FLOWSERVE

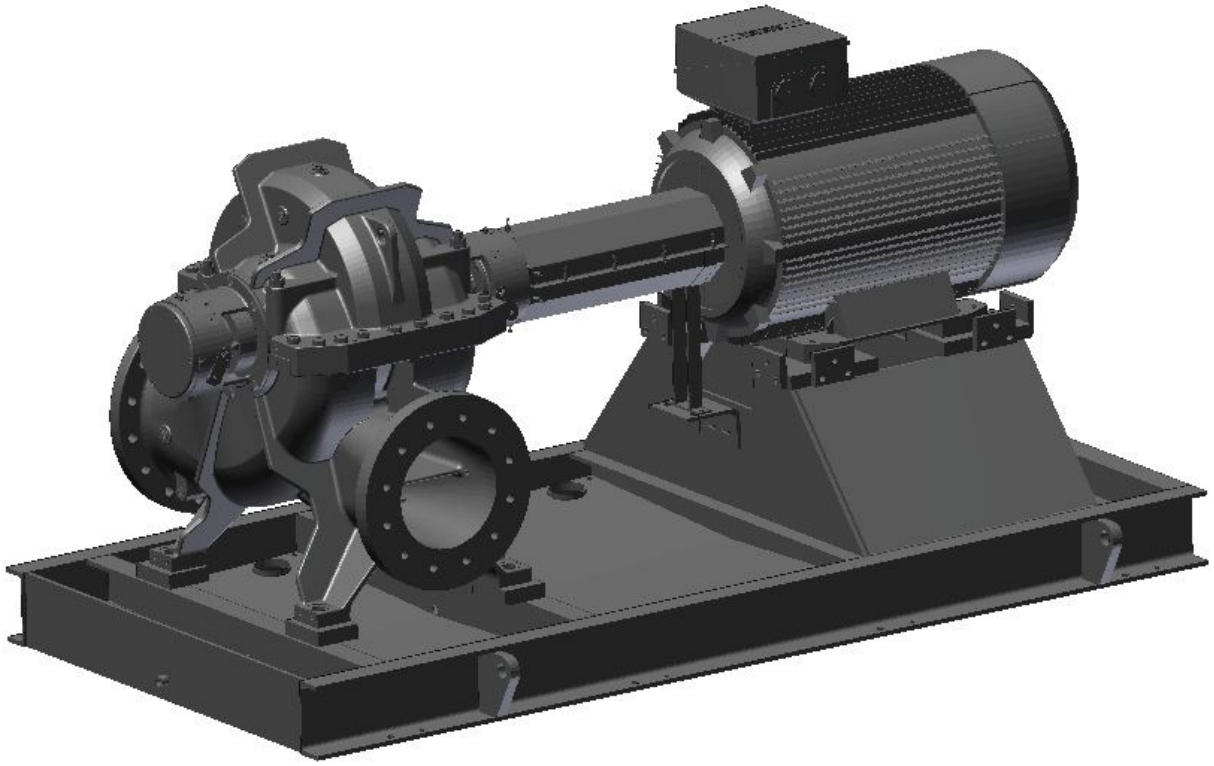
USER INSTRUCTIONS

WORTHINGTON ® LNN, LNNV and LNNC centrifugal pumps

Single stage, double suction, horizontally split, volute type centrifugal pumps

Installation
Operation
Maintenance

PCN=71569074 08-13 (E). (Based on C953KH001.)
Original instructions.



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 purchase 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

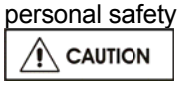
These User Instructions contain specific safety markings where non-observance of an instruction would cause hazards. The specific safety markings are:



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


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

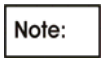

This symbol indicates "hazardous and toxic fluid" safety instructions where non-compliance would affect personal safety and could result in loss of life.



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


This symbol indicates 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.



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

1.6.2 Personnel qualification and training

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

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

1.6.3 Safety action

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



NEVER DO MAINTENANCE WORK WHEN THE UNIT IS CONNECTED TO POWER


GUARDS MUST NOT BE REMOVED WHILE THE PUMP IS OPERATIONAL


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


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


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


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


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


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

If the temperature is greater than 80 °C (175 °F) or below -5 °C (23 °F) in a restricted zone, or exceed local regulations, action as above shall be taken.

