounting bolt torques specified must be used to prevent relative movement between the pump casing and baseplate. (See section 6.6, *Fastener torques*.) The bolt material must have a minimum yield strength of 600 N/mm<sup>2</sup> (87 000 lb/in.<sup>2</sup>).



#### 4.6.4 Discharge piping

See section 4.6.2 for typical pipework design.

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

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

Fitting an isolation valve will allow easier maintenance.

#### 4.6.5 Auxiliary piping

##### 4.6.5.1 Drains

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

##### 4.6.5.2 Pumps fitted with packed gland

When suction pressure is below ambient pressure it is necessary to feed the gland packing with liquid to provide lubrication and prevent the ingress of air. This is normally achieved with a supply from the pump discharge volute to the stuffing box.

If the pumped liquid is dirty and cannot be used for sealing, a separate clean compatible liquid supply to the gland at 1 bar (15 psi) above suction pressure is recommended.

##### 4.6.5.3 Pumps fitted with mechanical seals

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

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

Special seals may require different auxiliary piping to that described above. Consult separate User Instructions and or Flowserve if unsure of correct method or arrangement.

For pumping hot liquids, to avoid seal damage, it is recommended that any external flush/cooling supply be continued after stopping the pump.

#### 4.6.6 Final checks


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


#### 4.7 Final shaft alignment check


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


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


#### 4.8 Electrical connections

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

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


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

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


 A device to provide emergency stopping must be fitted.

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

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

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

#### 4.9 Protection systems

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

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

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

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

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

## 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

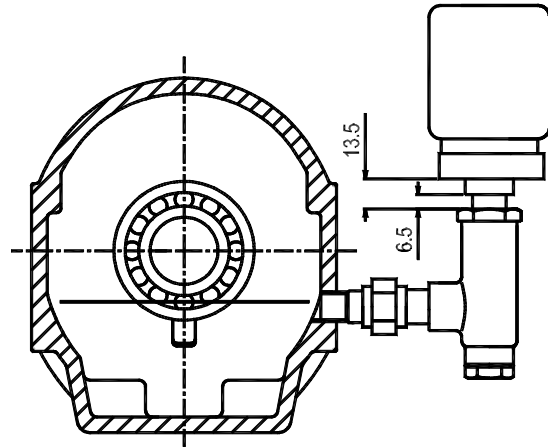
Determine the mode of lubrication of the pump set, eg grease, oil, product lubrication etc.

**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.

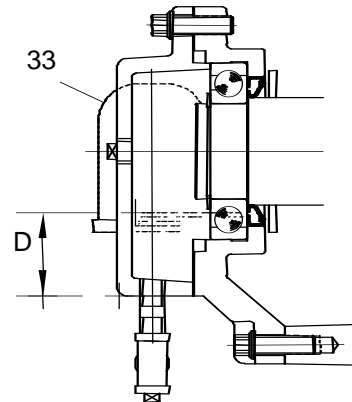
Where an adjustable body Denco oiler is fitted this should be set to the height shown in the following diagram:



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.

The LR-S pumps are fitted with a different oiler - set oil level D as below:

6LR-18S, 10LR-14S and 12LR-14S = 48 mm (1<sup>7</sup>/<sub>8</sub> in.)  
8LR-18S, 8LR-23S and 10LR-18S = 53 mm (2<sup>1</sup>/<sub>16</sub> in.)



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 oil lubricants

Centrifugal pump lubrication	Oil	Splash / force feed / purge oil mist lubrication		
	Viscosity cSt @ 40 °C	32	46	68
Oil temperature range *	-5 to 65 °C (23 to 149 °F)	<b>-5 to 78 °C (23 to 172 °F)</b>	-5 to 80 °C (23 to 176 °F)	
Designation to ISO 3448 and DIN51524 part 2	ISO VG 32 32 HLP	<b>ISO VG 46 46 HLP</b>	ISO VG 68 68 HLP	
Oil companies and lubricants	<b>BP Castrol</b> †	Energol HLP-HM 32	<b>Energol HLP-HM 46</b>	Energol HLP-HM 68
	<b>ESSO</b> †	NUTO HP 32	<b>NUTO HP 46</b>	NUTO HP 68
	<b>ELF/Total</b> †	ELFOLNA DS 32 Azolla ZS 32	<b>ELFOLNA DS 46 Azolla ZS 46</b>	ELFOLNA DS 68 Azolla ZS 68
	<b>LSC (for oil mist)</b>	LSO 32 (Synthetic oil)	<b>LSO 46 (Synthetic oil)</b>	LSO 68 (Synthetic oil)
	<b>ExxonMobil</b> †	Mobil DTE 24	<b>Mobil DTE 25</b>	Mobil DTE 26
	<b>Q8</b> †	Q8 Haydn 32	<b>Q8 Haydn 46</b>	Q8 Haydn 68
	<b>Shell</b> †	Shell Tellus 32	<b>Shell Tellus 46</b>	Shell Tellus 68
	<b>Chevron Texaco</b> †	Rando HD 32	<b>Rando HD 46</b>	Rando HD 68
	<b>Wintershall (BASF Group)</b> †	Wiolan HS32	<b>Wiolan HS46</b>	Wiolan HS68
<b>Fuchs</b> †	Renolin CL 32	<b>Renolin CL 46</b>	Renolin CL 68	

\* Note that it normally takes 2 hours for bearing temperature to stabilize and the final temperature will depend on the ambient, r/min, pumpage temperature and pump size. Also some oils have a very low pour point and good viscosity index which extend the minimum temperature capability of the oil. Always check the grade capability where the ambient is less than -5 °C (23 °F).

† Use LSC for oil mist. Oil parameters provide flash point >166 °C (331 °F), density >0.87 @ 15 °C (59 °F), pour point of -10 °C (14 °F) or lower.

### 5.2.2 Recommended grease lubricants

Grease	NLGI 2 *	NLGI 3
Temp. range	-20 to +100 °C (-4 to +212 °F)	-20 to +100 °C (-4 to +212 °F)
Designation acc. to DIN	KP2K-25	KP3K-20
<b>BP</b>	Energrease LS-EP2	Energrease LS-EP3
<b>Elf</b>	Multis EP2	Multis EP3
<b>Fuchs</b>	RENOLIT EP2	RENOLIT EP3
<b>ESSO</b>	Beacon EP2	Beacon EP3
<b>Mobil</b>	Mobilux EP2	Mobilux EP3 **
<b>Q8</b>	Rembrandt EP2	Rembrandt EP3
<b>Shell</b>	Alvania EP2	Alvania EP2
<b>Texaco</b>	Multifak EP2	Multifak EP3
<b>SKF</b>	LGEP 2	

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

\*\* Standard pre-packed grease for fitted antifriction bearings.

† Food type grease regreasing interval is 1200 hours. (Grease not to be mixed with non-food grade.)

### 5.2.3 Recommended fill quantities

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

### 5.2.4 Lubrication schedule

#### 5.2.4.1 Oil lubricated bearings

Normal oil change intervals are 4 000 operating hours or at least every 6 months. For pumps on hot service or in severely damp or corrosive atmosphere, the oil will require changing more frequently. Lubricant and bearing temperature analysis can be useful in optimizing lubricant change intervals.

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

The bearing temperature may be allowed to rise to 50 °C (90 °F) above ambient, but should not exceed 82 °C (180 °F). A continuously rising temperature or an abrupt rise, indicate a fault.

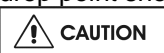
#### 5.2.4.2 Grease lubricated bearings

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 °C (99 °F) above ambient but should not exceed 95 °C (203 °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 °C (350 °F).

 Never mix greases containing different bases, thickeners or additives.

### 5.3 Direction of rotation



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.



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. In member countries of the EU and EFTA, it is a legal requirement that fasteners for guards must remain captive in the guard to comply with the Machinery Directive 2006/42/EC. When releasing such guards, the fasteners must be unscrewed in an appropriate way to ensure that the fasteners remain captive.

Whenever guarding is removed or disturbed ensure that all the protective guards are securely refitted prior to start-up.

### 5.5 Priming and auxiliary supplies



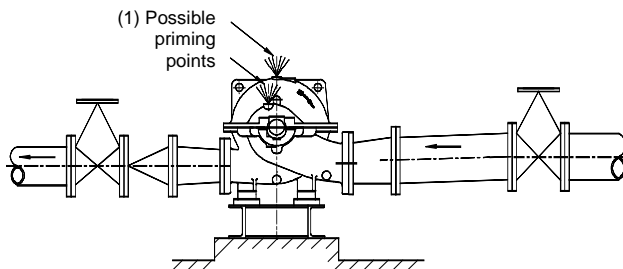
Ensure all electrical, hydraulic, pneumatic, sealant and lubrication systems (as applicable) are connected and operational.



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

#### 5.5.1 Suction pressure above atmospheric pressure

Horizontal pumps: open vent connection (1) on top of the pump upper casing to allow the trapped air to escape. Let liquid run out until free from air bubbles.



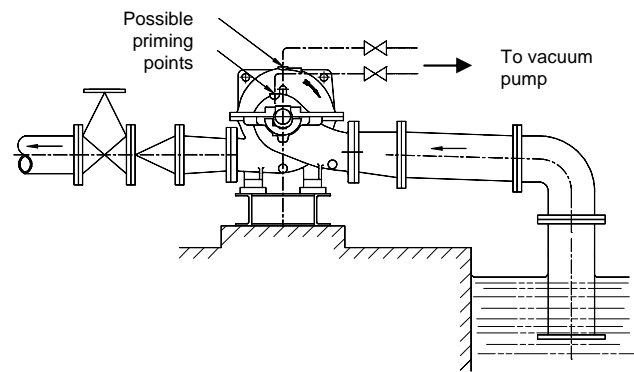
Vertical pumps: open vent connection (1) at the front of the upper half casing and disconnect the seal flush line at the mechanical seal/stuffing box to allow the trapped air to escape. Let liquid run out until free from air bubbles.

#### 5.5.2 Suction lift with foot valve fitted

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

#### 5.5.3 Suction lift without foot valve

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



### 5.6 Starting the pump

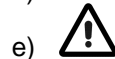


a) Ensure flushing and/or cooling/heating liquid supplies are turned ON before starting the pump.

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) 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.


### 5.7.2 Pumps fitted with packed gland


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

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

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

The pump should be run for 30 minutes with steady leakage and the gland nuts then tightened by 10 degrees at a time until leakage is reduced to an acceptable level, normally a minimum of 120 drops per minute is required. Bedding in of the packing may take another 30 minutes.


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


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

### 5.7.3 Pumps fitted with mechanical seal


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

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

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

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

### 5.7.4 Bearings

 If the pumps are working in a potentially explosive atmosphere, temperature or vibration monitoring at the pump 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) adjacent to the bearing and the ambient temperature (ta)
- Estimate the likely maximum ambient temperature (tb)
- Set the alarm at  $(t+tb-ta+5) \text{ } ^\circ\text{C}$  [ $(t+tb-ta+10) \text{ } ^\circ\text{F}$ ] and the trip at  $100 \text{ } ^\circ\text{C}$  ( $212 \text{ } ^\circ\text{F}$ ) for oil lubrication and  $105 \text{ } ^\circ\text{C}$  ( $220 \text{ } ^\circ\text{F}$ ) for grease lubrication

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

### 5.7.5 Normal vibration levels, alarm and trip

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

 **CAUTION** Alarm and trip values for installed pumps should be based on the actual measurements (N) taken on site on the bearing housings of the pump in the fully commissioned as new condition. The example (N) value is given for the preferred operating flow region (typically this may extend to 70 to 120% of the pump best efficiency point); outside the preferred flow region the actual vibration experienced may be multiplied by up to two.

These standard values can vary with the rotational speed and the power absorbed by the pump. For any special case, contact your nearest Flowserve office.

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

Vibration velocity – unfiltered	Horizontal pumps mm/s (in./s) r.m.s.	Vertical pumps mm/s (in./s) r.m.s.
Normal <b>N</b>	≤ 5.6 (0.22)	≤ 7.1 (0.28)
Alarm <b>N x 1.25</b>	≤ 7.1 (0.28)	≤ 9.0 (0.35)
Shutdown trip <b>N x 2.0</b>	≤ 11.2 (0.44)	≤ 14.2 (0.56)

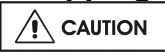

**5.7.6 Stop/start frequency**

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
90 (120) to 150 (200)	6
Above 150 (200)	Refer

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

**5.8 Stopping and shutdown**

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

**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<sub>R</sub>, 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<sub>A</sub> > NPSH<sub>R</sub>, and that noise and vibration are within local requirements and regulations.

**5.9.4 Net positive suction head (NPSH<sub>A</sub>)**

NPSH available (NPSH<sub>A</sub>) is a measure of the head available in the pumped liquid, above its vapour pressure, at the pump suction branch.

NPSH required (NPSH<sub>R</sub>) 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<sub>A</sub> > NPSH<sub>R</sub>. The margin between NPSH<sub>A</sub> > NPSH<sub>R</sub> should be as large as possible.


If any change in NPSH<sub>A</sub> 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)

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.

Guard fasteners must remain captive during dismantling of guards as described in section 5.4

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

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

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

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

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

**Do not spray air or compressed inert gas on skin.**

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

Never use air or compressed inert gas to clean clothes.

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

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

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

## 6.2 Maintenance schedule



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

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

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

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

- a) Refer to section 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)




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)  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

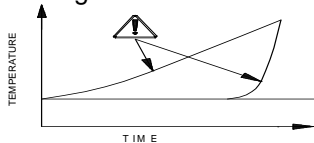
Lubricant and bearing temperature analysis can be useful in optimizing lubricant change intervals. In general however, the following is recommended.

#### 6.2.3.1 Grease lubrication

 See section 5.2.2 for grease recommendations.

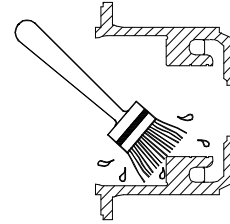
**Regrease** - via grease nipples every 2 000 hours or sooner depending on the severity of the application.

- a) It is important not to under or over grease the bearings as this will lead to over heating and premature failure. Grease lubricated bearing housings have grease nipples fitted in the bearing housings (except some LR-S pumps that have sealed-for-life bearings).
- b) 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 (99 °F) or a combined maximum of 95 °C (204 °F).
- c) 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.

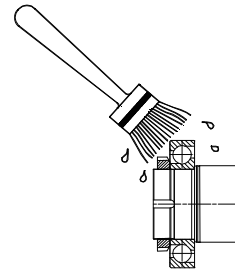
- a) Remove the bearing housing from the rotor assembly.
- b) Brush the bearing housing with hot kerosene (100 to 115 °C/212 to 240 °F) or other non-toxic solvent .
- c) Clean and flush out the housing with a light mineral oil.



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

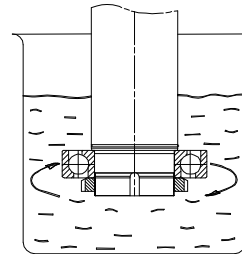
To clean the bearings:

- 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 that 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.

#### 6.2.3.2 Oil lubrication

 Maintaining the correct oil level is very important.

If the pump is supplied with a constant level oiler the oil level will be automatically maintained and as long as oil is visible in the glass bottle there is no need to



refill. If however a sight glass has been fitted then regular checks should be made to ensure the level is maintained at the centre of the glass window.

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

#### 6.2.4 Mechanical seals

No adjustment is possible. When leakage reaches an unacceptable level the seal will need replacement.

#### 6.2.5 Gland packing

The stuffing box gland can be backed off for re-packing or to enable the addition of extra rings of packing.

The stuffing box is normally supplied with a lantern ring to enable a clean or pressurised flush to the centre of the packing. If not required, this can be replaced by an extra 2 rings of packing.

There must always be a small leakage, normally a minimum of 120 drops per minute to atmosphere to lubricate and cool the packing is required.

#### 6.2.6 Internal coating

If the pump has an internal coating, this coating must be inspected periodically. Any wear or cracks of the coating found must be immediately repaired. Failure to do this may lead to accelerated wear of the coating during operation and corrosion of the exposed base metal, depending on the material and pumped liquid. Special attention must be paid to the coating edges. Any loss of coating material is considered to be normal wear and tear on the pump and is not considered as warranty. Flowserve has applied the coatings according to the supplier's instructions but will not be held responsible for coating wear or cracks that may develop over time.

### 6.3 Spare parts

#### 6.3.1 Ordering of spares

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

- 1) Pump serial number.
- 2) Pump size.
- 3) Part name – taken from 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 safety certification.

#### 6.3.2 Storage of spares

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

### 6.4 Recommended spares and consumable items

*For start up purposes:*

- 1 - complete set of gland packing
- 2 - shaft sleeves
- 1 - set of gaskets and seals
- (optional: 2 - mechanical seals)

*For 2 years operation:*

- 1 - set of bearings (line and thrust)
- 2 - sets of gland packing
- 2 - shaft sleeves
- 2 - sets of gaskets and seals
- 2 - lantern rings
- 2 - casing wear rings
- (optional: 2 - mechanical seals
- 2 - impeller wear rings)

*For 4 years operation:*

- 1 - set of bearings (line and thrust)
- 2 - sets of gland packing
- 2 - shaft sleeves
- 2 - sets of gaskets and seals
- 2 - lantern rings
- 2 - casing wear rings
- 1 - impeller
- (optional: 2 - mechanical seals
- 2 - impeller wear rings)

### 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 24 (7/8 in.) screws/nuts
- Socket spanners (wrenches), up to M 24 (7/8 in.) screws
- Allen keys, up to 6 mm (¼ in.) 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.  
(Consult Flowserve if this is difficult to source.)

See also section 6.8.1.k.

### 6.6 Fastener torques

Screw/bolt size	Torque Nm (lbf-ft)	
	Pump feet fasteners	All other fasteners
M8 (5/16 in.)	-	10 (7)
M10 (3/8 in.)	-	20 (15)
M12 (1/2 in.)	63 (46)	34 (25)
M16 (5/8 in.)	170 (125)	84 (62)
M20 (3/4 in.)	340 (250)	165 (120)
M24 (7/8 in.)	590 (435)	285 (210)

**CAUTION** Non-metallic gaskets incur creep relaxation - before commissioning the pump check and retighten fasteners to tightening torques stated.

### 6.7 Renewal clearances

As wear takes place between the impeller and casing 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. On the LRV it is recommended that the product lubricated bearing is renewed at a diametrical clearance of 0.5 mm (0.02 in.).

### 6.8 Disassembly

**CAUTION** Refer to section 1.6, *Safety*, before dismantling the pump.

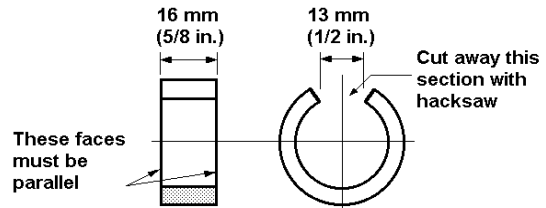
**CAUTION** Before dismantling the pump for overhaul, ensure genuine Flowserve replacement parts are available.

To dismantle the pump consult the sectional drawings. See section 8, *Parts lists and drawings*.

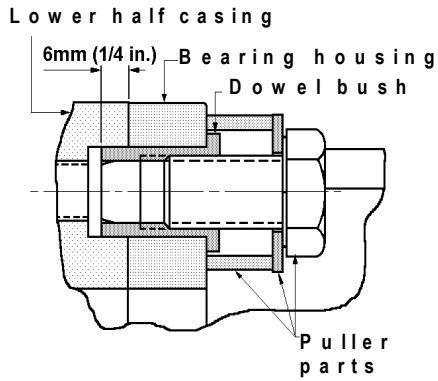
#### 6.8.1 LR and LLR

- Isolate motor and lock off electrical supply in accordance with local regulations.
- Isolate suction and discharge valves.
- Remove coupling guards and disconnect the coupling halves.
- Drain pump casing. Remove any auxiliary piping if applicable.
- If bearings are oil lubricated drain oil from both bearing housings [3200].
- Remove the pump half coupling.
- Unbolt the glands/seal covers from the casing. If glands are split type, remove completely.
- With a suitable punch, drive out the two straight roll pins which are used on the horizontal split flange to align the upper and lower half casings [1214 and 1213].
- Remove the screws, which hold the upper and lower half of the casing together, and remove the upper half. Tapped holes are provided in the joint flange to enable the use of forcing bolts to loosen the joint.
- Lift the casing upper half using the cast on lifting lugs where provided. Where there are no integral lifting lugs, remove the pipe plug or fittings, if used, from the volute vent connection located on top of the casing upper half and install a special steel lifting eye with a threaded shank to match the pipe tap opening in the casing.
- Remove the bearing housing to casing screws [6570.1] and remove the 2 dowel bushings on each side. A tool for removing the bushings can be easily and economically made as shown in the following diagrams:

**CAUTION** Do **NOT** use these methods to lift the bottom half or complete pump casing.



Material: 25 mm (1 in.) standard weight steel pipe



- l) Lift out rotor assembly. Use care in slinging, handling and supporting of the rotor for subsequent dismantling. Place rotor securely on two support blocks.
- m) When removing the rotor assembly, the casing wear rings [1500] will be attached to it. They are fixed by two diametrically opposite grub screws [6814.1] inserted into the casing ring and located in grooves in the lower half casing. (On the LLR design the interstage bush [1610] between the two impellers will also be attached to the shaft.)
- n) Remove bearing covers and slide bearing housing off the bearings. Some pump sizes have a shim fitted at the non-drive end – retain for future use.
- o) Release the bearing lockwasher [6541] at the non-drive end and remove the bearing nut [3712]. Pull off both ball bearings using a suitable puller, ensuring force is applied to inner race only. Retain the non-drive end bearing disc spacer [3645], fitted to the shaft [2100] on some pump sizes, for future use. Remove the bearing covers [3260].
- p) Depending on configuration remove glands/seal covers, packing and lantern ring/mechanical seal.
  - Refer to any special instructions supplied with the mechanical seal.
- q) Remove the two socket head grub screws [6814.2] securing each shaft nut [2910.1]. Using C-spanner remove shaft nuts. Slide off shaft sleeves [2450].
- r) Remove impeller(s), casing wear rings, impeller key, and interstage bush, if fitted. The 2.5LR10 and 2.5LR13 are not fitted with shaft sleeves and removal of the impeller nut will allow the impeller to be withdrawn.
  - If impellers prove difficult to remove, the use of heat is permissible. Refer to Section 1.6, *Safety, Applying heat to remove impeller*, for more details.
- s) If impeller wear rings [2300] are also fitted, they are shrunk onto the impeller and fixed with locking grub screws [6814.4] between their diametral mating surfaces.

- t) To remove the impeller wear rings, remove the locking grub screws and heat up the wear ring until it slides off easily.

**6.8.2 LR-S**

- a) Isolate motor and lock off electrical supply in accordance with local regulations.
- b) Isolate suction and discharge valves.
- c) Remove coupling guards and disconnect the coupling halves.
- d) Drain pump casing. Remove any auxiliary piping if applicable.
- e) If bearings are oil lubricated drain oil from both bearing housings [3200].
- f) Remove the pump half coupling.
- g) Unbolt the glands/seal covers from the casing. If glands are split type, remove completely.
- h) With a suitable punch, drive out the two straight roll pins which are used on the horizontal split flange to align the upper and lower half casings [1214 and 1213].
- i) Remove the screws [6569.4] that hold the upper and lower half of the casing together and remove the upper half. Tapped holes are provided in the joint flange to enable the use of forcing screws to loosen the joint.
- j) Lift the casing upper half using the cast on lifting lugs where provided. Where there are no integral lifting lugs, remove the pipe plug or fittings, if used, from the volute vent connection located on top of the casing upper half and install a special steel lifting eye with a threaded shank to match the pipe tap opening in the casing.
  - Do NOT use these methods to lift the bottom half or complete pump casing.**
- k) Remove the bearing housing to casing bolts and dowels on each side.
- l) Lift out rotor assembly. Use care in slinging, handling, and supporting of the rotor for subsequent dismantling.
- m) Place rotor securely on two support blocks.

- n) When removing the rotor assembly, the casing wear rings [1500] will be attached to it. They are both secured against rotation by one cylindrical pin [6811] inserted into the casing wear ring and located in a hole at 6 o'clock in the lower half casing.
- o) Remove both bearing covers and circlip from non-drive end bearing. Using bearing pullers remove bearing housing complete with bearings and shaft seal rings from the pump shaft. If double row bearings are fitted the non-drive end bearing will be secured by bearing nut [3712] and lockwasher [6541].
- p) Depending on configuration remove glands/seal covers, packing and lantern rings/mechanical seal.



Refer to any special instructions supplied with the mechanical seal.

- q) Remove the socket head grub screws [6814.1] securing each shaft nut. Using C-spanner remove shaft nuts [2910]. Slide off shaft sleeves [2450].
- r) Remove impeller [2200], casing wear rings and impeller key.



The impeller is a shrink fit on the shaft and the boss of the impeller must be heated in order to remove it. Refer to Section 1.6, *Safety, Applying heat to remove impeller*, for more details.