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

Gland packing must not be used when pumping hazardous liquids.

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

CAUTION ENSURE CORRECT LUBRICATION
(See section 5, *Commissioning, start up, 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 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

Ex Measures are required to:

- Avoiding excessive surface temperature
- Preventing build up of explosive mixtures
- Preventing the generation of sparks
- Preventing leakages
- Maintaining 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 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

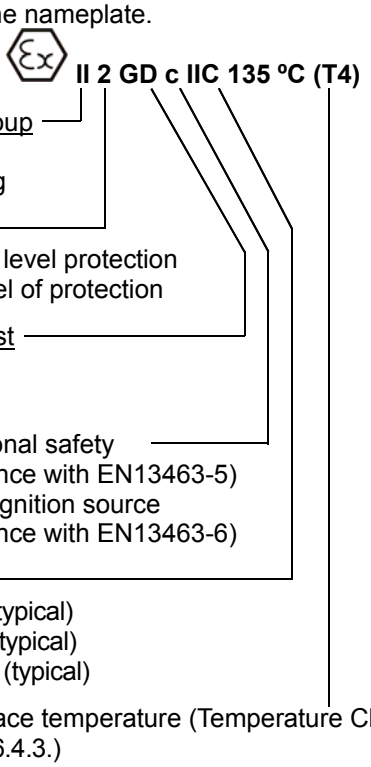
Ex Use equipment only in the zone for which it is appropriate. Always check that the driver, drive coupling assembly, seal and pump equipment are suitably rated and/or certified for the classification of the specific atmosphere in which they are to be installed.

Where Flowserve has supplied only the bare shaft pump, the Ex rating applies only to the pump. The party responsible for assembling the 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 effects in the motor and so, for pumps sets with a VFD, the ATEX Certification for the motor must state that it is covers the situation where electrical supply is from the VFD. This particular requirement still applies even if the VFD is in a safe area.

1.6.4.2 Marking

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



1.6.4.3 Avoiding excessive surface temperature

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 ATEX 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)	65 °C (149 °F) *
T5	100 °C (212 °F)	80 °C (176 °F) *
T4	135 °C (275 °F)	115 °C (239 °F) *
T3	200 °C (392 °F)	180 °C (356 °F) *
T2	300 °C (572 °F)	275 °C (527 °F) *
T1	450 °C (842 °F)	400 °C (752 °F) *

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

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

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

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

Avoid mechanical, hydraulic or electrical overload by using motor overload trips, temperature monitors 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.

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.

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.

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 vapor 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, 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.

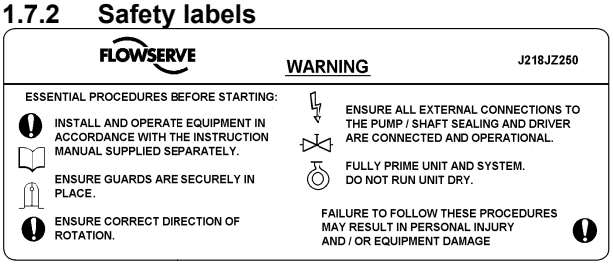
It is recommended that a maintenance plan and schedule is adopted. (See section 6, *Maintenance.)*

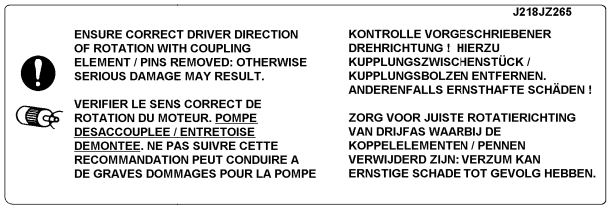
1.7 Nameplate and safety labels

1.7.1 Nameplate

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

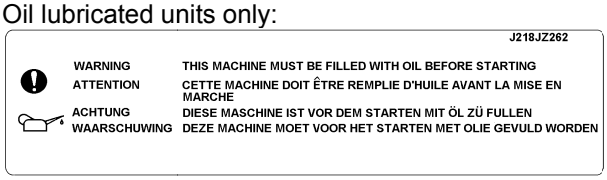
1.7.2 Safety labels







Oil lubricated units only:



1.8 Specific machine performance

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

1.9 Noise level

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

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

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

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

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

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

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

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

Motor size and speed kW (hp)	**Typical sound pressure level L_{pA} at 1 m reference 20 µPa, 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
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
500 (670)					88	①	86	①
1 000 (1 300)					90	①	88	①
1 500 (2 000)					90	①	90	①

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

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

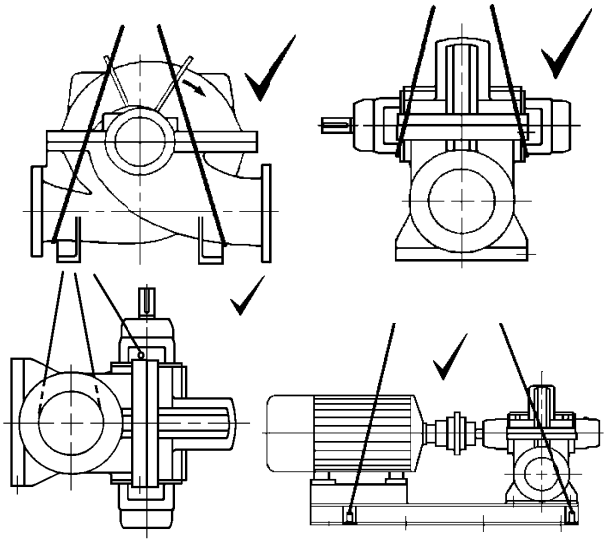
2.2 Handling

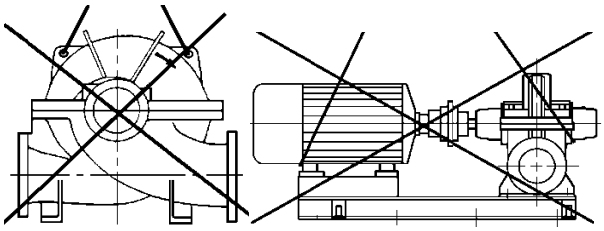
Boxes, crates, pallets or cartons may be unloaded using fork-lift vehicles or slings dependent on their size and construction.

2.3 Lifting

A crane must be used for all pump sets and components 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.





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.

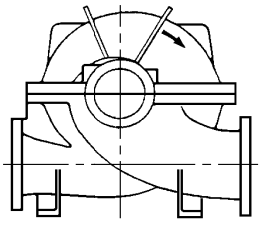
Make sure that hazardous substances are disposed of safely and that the correct personal protective equipment is used. The safety specifications must be in accordance with the current regulations at all times.

3 PUMP DESCRIPTION

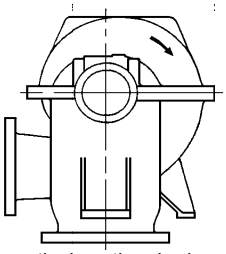
3.1 Configurations

The LNN type pump is a single stage, double suction, horizontal split volute type centrifugal pump designed for water works, drainage, general service and circulating applications. It can be used with motor, steam turbine and gasoline or diesel engine drives.

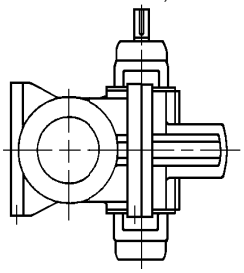
The LNN can [illegible] irations:



LNN horizontal suction and discharge nozzles (inline)



LNNC bottom vertical suction, horizontal discharge



LNNV horizontal suction/discharge, vertical shaft (inline)

There is also an advanced design designated LNNA.

3.2 Name nomenclature

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

400-LNNA-875-AA

Nominal discharge branch size

Configuration – see 3.1 above

Nominal maximum impeller diameter

Impeller hydraulic type *

Casing hydraulic type *

(* Normally the hydraulic type will appear on the performance curve.)

The typical nomenclature above is the general guide to the LNN 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, protected by V-ring seals.

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 LNNV 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. A grease lubricated ball bearing option may be fitted at the non-drive end.

3.3.5 Bearing housing

Two grease nipples enable grease lubricated bearings to be replenished between major service intervals. For oil lubricated bearings, a constant level oiler is fitted.