- s) This work must only be undertaken when both shaft nuts and sleeves have been fully removed.
- t) If impeller wear rings are also fitted, they are shrunk onto the impeller and fixed with locking grub screws [6814.3] between their diametral mating surfaces.
- u) To remove the impeller wear rings, remove the locking grub screws and heat up the ring until it slides off easily.

### 6.8.3 LRV

The pump is best removed from the system to carry out a complete strip down. It should be set down with the shaft horizontal to enable the pump to be dismantled in a similar fashion to the LR and LLR.

- a) Isolate motor and lock off electrical supply in accordance with local regulations.
- b) Isolate suction and discharge valves.
- c) Remove coupling guards and disconnect the coupling halves.
- d) Drain pump casing and, if applicable, remove any auxiliary piping.
- e) Remove motor complete with motor stool and set down carefully in a safe location.
- f) Retain any shimming between stool and pump casing.
- g) Remove screws securing the pump suction and discharge flanges.

- h) Sling pump as shown in section 2.3 and allow lifting gear to just take the pump weight. Remove screws securing the pump casing to the baseplate.
- i) Remove the pump to a safe location and manoeuvre the pump shaft into a horizontal position.
- j) Remove the pump half coupling.
- k) Unbolt the seal cover from the casing at the drive end.
- l) Remove the bottom bearing carrier [3240] (non-drive end) complete with bearing bush [3300], taking care not to damage the bearing surfaces.
- m) With a suitable punch, drive out the two straight roll pins which are used on the horizontal split flange to align the upper and lower half casings [1214 and 1213].
- n) Carry on as for LR and LLR section 6.8.1, j) to k).
- o) Lift out rotor assembly. Use care in slinging, handling, and supporting of the rotor for subsequent dismantling. Place rotor securely on two support blocks. Protect the bearing surface on the outside diameter of the bottom shaft sleeve from damage.
- p) Remove drive end bearing cover, outboard shaft seal ring [4305.2] and slide bearing housing [3200] off the bearing. Some pump sizes have a shim fitted – retain for future use.
- q) Release the bearing lockwasher [6541] and remove the bearing nut [3712]. Pull off drive end thrust ball bearing using a suitable puller, ensuring force is applied to inner race only. Remove the bearing cover and inboard shaft seal ring [4305.1].
- r) Depending on configuration remove the gland/seal cover, packing and lantern ring/mechanical seal from the drive end.



Refer to any special instructions supplied with the mechanical seal.

- s) Remove the two socket head grub screws [6814.3] securing the shaft nut [2910.1] at the drive end. Using a C-spanner remove shaft nut. Slide off top shaft sleeve [2450.2].
- t) Remove socket head cap screw [6579], sleeve end cap [6415], and bottom shaft sleeve [2450.1]. Take care not to damage the bearing surface on the sleeve.
- u) Remove impeller, casing wear rings [1500] and impeller key [6700.1].



If impeller proves difficult to remove, the use of heat is permissible. Refer to Section 1.6, *Safety, Applying heat to remove impeller*, for more details.

- v) If impeller rings [2300] are fitted, they are shrunk onto the impeller and fixed with locking grub screws [6814.4] as for LR/LLR. To remove refer to 6.8.1, paragraph t).

## 6.9 Examination of parts



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, seal housing and impeller

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

### 6.9.2 Shaft and sleeve (if fitted)

Replace if grooved, pitted or worn.

### 6.9.3 Gaskets and O-rings

After dismantling, discard and replace.

### 6.9.4 Bearings

- It is recommended that bearings are not re-used after any removal from the shaft.
- The plain liquid lubricated bearings may be re-used if both the bearing bush and bottom shaft 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 shaft seal rings (if fitted)

- The lubricant, bearings and shaft seal rings are to be inspected for contamination and damage. If oil bath lubrication is utilised, these provide useful information on operating conditions within the bearing housing.
- 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.
- Labyrinth seals and bearing isolators, if fitted as options, should be inspected for damage but are normally non-wearing parts and can be re-used.
- Shaft seal rings are not totally leak free devices. Oil from these may cause staining adjacent to the bearings.

## 6.10 Assembly

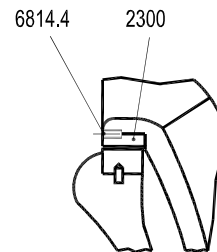
To assemble the pump consult the sectional drawings, see section 8, *Parts list and drawings*.

Ensure threads, gasket and O-ring mating faces are clean. Apply thread sealant to non-face sealing pipe thread fittings. Coat the outside diameter of the dowel bushings with pipe compound prior to installation.

### 6.10.1 LR/LLR

#### 6.10.1.1 Impeller wear rings

- Impeller rings (when fitted) should be heated up to approximately 100 °C (212 °F) using a hotplate or hot oil bath and then slipped onto the impeller and pressed down to the shoulder. (Do NOT use a steel hammer to knock them into position.)
- Drill and tap 3 holes approximately 120 degrees apart into the diametral mating faces of the ring and impeller and insert socket head grub screws. (The existing half tapped holes from the removed impeller ring cannot be re-used.)



#### 6.10.1.2 Pre-assembly of casing gasket

- Fit casing gasket to the bottom half horizontal flange using a small amount of contact adhesive to prevent movement when the top half is fitted. Do not apply adhesive to the top surface of the gasket.
- It is important that the external corner of the casing gasket face and the stuffing box face is as sharp as possible.

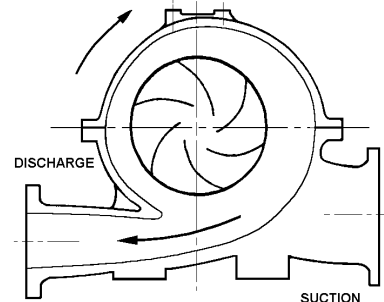


**Do not chamfer with a file.**

- If necessary trim gasket to match volute profile. Do not trim to stuffing box face at this stage.

#### 6.10.1.3 Rotating element and bearing housing

- Ensure all gaskets and O-rings are renewed and replaced in the correct position during assembly.
- Assemble the impeller on the shaft. It is important to mount the impeller so that the vane tips point away from the apparent flow direction.



The rotor always rotates towards the expanding section of the volute

- If working on a two-stage LLR pump, the interstage sleeve and interstage bush, complete with anti-rotation grub screw, must be fitted on to the shaft between the two impellers.

- d) Fit the two shaft sleeves, O-rings and shaft nuts and lightly secure the impeller(s) on the shaft. Take care to protect the sleeve O-rings from damage on the shaft threads. The sleeves and nuts define the impeller position on the pump shaft and hence in the pump casing. Initially position the impeller(s) centrally on its keyway. This position may be adjusted slightly later on in the assembly process.

**Note:**

2.5LR pumps do not have sleeves fitted and the impeller is positively held against the shaft shoulder by the impeller nut and cannot subsequently be adjusted.

- e) It is recommended that gasket sealing compound Loctite 574 or equivalent is used between sleeve and impeller mating faces to protect the shaft from the liquid pumped.
- f) When mechanical seals are fitted the rotating parts can be slid onto the sleeves before the sleeves are fitted onto the shaft. The seal retaining rings should be left loose. On some sizes of LLR a second stage stuffing throttling box bush [1630] is fitted, this must be slid onto the shaft before the seal.

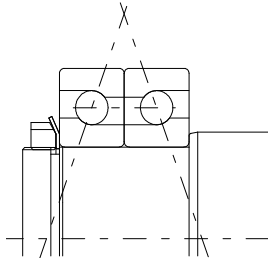


Refer to any special instructions supplied with the mechanical seal.

- g) If gland packing is used fit stuffing box throttling bush and glands.
- h) Fit mechanical seal covers complete with seal seat, liquid flingers [2540] and bearing covers complete with gaskets.
- i) Fit the bearings onto the shaft. The main thrust bearing is at the non-drive end.

**Note:**

Where double row bearings are fitted these must be assembled 'back to back' as below:



The 2.5LR13, 4LR11, 4LR14 and 5LR13 pumps have bearing disc spacers fitted to the shaft at the non-drive end. Ensure this is fitted before the bearing is assembled to the shaft. The bearings must be heated up to 100 °C (212 °F) using a hot plate, oil bath or induction heater and slid onto the shaft. Ensure bearing is fully seated against the shaft shoulder and bearing disc spacer, where fitted.

- j) If grease lubricated, fill both sides of bearing with grease.
- k) Fit the bearing lockwasher and tighten the bearing nut.

- l) Bend over a tab of lockwasher into bearing nut slot.
- m) Slip casing wear rings, complete with anti-rotation grub screws, loosely over the impeller hubs.
- n) Slide the bearing housings over the bearings. All pumps except the 10LR17 and 10LR18 have a shim fitted between the outside diameter of the non-drive end bearing and the bearing housing. Ensure shim is seated against the shoulder in the bearing housing before sliding housing over the bearing. Ensure bearings are located square in the housing bore.
- o) If grease lubricated, one third fill the space between bearing cover and bearing with grease. Secure bearing cover, complete with gasket.
- p) Fit the coupling hub.

#### 6.10.1.4 Casing lower half

- a) Coat the bearing housing to casing face with liquid sealant to protect against corrosion.
- b) Place the complete rotating assembly into the casing ensuring that wear rings are in the correct position and the anti-rotation grub screws are located in the slots on the horizontal flange. If working on an LLR pump the anti-rotation grub screw in the second stage stuffing box bush, when fitted, and the interstage bush must also locate in the slot on the horizontal flange.
- c) Locate the dowel bush within the holes in the lower half casing and bolt the bearing housings to the casing. The dowel bushes must be sprayed with anti-seize compound (Molyslip or equivalent) before assembly in to the housing/casing.
- d) Torque up the fixing screws.
- e) Check rotor for free rotation.
- f) Centralize the impeller(s) within the casing waterway by adjusting the shaft nut, if necessary. Using a C-spanner fully tighten the shaft nuts and lock with the two radial socket head grub screws.
- g) Set the mechanical seals, if fitted, to correct working length and tighten seal retaining ring screws.



Refer to any special instructions supplied with the mechanical seal.

- h) Check for free rotation.

#### 6.10.1.5 Casing upper half

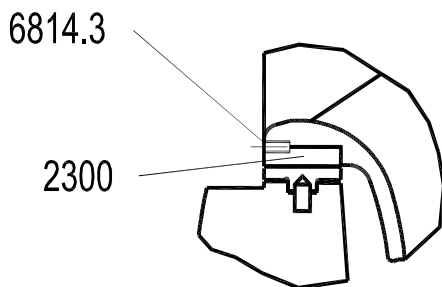
- a) Lower the casing upper half over the lower half. Take care to ensure the wear rings are correctly located in the upper half bores.
- b) Drive home the two casing roll pins to accurately position the casing and torque up all horizontal flange screws.
- c) Check for free rotation.
- d) Using a sharp flexible-bladed knife, cut off the exposed casing gasket in the stuffing box area flush with the stuffing box face.

- e) If mechanical seals are fitted apply a small amount of silicon rubber sealant along the horizontal joint line on the stuffing box face and fit seal cover complete with gasket or O-ring. Take care not to damage O-ring, if fitted, and locate cover squarely on stuffing box face. Some seal covers do not have a spigot location in the casing bore and care must be taken to ensure the seal seat bore is concentric to the shaft sleeve. This is best achieved using feeler gauges between the stationary seal seat bore and the shaft sleeve.
- f) Torque up seal cover screws and check shaft/sleeve does not rub on seal cover or stationary seal seat bore. Ensure any spare holes in mechanical seal cover, particularly on cartridge mechanical seals, have sealing plugs fitted.
- g) If gland packing is fitted pack the gland, ensuring that the cut ends in each ring are staggered by 120 degrees. The glands are packed as shown on the relevant drawings in Sections 8.1 to 8.3. Finger tighten the gland nuts.
- h) Check coupling alignment, fit coupling drive element(s) and fit guards.
- i) Pipe up any external auxiliary connections.
- j) Check for free rotation.

**6.10.2 LR-S**

**6.10.2.1 Impeller wear rings**

- a) Impeller rings (when fitted) should be heated up to approximately 100 °C (212 °F) using a hotplate or hot oil bath and then slipped onto the impeller and pressed down to the shoulder. (Do NOT use a steel hammer to knock them into position.)
- b) Drill and tap 3 holes approximately 120 degrees apart into the diametral mating faces of the ring and impeller and insert socket head grub screws. (The existing half tapped holes from the removed impeller ring cannot be re-used.)



**6.10.2.2 Pre-assembly of casing gasket**

- a) Fit casing gasket to the bottom half horizontal flange using a small amount of contact adhesive to prevent movement when the top half is fitted. Do not apply adhesive to the top surface of the gasket.

- b) It is important that the external corner of the casing gasket face and the stuffing box face is as sharp as possible.

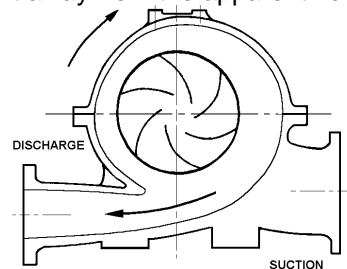


**Do not chamfer with a file.**

- c) If necessary trim gasket to match volute profile. Do not trim to stuffing box face at this stage.

**6.10.2.3 Rotating element and bearing housing**

- a) Ensure all gaskets and O-rings are renewed and replaced in the correct position during assembly.
- b) Assemble the impeller on the shaft. It is important to mount the impeller so that the vane tips point away from the apparent flow direction.



*The rotor always rotates towards the expanding section of the volute.*



- c) The impeller is an interference fit on the shaft and the impeller boss needs quickly heating up to allow it to be fitted to the shaft. Take extreme care when handling hot components. Position impeller centrally on its keyway.
- d) Fit the two shaft sleeves, O-rings and shaft nuts. Take care to protect the sleeve O-rings from damage on the shaft threads.
- e) It is recommended that gasket sealing compound Loctite 574 or equivalent is used between sleeve and impeller mating faces to protect the shaft from the liquid pumped.
- f) When mechanical seals are fitted the rotating parts can be slid onto the sleeves before the sleeves are fitted onto the shaft. The seal retaining ring should be left loose.



Refer to any special instructions supplied with the mechanical seal.

- g) If gland packing is used fit stuffing box throttling bush [1630] and glands.
- h) Fit mechanical seal covers complete with seal seat, liquid flingers [2540] and bearing housings complete with shaft seal rings.
- i) Fit the bearings on to the shaft. The main thrust bearing is at the non-drive end. The bearings must be heated up to 100 °C (212 °F) using a hot plate, oil bath or induction heater and slid onto the shaft. Ensure bearing is fully seated against the shaft shoulder.

- j) If bearings are grease lubricated they will be sealed for life and do not require any extra grease.
- k) Fit the bearing circlip [6544] or bearing nut/lockwasher at the non-drive end. Bend over a tab of lockwasher into the bearing nut slot, if fitted.
- l) Slide bearing housings over bearings ensuring bearings are located square in the bores.
- m) Fit bearing cover complete with gasket and shaft seal ring.
- n) Slip casing rings complete with anti-rotation cylindrical pins loosely over the impeller hubs.
- o) Fit the coupling hub.

**6.10.2.4 Casing lower half**

- a) Coat the bearing housing to casing face with liquid sealant to protect against corrosion.
- b) Place the complete rotating assembly into the casing ensuring that wear rings are fitted in the grooves machined into the casing and the anti-rotation cylindrical pins are located in the holes in the bottom of the casing bore.
- c) Locate the dowels in the bearing housing into the holes in the lower half casing and bolt the bearing brackets to the casing. The dowels must be sprayed with anti-seize compound (Molyslip or equivalent) before assembly into the bearing housing/casing.
- d) Torque up the fixing screws.
- e) Check rotor for free rotation.
- f) Check end float of rotor is between 0.2 mm to 1.5 mm (0.008 in. to 0.060 in.).
- g) Using a C-spanner fully tighten the shaft nuts and lock with the two radial socket head grub screws.
- h) Set the mechanical seals, if fitted, to the correct working length and tighten the seal collar screws.



Refer to any special instructions supplied with the mechanical seal.

- i) Check for free rotation.

**6.10.2.5 Casing upper half**

- a) Lower the casing upper half over the lower half. Take care to ensure that the wear rings are correctly located in the upper half bores.
- b) Drive home the two casing roll pins to accurately position the casing and torque up all horizontal flange screws.
- c) Check for free rotation.
- d) Using a sharp flexible bladed knife, cut off the exposed casing gasket in the stuffing box area flush with the stuffing box face.
- e) If mechanical seals are fitted apply a small amount of silicon rubber sealant along the horizontal joint line on the stuffing box face and fit the seal cover complete with gasket or O-ring. Take care not to damage the O-ring, if fitted, and locate the cover squarely on the stuffing box face. Some seal

covers do not have a spigot location in the casing bore and care must be taken to ensure the seal seat bore is concentric to the shaft sleeve. This is best achieved using feeler gauges between the stationary seal seat bore and the shaft sleeve.

- f) Torque up seal cover screws and check shaft/sleeve does not rub in seal cover bore. Ensure any spare holes in seal cover, particularly on cartridge mechanical seals, have sealing plugs fitted.
- g) If gland packing is fitted, pack the gland, ensuring that the cut ends in each ring are staggered by 120 degrees.
- h) The glands are packed as shown in section 8.4. Finger tighten the gland nuts.
- i) Check coupling alignment, fit coupling drive element(s) and fit guards.
- j) Pipe up any external auxiliary connections.

**6.10.3 LRV**

**6.10.3.1 Impeller wear rings**

As for LR/LLR. (See section 6.10.1.1.)

**6.10.3.2 Pre-assembly of casing gasket**

As for LR/LLR. (See section 6.10.1.2.)

**6.10.3.3 Pre-assembly of bottom bearing carrier – silicon carbide bearing**

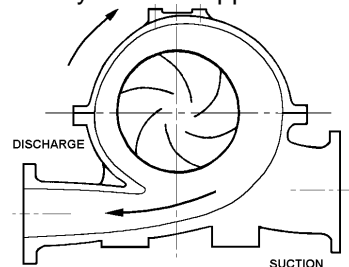
- a) Insert tolerance ring [2550] in bottom bearing carrier and press in bearing bush [3300.1] until it is square against the shoulder at the bottom of the carrier.
- b) Fit bearing retaining ring and secure with radial locking screw.

**6.10.3.4 Pre-assembly of bottom bearing housing - Cutless rubber bearing**

Press Cutless rubber bearing [3300.2] into bottom bearing carrier.


**6.10.3.5 Rotating element and bearing housing**

- a) Ensure all gaskets and O-rings are renewed and replaced in the correct position during assembly.
- b) Assemble the impeller on the shaft. It is important to mount the impeller so that the vane tips point away from the apparent flow direction.



The rotor always rotates towards the expanding section of the volute



- c) Fit the two shaft sleeves, top O-ring, drive end shaft nut, bottom sleeve end cap and socket headed cap screw. Take care to protect the sleeve O-ring from damage on the shaft thread. It is recommended Loctite 243 or equivalent is used to lock the socket headed cap screw in the shaft.
  - d) Lightly secure the impeller on the shaft. Take care to protect the bearing surface on the bottom shaft sleeve. The shaft sleeves and shaft nuts define the impeller position on the pump shaft and hence in the pump casing. Initially position the impeller centrally on its keyway. This position may be adjusted slightly, later on in the assembly process.
  - e) It is recommended that gasket sealing compound (Loctite 574 or equivalent) is used between sleeve and impeller mating faces to protect the shaft from the liquid pumped.
  - f) The rotating parts of the mechanical seal can be slid onto the top shaft sleeve [2450.2] before it is fitted on to the shaft. The seal retaining ring should be left loose.
-  Refer to any special instructions supplied with the mechanical seal.
- g) If gland packing is used fit stuffing box throttling bush and gland.
  - h) Fit seal cover complete with seal seat, inboard shaft seal ring and drive end bearing cover complete with gasket.
  - i) Fit the ball thrust bearing at the drive end onto the shaft. The 5LRV15, 6LRV13, 6LRV16 and 6LRV18 pumps have bearing disc spacers fitted to the shaft at the drive end - ensure this is fitted before the bearing is assembled to the shaft. The bearing must be heated up to 100 °C (212 °F) using a hot plate, oil bath or induction heater and slid onto the shaft. Ensure bearing is fully seated against the shaft shoulder and bearing disc spacer, where fitted.
  - j) Fill both sides of bearing with grease.
  - k) Fit the bearing lockwasher and tighten the bearing nut. Bend over a tab of lockwasher into bearing nut slot.
  - l) Slip casing wear rings complete with anti-rotation screws loosely over impeller hubs.
  - m) Slide the bearing housing over the drive end bearing. All pumps except the 10LR17 and 10LR18 have a shim fitted between the outside diameter of the drive end bearing and the bearing housing. Ensure shim is seated against the shoulder in the bearing housing before sliding housing over the bearing. Ensure bearing is located square in the housing bore.
  - n) One third fill the space between bearing cover and bearing with grease.

- o) Secure bearing cover, complete with gasket.
- p) Fit outboard shaft seal ring.
- q) Fit the coupling hub.

### 6.10.3.6 Casing lower half

- a) Coat the bearing housing to casing face with liquid sealant to protect against corrosion.
- b) Place the complete rotating assembly into the casing ensuring that wear rings are in the correct position and the anti-rotation grub screws are located in the slots on the horizontal flange.
- c) Locate the dowel bushings within the holes in the lower half casing and bolt the bearing housing to the casing. The dowel bushes must be sprayed with anti-seize compound (Moly slip or equivalent) before assembly into the bearing housing/casing.
- d) Lightly torque up the fixing screws.
- e) Centralize the impeller within the casing waterway by adjusting the shaft nut and socket head capscrew, if necessary. Apply locking compound (Loctite 222 or equivalent) to the threads of the capscrew.
- f) Fully tighten the shaft nut and socket head capscrew and lock the shaft nut with the two radial socket head grub screws.
- g) Set the mechanical seal to the correct working length and tighten the seal retaining ring screws.



Refer to any special instructions supplied with the mechanical seal.

### 6.10.3.7 Casing upper half

- a) Lower the casing upper half over the lower half. Take care to ensure the wear rings are correctly located in the upper half bores.
- b) Drive home the two casing roll pins to accurately position the casing and torque up all horizontal flange screws [6570.1 and 6570.2].
- c) Using a sharp flexible bladed knife, cut off the exposed casing gasket in the stuffing box area flush with the stuffing box face.
- d) Secure bottom bearing carrier complete with bearing bush and O-ring seal into stuffing box bore.
- e) Fully torque up bearing carrier fixing screws [6570.5].
- f) Check for free rotation.
- g) Apply silicon rubber sealant along the horizontal joint line on the stuffing box face at drive end and fit seal cover complete with gasket or O-ring. Take care not to damage O-ring, if fitted, and locate cover squarely on stuffing box face. Some seal covers do not have a spigot location in the casing bore and care must be taken to ensure the seal seat bore is concentric to the shaft sleeve. This is best achieved using feeler gauges between the stationary seal seat bore and the shaft sleeve.

- h) Torque up seal cover screws [6570.3] and check shaft/sleeve does not rub in seal cover or stationary seal seat bore. Ensure any spare holes in mechanical seal cover, particularly on cartridge mechanical seals, have sealing plugs fitted.
- i) If gland packing is fitted, pack the gland, ensuring that the cut ends in each ring are staggered by 120 degrees.
- j) The glands are packed as shown in section 8.2. Finger tighten gland nuts.
- k) Add the same grease as used on the bearings under the lips of the inboard and outboard shaft seal rings [4305] and slide up to bearing cover and bearing housing faces to give light contact.
- l) Pipe up any external auxiliary connections.
- m) Check for free rotation.