3.3.6 Stuffing box housing

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

3.3.7 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.

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 +80 ºC (-4 to +176 ºF)
Maximum ambient temperature *	-20 to +40 ºC (-4 to +104 ºF)
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
Ex Equipment operated in hazardous locations must comply with the relevant explosion protection regulations. See section 1.6.4, *Products used in potentially explosive atmospheres.*

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

Refer to the general arrangement drawing for the pump set.

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

3.4.2 Pump and impeller data

Pump size	Hydraulic Impeller type	Impeller minimum passage size mm (in.)	Nominal wear ring diameter mm (in.)	Mean radial wear ring clearance mm (in.)
200LNN300	A	22.4 (0.90)	215 (8.5)	0.3 (0.012)
200LNN325		24.3 (0.96)	240 (9.5)	
200LNN375	A and B	25.5 (1.00)	215 (8.5)	
200LNN400		29.6 (1.20)	240 (9.5)	
200LNN475		24.0 (0.95)		
200LNN500		17.5 (0.70)	215 (8.5)	
200LNN525	A	30,0 (1.20)	240 (9.5)	
200LNN600	A and B	16.0 (0.63)		
250LNN325	D	30.1 (1.20)		
250LNN375	A and B	27.8 (1.10)	264 (10.4)	
250LNN475		32.5 (1.30)		
250LNN600		22.0 (0.87)		
250LNN650		32.0 (1.26)	330 (13.0)	
300LNN325	A	20.0 (0.78)	300 (11.8)	
300LNN450		30 (1.20)		
300LNN475	A and B	36.3 (1.40)	330 (13.0)	
300LNN500		36.8 (1.40)	300 (11.8)	
300LNN575		42.9 (1.70)	350 (13.8)	
300LNN600		30.0 (1.20)	300 (11.8)	
300LNN625		25.0 (1.00)	330 (13.0)	
300LNN750		27.9 (1.10)		
350LNN375	A	25.0 (0.94)		
350LNN475	A and B	45.4 (1.80)	380 (15.0)	
350LNN575		41.2 (1.60)		
350LNN725		48.0 (1.90)		
350LNN900		33.0 (1.30)		
400LNN600	A	46 (1.80)	420 (16.5)	
400LNN600	D	45 (1.77)		
400LNN725	A	53.3 (2.10)		
400LNN725	B	45 (1.77)		
400LNN800	A	50 (1.97)	470 (18.5)	
400LNNA875		40 (1.57)	440 (17.3)	0.34 (0.013)
400LNN900		45.7 (1.80)		
400LNN925	F	50 (1.97)	496 (19.5)	0.3 (0.012)
500LNN600	A	60 (2.36)	440 (17.3)	
500LNN650		61 (2.40)	470 (18.5)	
500LNN650	B	55 (2.16)		
500LNN650	C	61 (2.4)		
500LNN700	A	48.3 (1.90)	440 (17.3)	
500LNN775		53.3 (2.10)	500 (19.7)	0.34 (0.013)
500LNN775	B	49 (1.93)		
500LNN775	C	50 (1.97)		
500LNN950	A	63.5 (2.50)		
500LNN1000		45 (1.77)		
500LNN1150		40.6 (1.60)		
500LNN1250		37 (1.45)		
600LNN750		80 (31.5)	564 (22.2)	0.45 (0.018)
600LNN750	B	70 (2.75)		
600LNN950	A and C	68.6 (2.70)	620 (24.4)	
600LNN975	A	71.1 (2.80)	564 (22.2)	
600LNN975	B	60 (2.36)		
600LNN1200	A	61 (2.40)	582 (22.9)	
600LNN1200	B	50 (1.97)		
600LNN1200	C	55 (2.16)		
700LNN1225	A	88.9 (3.50)	700 (27.6)	
700LNN1225	B	70 (2.75)		
700LNN1225	D	60 (2.36)		
900LNN1200	A	100 (3.94)	866 (34.1)	
1000LNN750	A	85 (3.35)	658 (25.9)	0.55 (0.022)
1000LNN750	C	90 (3.54)		
1000LNN800	A	80 (3.15)		0.5 (0.197)

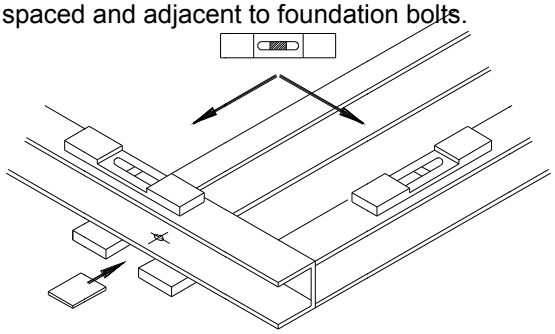
Note: Clearances for non-metallic wear rings are smaller, typically 50 to 65% of those for the standard metallic rings shown above.

4.3 Foundation

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

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 pipe work 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

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

4.5.2 Alignment methods

DANGER Pump and driver must be isolated electrically and the half couplings disconnected.

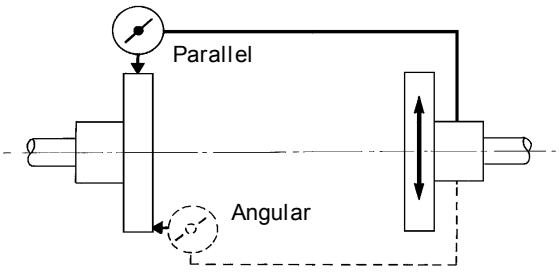
CAUTION The alignment MUST be checked. Although the pump will have been aligned at the factory it is most likely that this alignment will have been disturbed during transportation or handling. If necessary, align the motor to the pump, not the pump to the motor.

Horizontal pumps – LNN and LNNC
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. Alignment can be achieved by use of the motor adjusters if fitted.

Vertical pumps – LNNV
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 if the motor has a spigot (rabbet) fit into the motor stool then it is not possible to achieve

dicator
ular
ns for



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.

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

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

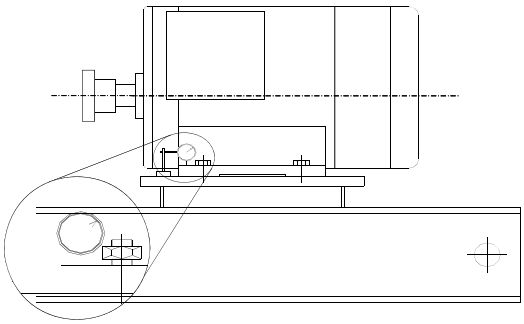
When the electric motor has sleeve bearings it is necessary to ensure that the motor is aligned to run on its magnetic centerline.

Refer to the motor manual for details.

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

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

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 the 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, start up, operation and shutdown* before connecting driver and checking actual rotation.

4.6 Piping

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

4.6.1 Suction and discharge pipe work

CAUTION Never use the pump as a support for piping.

In order to minimize friction losses and hydraulic noise in the pipe work it is good practice to choose pipe work that is one or two sizes larger than the pump suction and discharge. Typically main pipe work 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.

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

- Prevent excessive external pipe load
- Never draw piping into place by applying force to pump flange connections
- Do not mount expansion joints so that their force, due to internal pressure, acts on the pump flange. It is recommended that expansion joints use threaded rod to limit any forces of this type

The tables in 4.6.2 summarize the maximum forces and moments allowed on LNN pump casings. Refer to Flowserve for other configurations.

CAUTION Ensure piping and fittings are flushed before use.

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

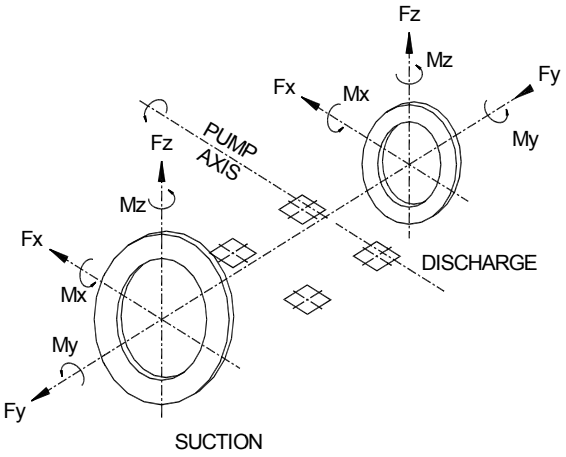
4.6.2 Maximum forces and moments allowed on pump flanges