## 7 FAULTS; CAUSES AND REMEDIES

### FAULT SYMPTOM

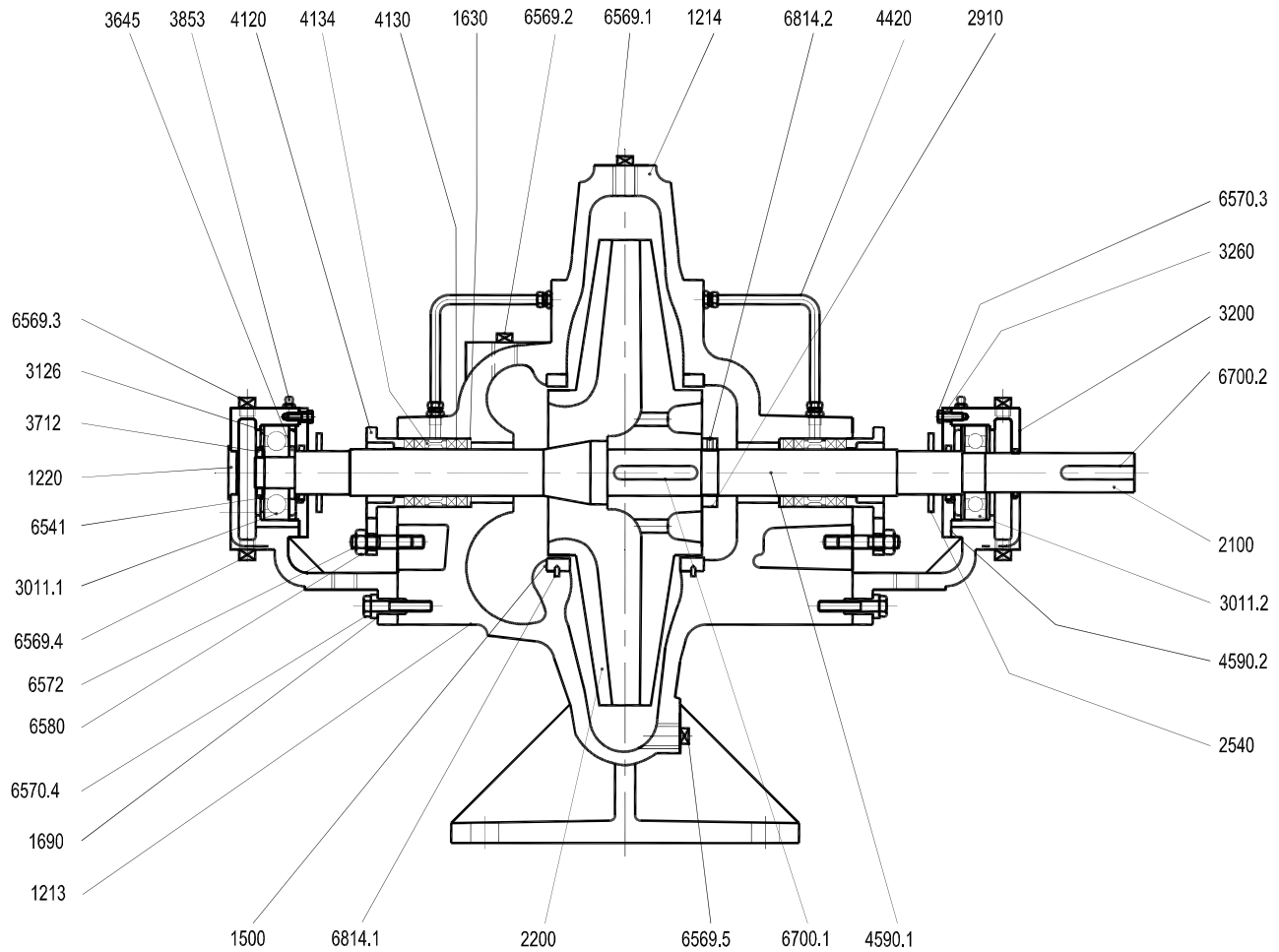
Pump overheats and seizes												
↓	Bearings have short life											
↓	↓	Pump vibrates or is noisy										
↓	↓	↓	Mechanical seal has short life									
↓	↓	↓	↓	Mechanical seal leaks excessively								
↓	↓	↓	↓	↓	Pump requires excessive power							
↓	↓	↓	↓	↓	↓	Pump loses prime after starting						
↓	↓	↓	↓	↓	↓	Insufficient pressure developed						
↓	↓	↓	↓	↓	↓	Insufficient capacity delivered						
↓	↓	↓	↓	↓	↓	Pump does not deliver liquid						
					↓	PROBABLE CAUSES				POSSIBLE REMEDIES		
<b>A. SYSTEM TROUBLES</b>												
●										●	Pump not primed.	Check complete filling.
		●								● ● ●	Pump or suction pipe not completely filled with liquid.	Check and complete filling.
●	●									● ● ●	Suction lift too high or level too low.	Check $NPSH_A > NPSH_R$ , proper submergence, losses at strainers and fittings.
										● ● ●	Excessive amount of air or gas in liquid.	Check and purge from pipes.
										● ● ●	Air or vapour pocket in suction line.	Check suction line design for pockets.
										● ●	Air leaks into suction line.	Check airtight pipe then joints and gaskets.
										● ●	Air leaks into pump through mechanical seal, sleeve joints, casing joint or pipe lugs.	Check airtight assembly then joints and gaskets.
	●									●	Foot valve too small.	Investigate replacing the foot valve.
	●									●	Foot valve partially clogged.	Clean foot valve.
	●									● ● ●	Inlet of suction pipe insufficiently submerged.	Check cut out system design.
										● ● ●	Total head of system higher than differential head of pump.	Check discharge head and head losses in discharge pipe at the valve settings. Check back pressure is not too high.
										●	Total head of system lower than pump design head.	Throttle at discharge valve or ask Flowserve if the impeller can be trimmed.
										●	Specific gravity of liquid different from design.	Consult Flowserve.
										● ● ●	Viscosity of liquid differs from design.	Consult Flowserve.
●	●										Operation at very low capacity.	Measure value and check minimum permitted.
●	●										Operation at high capacity.	Measure value and check maximum permitted.

**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					
<b>B. MECHANICAL TROUBLES</b>											
●	●	●	●	●	●	Misalignment due to pipe strain.				Check the flange connections and eliminate strains using elastic couplings or a method permitted.	
	●					Improperly designed foundation.				Check setting of baseplate: tighten, adjust, grout base as required.	
●	●	●	●	●		Shaft bent.				Check shaft runouts within acceptable values.	
●	●	●			●	Rotating part rubbing on stationary part internally.				Check for signs of this and consult Flowserve if necessary.	
●	●	●	●	●	●	Bearings worn				Replace bearings.	
					●	●	●	Wearing ring surfaces worn.			Replace worn wear ring/surfaces.
	●					●	●	Impeller damaged or eroded.			Replace impeller and check reason.
				●				Leakage under sleeve due to joint failure.			Replace joint and check for damage.
		●	●	●				Mechanical seal improperly installed.			Check alignment of faces or damaged parts and assembly method used.
		●	●	●				Incorrect type of mechanical seal for operating conditions.			Consult Flowserve
●	●	●	●	●	●	Shaft running off centre because of worn bearings or misalignment.				Check misalignment and correct if necessary. If alignment satisfactory check bearings for excessive wear.	
●	●	●	●			Impeller out of balance resulting in vibration.				Check and consult Flowserve.	
		●	●	●		Abrasive solids in liquid pumped.				Check and consult Flowserve.	
		●	●			Mechanical seal was run dry.				Check mechanical seal condition and source of dry running and repair.	
●	●	●	●	●	●	Internal misalignment due to improper repairs causing impeller to rub.				Check method of assembly, possible damage or state of cleanliness during assembly.	
●	●	●				Excessive thrust caused by a mechanical failure inside the pump.				Check wear condition of impeller, its clearances and liquid passages.	
●	●					Excessive grease in ball bearings.				Check method of regreasing.	
●	●					Lack of lubrication for bearings.				Check hours run since last change of lubricant, the schedule and its basis.	
●	●					Improper installation of bearings.				Check method of assembly, possible damage or state of cleanliness during assembly and type of bearing used.	
●	●					Damaged bearings due to contamination.				Check contamination source and replace damaged bearings.	
<b>C. ELECTRICAL TROUBLES</b>											
	●			●	●	Wrong direction of rotation.				Reverse 2 phases on motor terminal box.	
	●				●	●	Motor running too slow.				Check motor terminal box connections.

## 8 PARTS LISTS AND DRAWINGS

### 8.1 Sectional drawings – LR single entry impeller, grease lubricated, gland packed



(Drawing taken from A336/044, sheet 1, rev -)

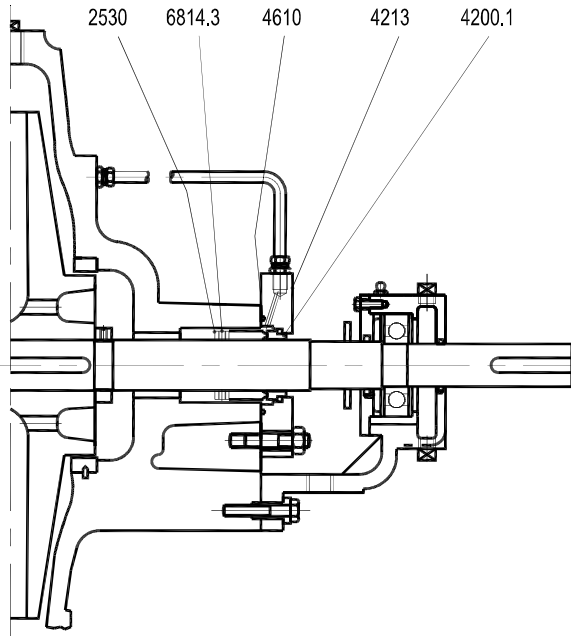
#### 8.1.1 Parts list – LR single entry impeller

Ref. no.	Description
1213	Casing half - lower
1214	Casing half - upper
1220	Cover
1500	Casing wear ring
1630	Throttling bush
1690	Bush (dowel)
2100	Shaft
2200	Impeller
2540	Flinger (liquid)
2910	Shaft nut
3011.1	Ball bearing
3011.2	Ball bearing
3126	Shim
3200	Bearing housing
3260	Bearing cover
3645	Disc spacer *
3712	Bearing nut
3853	Grease nipple
4120	Gland
4130	Gland packing

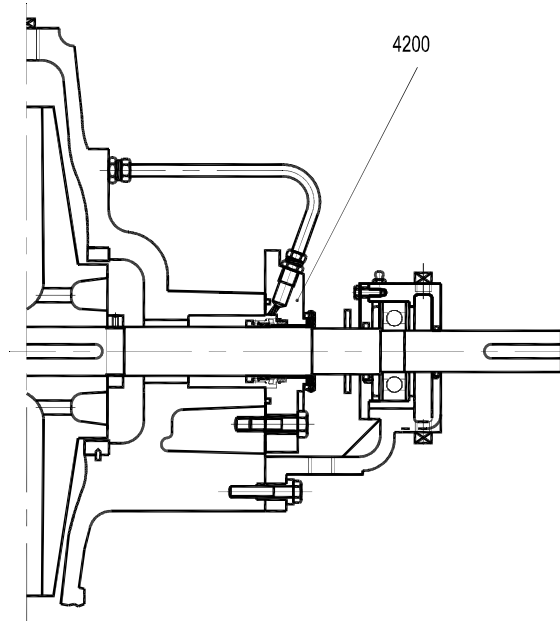
4134	Lantern ring
4420	Sealing pipe
4590.1	Gasket
4590.2	Gasket
6541	Lockwasher
6569.1	Plug
6569.2	Plug
6569.3	Plug
6569.4	Plug
6569.5	Plug
6570.1	Screw
6570.2	Screw
6570.3	Screw
6570.4	Screw
6572	Stud
6580	Nut
6700.1	Key
6700.2	Key
6814.1	Grub screw
6814.2	Grub screw

\* Fitted on 2.1/2LR13 pump size only

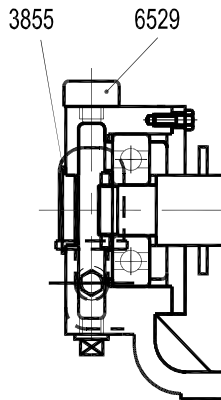
**8.1.2 Options - LR single entry impeller**