4.6.2.1 LNN, LNNV maximum forces and moments allowed

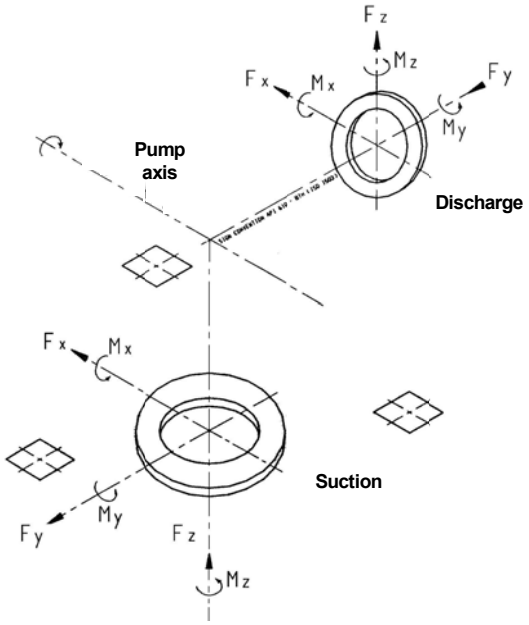
Type and size	Maximum forces (F) in kN (lbf) and moments (M) in kNm (lbf•ft)											
	Suction						Discharge					
	Fx	Fy	Fz	Mx	My	Mz	Fx	Fy	Fz	Mx	My	Mz
200-LNN-300 to 200-LNN-600	5.34 (1 200)	6.68 (1 500)	4.45 (1 000)	5.02 (3 700)	2.44 (1 800)	3.80 (2 800)	3.78 (850)	4.90 (1 100)	3.12 (700)	3.53 (2 600)	1.76 (1 300)	2.58 (1 900)
250-LNN-325 to 250-LNN-600	6.68 (1 500)	8.01 (1 800)	5.34 (1 200)	6.10 (4 500)	2.98 (2 200)	4.61 (3 400)	5.34 (1 200)	6.68 (1 500)	4.45 (1 000)	5.02 (3 700)	2.44 (1 800)	3.80 (2 800)
300-LNN-325 to 300-LNN-450, 300-LNN-575, 300-LNN-625 and 300-LNN-750	8.46 (1 900)	10.20 (2 290)	6.68 (1 500)	7.32 (5 400)	3.66 (2 700)	5.42 (4 000)	6.68 (1 500)	8.01 (1 800)	5.34 (1 200)	6.10 (4 500)	2.98 (2 200)	4.61 (3 400)
300-LNN-500 and 300-LNN-600	7.12 (1 600)	8.90 (2 000)	5.79 (1 300)	6.37 (4 700)	3.12 (2 300)	4.75 (3 500)	6.68 (1 500)	8.01 (1 800)	5.34 (1 200)	6.10 (4 500)	2.98 (2 200)	4.61 (3 400)
350-LNN-375 to 350-LNN-900	10.70 (2 410)	12.90 (2 900)	8.58 (1 930)	9.12 (6 725)	4.90 (3 615)	6.74 (4 970)	7.12 (1 600)	8.90 (2 000)	5.79 (1 300)	6.37 (4 700)	3.12 (2 300)	4.75 (3 500)
400-LNN-600, 400-LNN-725 and 400-LNN-900	10.32 (2 320)	12.50 (2 810)	8.05 (1 810)	8.71 (6 420)	4.38 (3 230)	6.40 (4 720)	8.45 (1 900)	10.20 (2 290)	6.67 (1 500)	7.32 (5 400)	3.66 (2 700)	5.42 (4 000)
400-LNN-800, 400-LNNA-875 and 400-LNN-925	12.27 (2 760)	14.82 (3 330)	9.47 (2 130)	10.15 (7 490)	5.14 (3 790)	7.40 (5 460)	8.45 (1 900)	10.20 (2 290)	6.67 (1 500)	7.32 (5 400)	3.66 (2 700)	5.42 (4 000)
500-LNN-600 to 500-LNN-1250	12.27 (2 760)	14.82 (3 330)	9.47 (2 130)	10.15 (7 490)	5.14 (3 790)	7.40 (5 460)	10.32 (2 320)	12.50 (2 810)	8.05 (1 810)	8.71 (6 420)	4.38 (3 230)	6.40 (4 720)
600-LNN-750	15.21 (3 420)	18.29 (4 110)	11.60 (2 610)	12.30 (9 070)	6.28 (4 630)	8.90 (6 560)	12.27 (2 760)	14.82 (3 330)	9.47 (2 130)	10.15 (7 490)	5.14 (3 790)	7.40 (5 460)
600-LNN-950	16.19 (3 640)	19.45 (4 370)	12.31 (2 770)	13.01 (9 600)	6.66 (4 910)	9.40 (6 930)	12.27 (2 760)	14.82 (3 330)	9.47 (2 130)	10.15 (7 490)	5.14 (3 790)	7.40 (5 460)
600-LNN-975 and 600-LNN-1200	14.23 (3 200)	17.14 (3 850)	10.89 (2 450)	11.58 (8 540)	5.90 (4 350)	8.40 (6 200)	12.27 (2 760)	14.82 (3 330)	9.47 (2 130)	10.15 (7 490)	5.14 (3 790)	7.40 (5 460)
700-LNN-1100	20.10 (4 519)	24.08 (5 413)	15.15 (3 406)	15.88 (11 712)	8.18 (6 033)	11.40 (8 408)	14.23 (3 199)	17.14 (3 853)	10.89 (2 448)	11.58 (8 541)	5.90 (4 352)	8.40 (6 196)
700-LNN-1225	18.14 (4 080)	21.77 (4 890)	13.73 (3 090)	14.45 (10 660)	7.42 (5 470)	10.40 (7 670)	14.23 (3 200)	17.14 (3 850)	10.89 (2 450)	11.58 (8 540)	5.90 (4 350)	8.40 (6 200)
900-LNN-1200	24.01 (5 400)	28.72 (6 460)	17.99 (4 040)	18.75 (13 830)	9.70 (7 150)	13.40 (9 880)	18.14 (4 080)	21.77 (4 890)	13.73 (3 090)	14.45 (10 660)	7.42 (5.470)	10.40 (7 670)
1000-LNN-750 and 1000-LNN-800	20.10 (4 520)	24.08 (5 410)	15.15 (3 410)	15.88 (11 710)	8.18 (6 030)	11.40 (8 410)	20.10 (4 520)	24.08 (5 410)	15.15 (3 410)	15.88 (11 710)	8.18 (6 030)	11.40 (8 410)