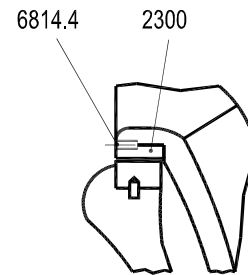
**Mechanical seal assembly**



**Cartridge seal assembly**



**Oil lubrication**



**Impeller wear ring**

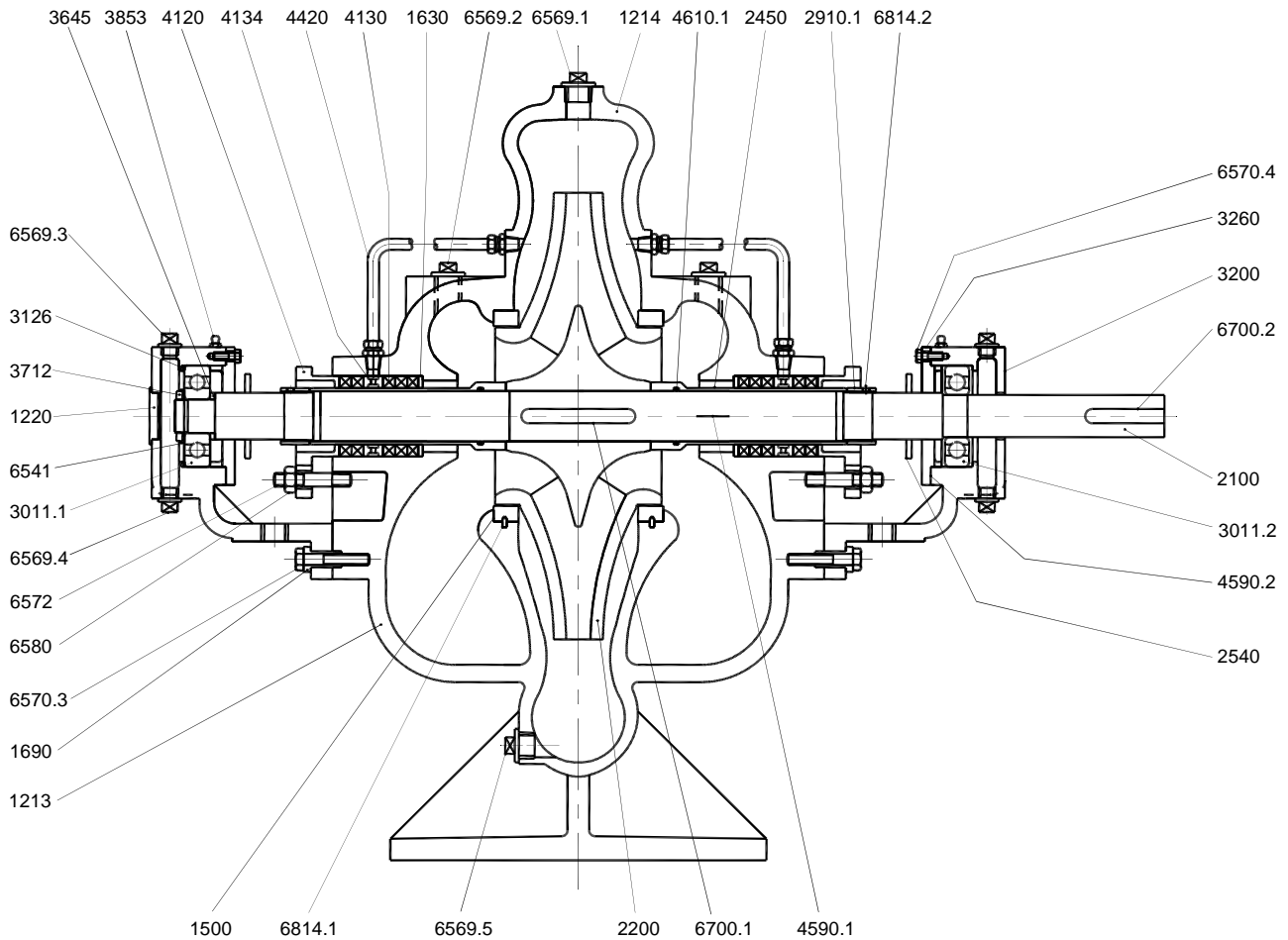
(Drawings taken from A336/044, sheet 2, rev -)

**8.1.3 Options parts list - LR single entry impeller**

Ref. no.	Description
2300	Impeller wear ring
2530	Retaining ring *
3855	Constant level oiler
4200	Mechanical seal (cartridge)
4200.1	Mechanical seal
4213	Mechanical seal cover
4610	O-ring
6529	Ventilation device (breather)
6814.3	Grub screw *
6814.4	Grub screw

\* When required, dependent on type of mechanical seal fitted.

## 8.2 Sectional drawings – LR double entry impeller, grease lubricated, gland packed



(Drawing taken from A336/040, sheet 1, rev -)

### 8.2.1 Parts list – LR double entry impeller

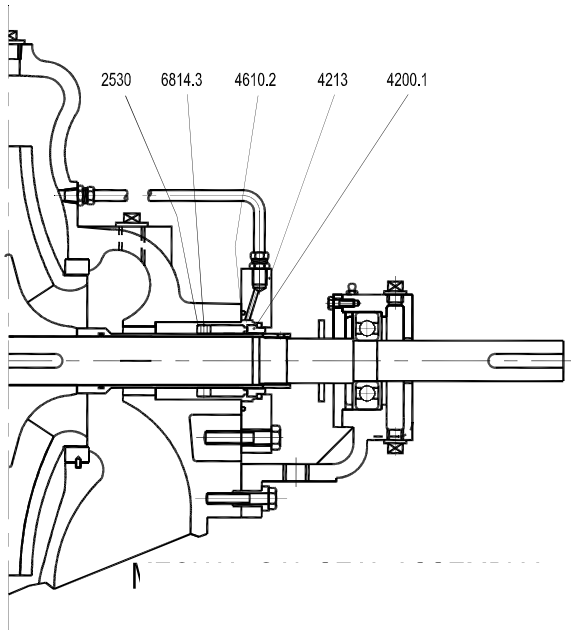
Ref. no.	Description
1213	Casing half - lower
1214	Casing half - upper
1220	Cover
1500	Casing wear ring
1630	Throttling bush
1690	Bush (dowel)
2100	Shaft
2200	Impeller
2450	Shaft sleeve
2540	Flinger (liquid)
2910.1	Shaft nut
3011.1	Ball bearing
3011.2	Ball bearing
3126	Shim **
3200	Bearing housing
3260	Bearing cover
3645	Disc spacer *
3712	Bearing nut
3853	Grease nipple
4120	Gland
4130	Gland packing
4134	Lantern ring

4420	Sealing pipe
4590.1	Gasket
4590.2	Gasket
4610.1	O-ring
6541	Lockwasher
6569.1	Plug
6569.2	Plug
6569.3	Plug
6569.4	Plug
6569.5	Plug
6570.1	Screw
6570.2	Screw
6570.3	Screw
6570.4	Screw
6572	Stud
6580	Nut
6700.1	Key
6700.2	Key
6814.1	Grub screw
6814.2	Grub screw

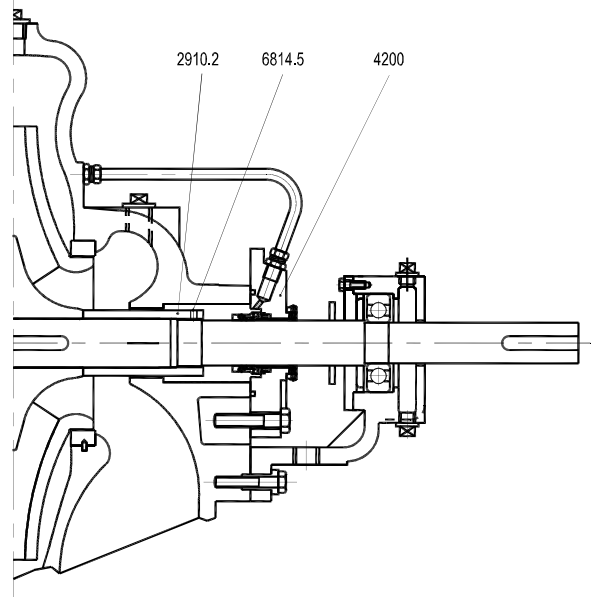
\* Fitted on 2.1/2LR13 pump size only.

\*\* Not required for 10LR17 and 19LR18 pump sizes.

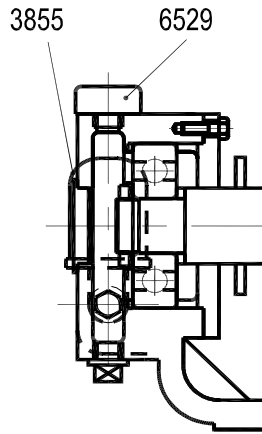
**8.2.2 Options - LR double entry impeller**



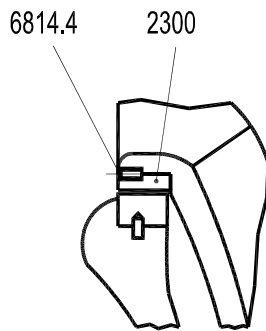
**Mechanical seal assembly**



**Shaft without sleeve  
fitted with cartridge seal assembly**



**Oil lubrication**



**Impeller wear ring**

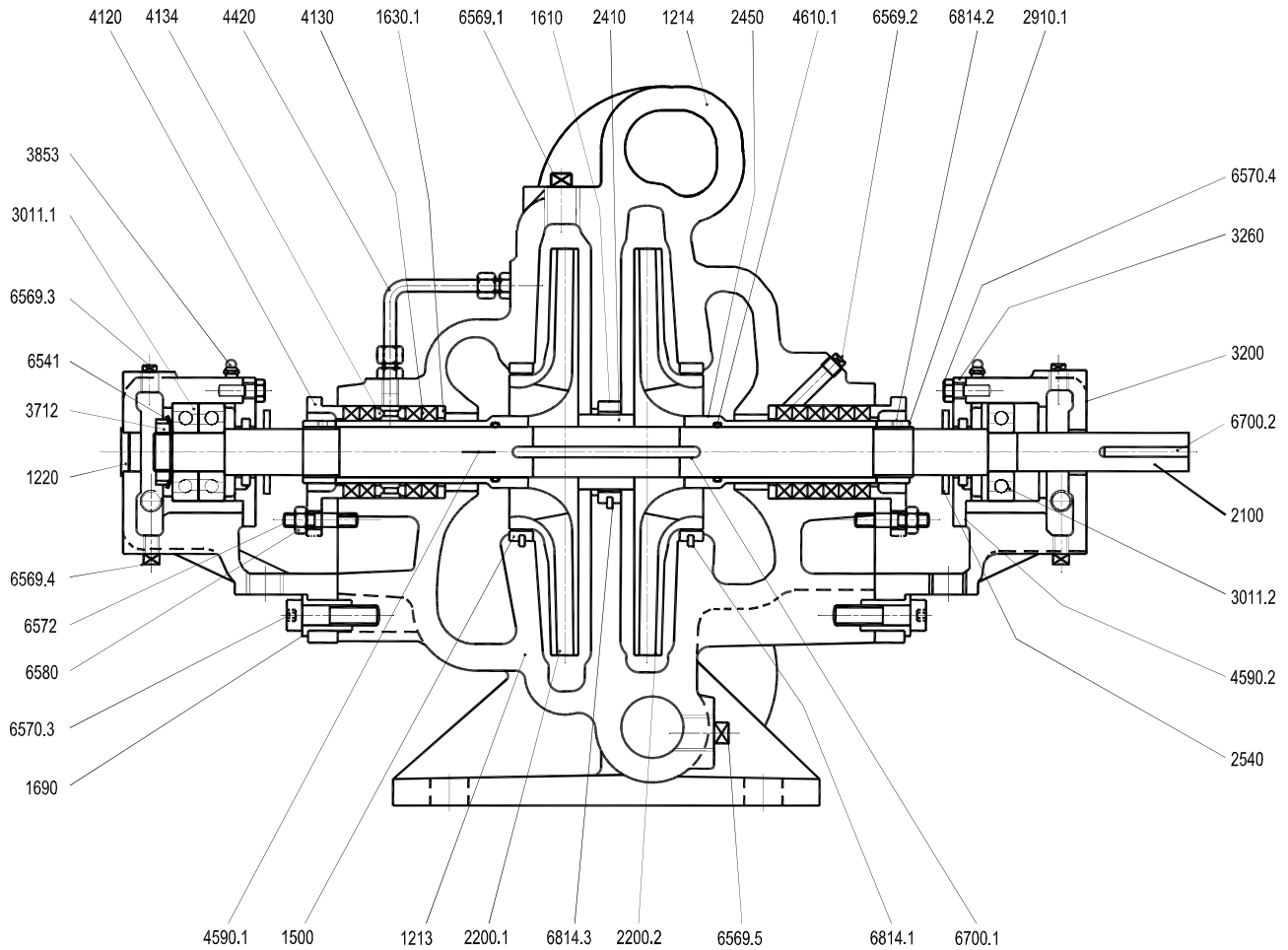
(Drawings taken from A336/040, sheet 2, rev -)

**8.2.3 Options parts list - LR double entry impeller**

Ref. no.	Description
2300	Impeller wear ring
2530	Retaining ring *
2910.2	Shaft nut
3855	Constant level oiler
4200	Mechanical seal (cartridge)
4200.1	Mechanical seal
4213	Mechanical seal cover
4610.2	O-ring
6529	Ventilation device (breather)
6814.3	Grub screw *
6814.4	Grub screw
6814.5	Grub screw

\* When required, dependent on type of mechanical seal fitted.

### 8.3 Sectional drawings – LLR grease lubricated, gland packed



(Drawing taken from A336/042, sheet 1, rev -)

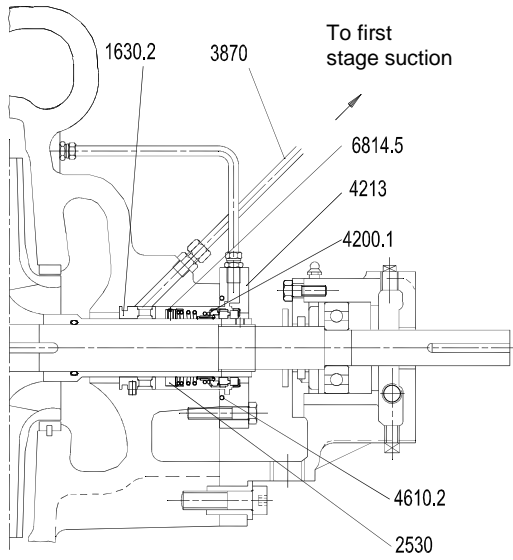
#### 8.3.1 Parts list – LLR

Ref. no.	Description
1213	Casing half - lower
1214	Casing half - upper
1220	Cover
1500	Casing wear ring
1610	Interstage bush
1630.1	Throttling bush
1690	Bush (dowel)
2100	Shaft
2200.1	Impeller (first stage)
2200.2	Impeller (second stage)
2410	Interstage sleeve
2450	Shaft sleeve
2540	Flinger (liquid)
2910.1	Shaft nut
3011.1	Ball bearing
3011.2	Ball bearing
3200	Bearing housing
3260	Bearing cover
3712	Bearing nut
3853	Grease nipple
4120	Gland

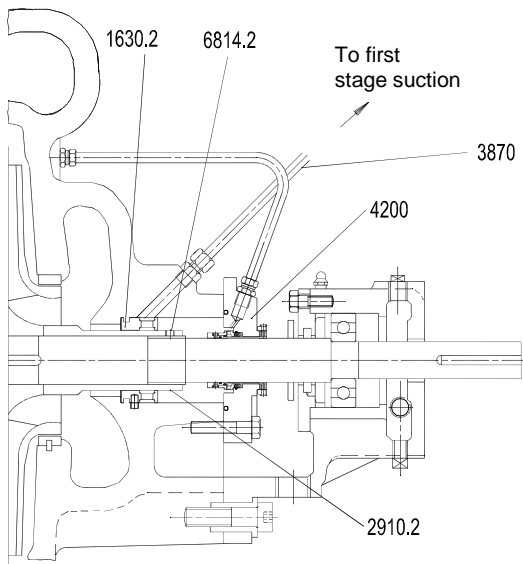
4130	Gland packing
4134	Lantern ring
4420	Sealing pipe
4590.1	Gasket
4590.2	Gasket
4610.1	O-ring
6541	Lockwasher
6569.1	Plug
6569.2	Plug
6569.3	Plug
6569.4	Plug
6569.5	Plug
6570.1	Screw
6570.2	Screw
6570.3	Screw
6570.4	Screw
6572	Stud
6580	Nut
6700.1	Key
6700.2	Key
6814.1	Grub screw
6814.2	Grub screw
6814.3	Grub screw



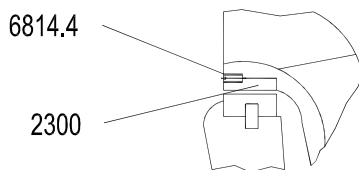
8.3.2 Options - LLR



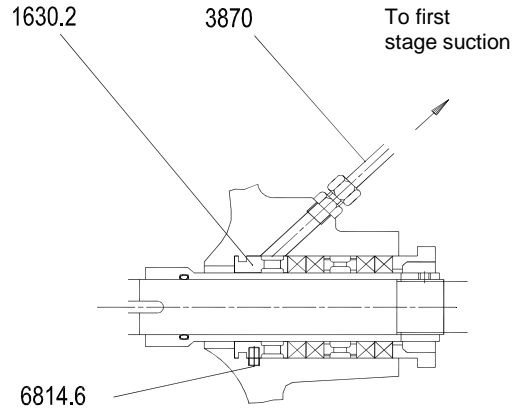
Scrap section showing mechanical seal



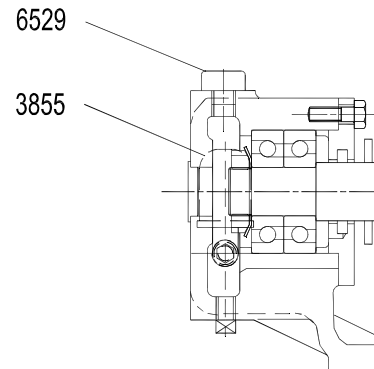
Scrap section showing shaft without sleeve and with cartridge seal assembly



Impeller wear ring



Optional second stage stuffing box arrangement on higher pressure applications



Oil lubrication (optional)

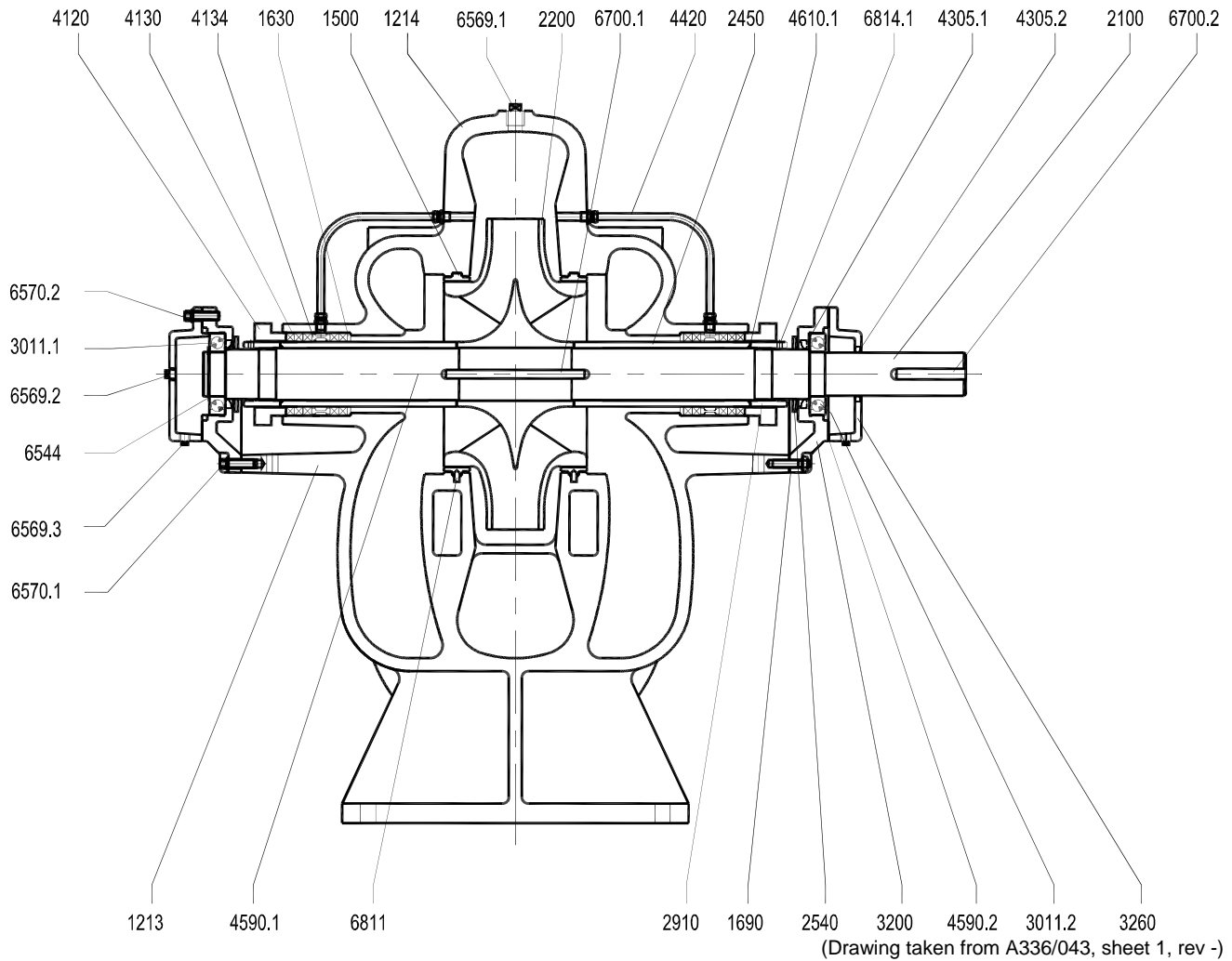
(Drawings taken from A336/042, sheet 2, rev -)

8.3.3 Options parts list - LLR

Ref. no.	Description
1630.2	Throttle bush
2300	Impeller wear ring
2530	Retaining ring *
2910.2	Shaft nut
3855	Constant level oiler
3870	Return pipe
4200	Mechanical seal (cartridge)
4200.1	Mechanical seal
4213	Mechanical seal cover
4610.2	O-ring
6529	Ventilation device (breather)
6814.4	Grub screw
6814.5	Grub screw *
6814.6	Grub screw

\* When required, dependent on type of mechanical seal fitted.

### 8.4 Sectional drawings – LR-S double entry impeller, grease lubricated, gland packed

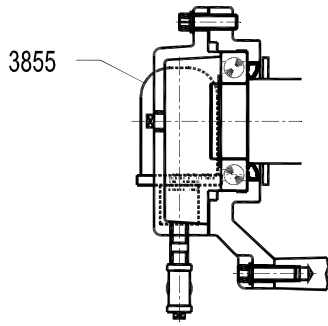


#### 8.4.1 Parts list – LR-S

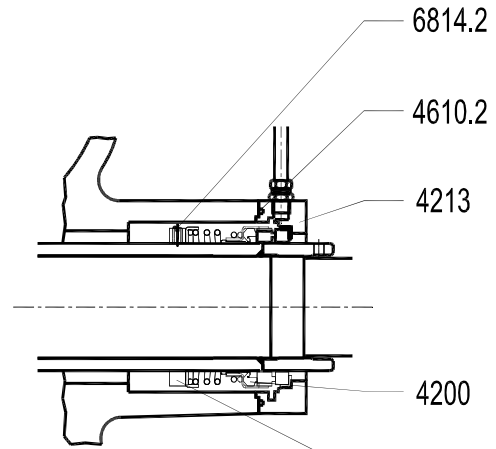
Ref. no.	Description
1213	Casing half - lower
1214	Casing half - upper
1500	Casing wear ring
1630	Throttling bush
1690	Bush (dowel)
2100	Shaft
2200	Impeller
2450	Shaft sleeve
2540	Flinger (liquid)
2910	Shaft nut
3011.1	Ball bearing
3011.2	Ball bearing
3200	Bearing housing
3260	Bearing cover
4120	Gland
4130	Gland packing
4134	Lantern ring
4305.1	Shaft seal ring
4305.2	Shaft seal ring

4420	Sealing pipe
4590.1	Gasket
4590.2	Gasket
4610.1	O-ring
6541	Lockwasher
6544	Circlip
6569.1	Plug
6569.2	Plug
6569.3	Plug
6569.4	Plug
6570.1	Screw
6570.2	Screw
6570.3	Screw
6700.1	Key
6700.2	Key
6811	Cylindrical pin
6814.1	Grub screw

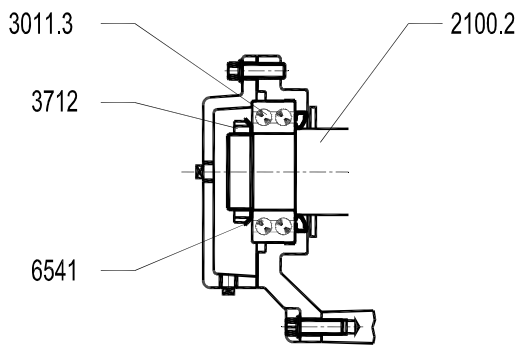
8.4.2 Options – LR-S



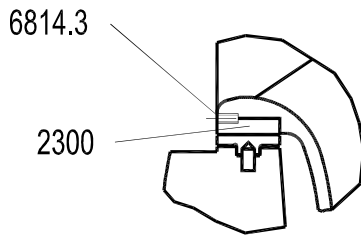
Oil lubrication (optional)



Scrap section showing mechanical seal option



Double row bearing (optional)