For load and momentum orientation, see following page.
Notes: see end of section 4.6.2.2.

Load and momentum orientation of LNN and LNNV pumps



Lo ıs



4.6.2.2 LNNC maximum forces and moments allowed

Type and size	Maximum forces (F) in kN (lbf) and moments (M) in kNm (lbf•ft)											
	Suction						Discharge					
	Fx	Fy	Fz	Mx	My	Mz	Fx	Fy	Fz	Mx	My	Mz
300-LNNC-475 and 300-LNNC-575	8.46 (1 900)	10.20 (2 290)	6.68 (1 500)	7.32 (5 380)	3.66 (2 690)	5.42 (3 990)	6.68 (1 500)	8.01 (1 800)	5.34 (1 200)	6.10 (4 490)	2.98 (2 190)	4.61 (3 390)
300-LNNC-500	7.12 (1 600)	8.90 (2 000)	5.79 (1 300)	6.37 (4 690)	3.12 (2 300)	4.75 (3 490)	6.68 (1 500)	8.01 (1 800)	5.34 (1 200)	6.10 (4 490)	2.98 (2 190)	4.61 (3 390)
350-LNNC-475 to 300-LNNC-900	10.70 (2 400)	12.90 (2 890)	8.58 (1 920)	9.12 (6 710)	4.90 (3 600)	6.74 (4 960)	7.12 (1 600)	8.90 (2 000)	5.79 (1 300)	6.37 (4 690)	3.12 (2 300)	4.75 (3 490)
600-LNNC-950	17.10 (3 840)	20.40 (4 580)	14.00 (3 140)	14.20 (10 450)	8.44 (6 210)	10.40 (7 650)	12.90 (2 890)	15.60 (3 500)	10.50 (2 360)	10.90 (8 020)	6.14 (4 520)	8.05 (5 920)
600-LNNC-975	14.90 (3 340)	17.80 (3 990)	12.10 (2 710)	12.40 (9 120)	7.22 (5 310)	9.14 (6 720)	12.90 (2 890)	15.60 (3 500)	10.50 (2 360)	10.90 (8 020)	6.14 (4 520)	8.05 (5 920)
700-LNNC-1225	19.30 (4 330)	23.00 (5 160)	15.90 (3 570)	15.90 (11 700)	9.65 (7 100)	11.70 (8 610)	14.90 (3 340)	17.80 (3 990)	12.10 (2 710)	12.40 (9 120)	7.22 (5 310)	9.14 (6 720)