Impeller wear ring

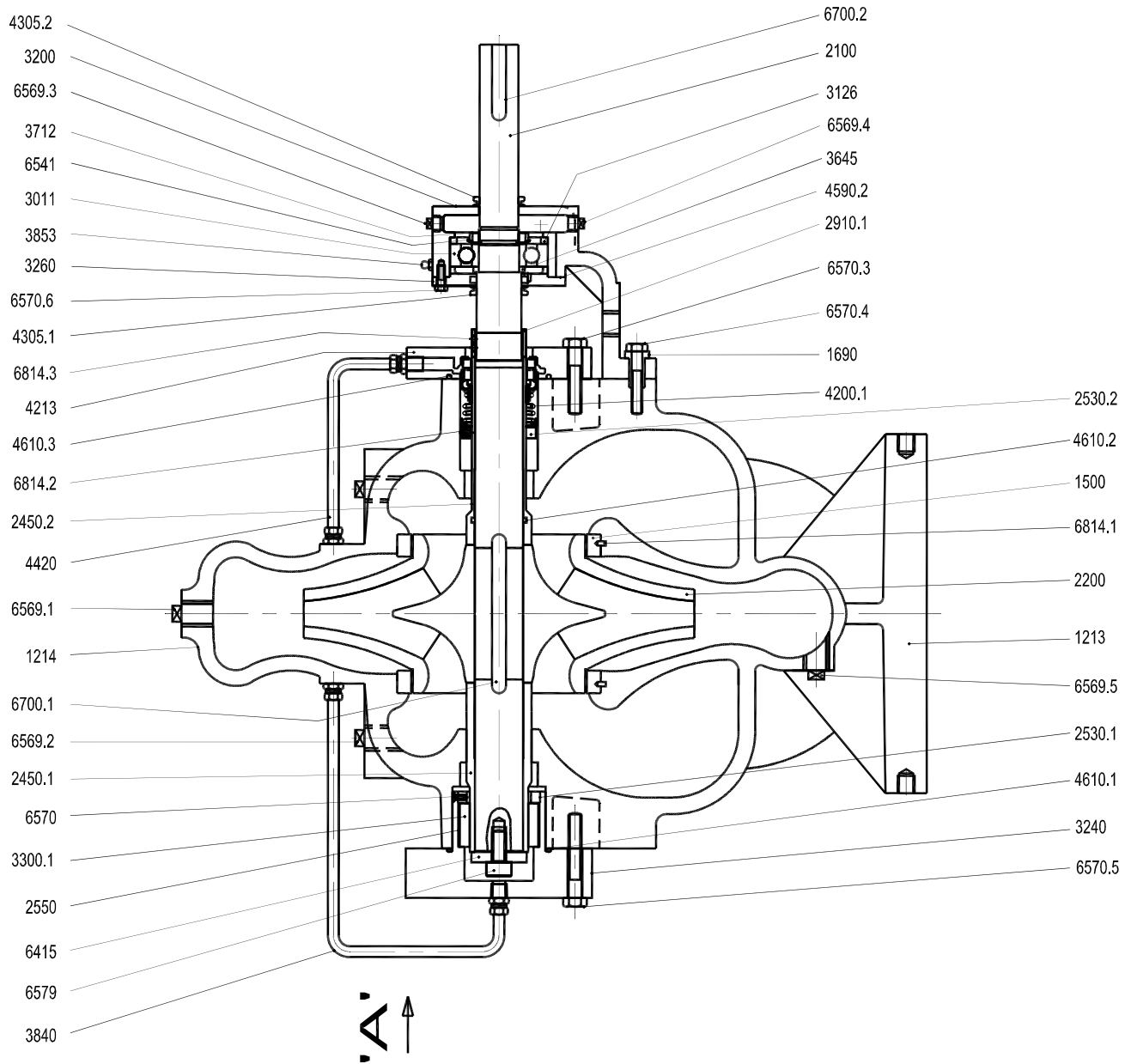
(Drawings taken from A336/043, sheet 2, rev -)

8.4.3 Options parts list – LR-S

Ref. no.	Description
2100.2	Shaft
2300	Impeller wear ring
2530	Retaining ring *
3011.3	Double row thrust bearing
3712	Bearing nut
3855	Constant level oiler
4200	Mechanical seal
4213	Mechanical seal cover
4610.2	O-ring
6541	Lockwasher
6814.2	Grub screw *
6814.3	Grub screw

\* When required, dependent on type of mechanical seal fitted.

**8.5 Sectional drawings – LRV double entry impeller, grease lubricated thrust bearing, component mechanical seal, silicon carbide bearing**



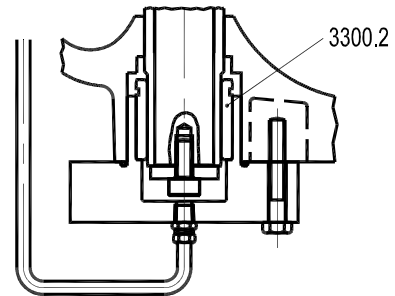
(Drawing taken from A336/041, sheet 1, rev -)

**8.5.1 Parts list – LRV**

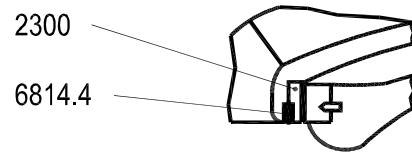
Ref. no.	Description
1213	Casing half - lower
1214	Casing half - upper
1500	Casing wear ring
1690	Bush (dowel)
2100	Shaft
2200	Impeller
2450.1	Shaft sleeve
2450.2	Shaft sleeve
2530.1	Retaining ring
2530.2	Retaining ring *
2550	Ring (tolerance)
2910.1	Shaft nut
3011	Ball bearing
3126	Shim **
3200	Bearing housing
3240	Bearing carrier
3260	Bearing cover
3300.1	Bearing bush (silicon carbide)
3645	Disc spacer ***
3712	Bearing nut
3840	Lubricating pipe
3853	Grease nipple
4200.1	Mechanical seal
4213	Mechanical seal cover
4305.1	Shaft seal ring
4305.2	Shaft seal ring
4420	Sealing pipe
4590.1	Gasket
4590.2	Gasket
4610.1	O-ring
4610.2	O-ring
4610.3	O-ring
6415	Cap
6541	Lockwasher
6569.1	Plug
6569.2	Plug
6569.3	Plug
6569.4	Plug
6569.5	Plug
6570	Screw
6570.1	Screw
6570.2	Screw
6570.3	Screw
6570.4	Screw
6570.5	Screw
6570.6	Screw
6579	Socket head cap screw
6700.1	Key
6700.2	Key
6814.1	Grub screw
6814.2	Grub screw *
6814.3	Grub screw

\* When required, dependent on type of mechanical seal fitted.  
 \*\* Not required for 10LR17 and 10LR18 pump sizes.  
 \*\*\* Fitted on 4LRV11, 4LRV14 and 5LRV13 pump sizes only.

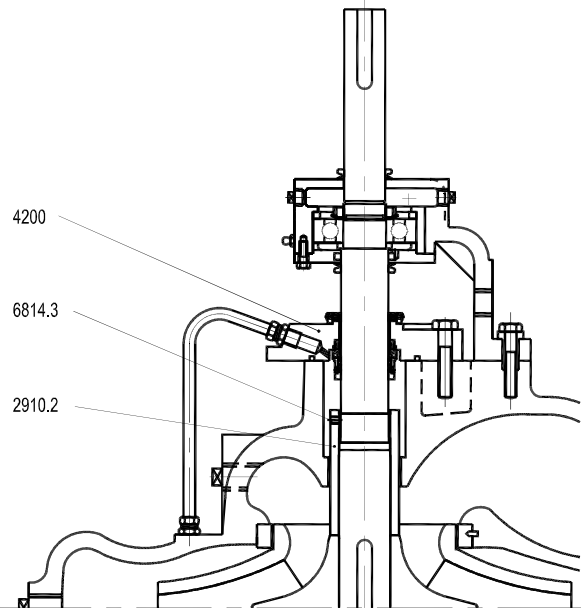
**8.5.2 Options - LRV**



Optional rubber bearing design  
(available on selected pump sizes)



Impeller wear ring



Shaft without sleeve fitted with cartridge seal assembly

(Drawings taken from A336/041, sheet 2, rev -)

**8.5.3 Options parts list – LRV**

Ref. no.	Description
2300	Impeller wear ring
2910.2	Shaft nut
3300.2	Bearing bush (rubber)
4200	Mechanical seal (cartridge)
6814.3	Grubscrew
6814.4	Grubscrew

### 8.6 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.

### 8.7 Interchangeability charts

#### 8.7.1 Interchangeability for LR, LLR and LR-S <sup>1</sup>

Pump size	Impeller	Shaft <sup>2</sup>	Sleeve assembly <sup>3</sup>	Bearing assembly <sup>4</sup>	Casing wear ring			
1.5LLR-7	A	A	A	A	A			
1.5LLR-10	B				B			
2LLR-9	C				C			
2LLR-11	D	B	B	B	D			
3LLR-11	E				E			
4LLR-11	F				F			
2.5LR-10 cw	G	C	None fitted	C	A			
2.5LR-10 ccw	H	D			D			
2.5LR-13 cw	I	E			F			
2.5LR-13 ccw	J	F			B			
3LR-9	K	G	C	E	F			
3LR-12	L				H	G		
4LR-10	M				I	H		
4LR-12	N	H	D	E	J			
5LR-10	O				K	I		
6LR-10	P	I	E	D	F			
4LR-11	Q	J <sup>5</sup>			F			
4LR-14	R	J			F	F	G	
5LR-13	S		K	H				
5LR-15	T	K	F	F	J			
5LR-19	U				L	G		
6LR-13	V				L	G	G	K
6LR-16	W							M
8LR-12	X	M	H	H				L
8LR-14	Y				N	I		
6LR-18	Z	L	G	G	M			
8LR-20	AA				O	I		
10LR-14	BB				O	I	I	N
10LR-16	CC	P	J					
10LR-17	DD	P	J	J	O			
10LR-18	EE				P	J	J	P
6LR-18S	FF							O
10LR-14S	GG	O	I	I	N			
12LR-14S	HH				P	J	J	
8LR-18S	II	P	J	J				N
10LR-18S	JJ				P	J	J	O
8LR-23S	KK	P	J	J				P

**Notes:**

- 1) All the above pump casings can be supplied for clockwise or counter clockwise rotation. The casings are interchangeable with each other although pump suction and discharge positions change – refer to the relevant Sectional arrangement drawing. The LLR has 1<sup>st</sup> and 2<sup>nd</sup> stage impellers, which are not interchangeable with each other.
- 2) The same shaft is used for gland packing and component mechanical seals. Cartridge mechanical seals use a different series of shafts fitted with impeller nuts – see relevant Sectional arrangement drawings.
- 3) Gland packing and inch-type component mechanical seals use the same shaft sleeve. Includes shaft sleeve, shaft nut, gland, packing, lantern ring, stuffing box bush and mechanical seal. When metric seals are fitted a different diameter shaft sleeve and nut is used.
- 4) Includes bearing housing, bearing cover, ball bearing set, bearing nut and washer (except 2.5LR-10 which uses the bearing nut and washer from the 1.5LLR7 group).
- 5) Dimensionally the same as other J, but may have had a material upgrade to handle some of the higher power applications.

**8.7.2 Interchangeability for LRV <sup>1</sup>**

Pump size	Impeller	Shaft <sup>2</sup>	Top sleeve assembly <sup>3</sup>	Top bearing assembly <sup>4</sup>	Silicon carbide bearing			Cutless rubber bearing			Casing wear ring	
					Bearing bush assembly <sup>5</sup>	Bottom shaft sleeve	Bottom bearing carrier	Bearing bush	Bottom shaft sleeve	Bottom bearing carrier		
3LRV-9	K	Q	C	E	A	A	A	A	A	A	B	
3LRV-12	L										F	
4LRV-10	M										G	
4LRV-12	N	R	D	F		B	B		C	B	F	
5LRV-10	O					C	C		C	C	H	
4LRV-11	Q	S	D	F		C	B		B	D	D	G
4LRV-14	R					H						
5LRV-13	S				I							
6LRV-10	P	T	C	E	B	C	B	C	C	H		
5LRV-15	T	U	E	G	B	D	D	B	D	D	G	
6LRV-13	V										H	
6LRV-16	W										J	
8LRV-12	X										K	
8LRV-14	Y										L	
6LRV-18	Z	V	F	H	B	E	E	C	E	E	K	
8LRV-20	AA											
10LRV-14	BB											
10LRV-16	CC											
10LRV-17	DD	W	G	I	B	F	F	C	F	F	L	
10LRV-18	EE											

- 1) The LRV impeller, top sleeve assembly, and casing wear ring are also interchangeable with the equivalent LR pump. The LRV pump casing is not interchangeable with the LR. The LRV clockwise and counter clockwise casings are not interchangeable with each other.
- 2) For component mechanical seals. Cartridge mechanical seals use different shafts fitted with impeller nuts – see relevant Sectional arrangement drawings.
- 3) For inch-type component mechanical seals, includes sleeve, shaft nut and mechanical seal. When metric seals are fitted a different diameter shaft sleeve is used.
- 4) Includes bearing housing, bearing cover, ball bearing set, bearing nut and lockwasher.
- 5) Includes tolerance ring and bearing retaining ring.

**9 CERTIFICATION**

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

**10 OTHER RELEVANT DOCUMENTATION AND MANUALS**

**10.1 Supplementary User Instructions**

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

**10.2 Change notes**

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

**10.3 Additional sources of information**

*Reference 1:*

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

*Reference 2:*

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

*Reference 3:*

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

*Reference 4:*

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

*Reference 5:*

ANSI B31.3 - Process Piping.



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