Notes:

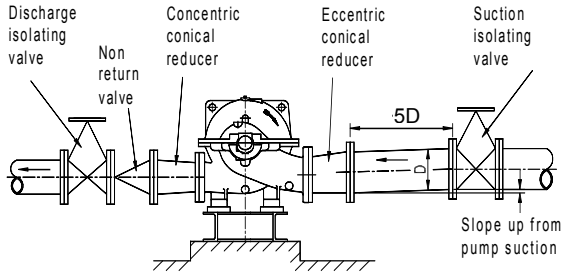
1) F = External force (tension or compression).
   M = External moment, clockwise or counter-clockwise.
   Sign convention follows ISO 1503 and ISO 13709/API610.
2) Forces and moments may be applied simultaneously in any direction.
3) Values apply to all materials.
4) The nozzle loads applied to the pump flanges must not exceed the values given in tables 4.6.2.1 and 4.6.2.2
5) Higher loads may be applicable, if direction and magnitude of individual loads are known, but these need written approval from Flowserve.
6) The pump nozzle is not to be used as a rigid support for the piping line.
7) The piping loads applied to the pump flanges can be minimized using the appropriate piping line supports.
8) The suction and discharge piping lines must not be connected to the pump nozzle with an expansion joint (or similar flexible pipes), unless they are rigidly blocked with tie rods.
9) Pumps must be on rigid foundations and baseplates must be fully grouted.
10) Pump/baseplate should not be used as pipe anchor.
11) 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.
12) The pump mounting bolt torques specified must be used to prevent relative movement between the pump casing and baseplate. (See section 6.6, *Fastener torques*.) The bolt material must have a minimum yield strength of 600 N/mm^2 (87 000 lb/in.^{2}).

Failure to complying with the above can result in damage to the pump.

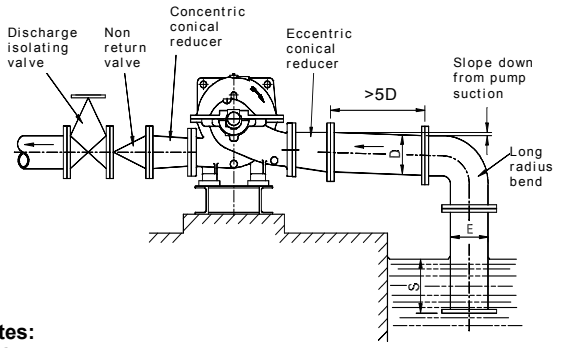
4.6.3 Suction piping

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

a) The inlet pipe should be one or two sizes larger than the pump inlet bore and pipe bends should be as large a radius as possible.
b) Pipe work reducers should be conical and have a maximum total angle of divergence of 15 degrees.
c) On suction lift the piping should be inclined up towards the pump inlet with eccentric reducers incorporated to prevent air locks.
d) On positive suction, the inlet piping must have a constant fall towards the pump.
e) 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.
f) Do not install elbows at an angle other than perpendicular to the shaft axis. Elbows parallel



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.



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

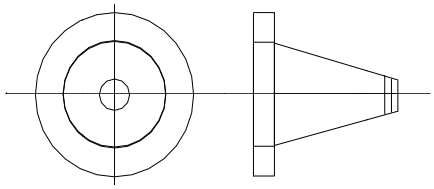
g) Except in unusual circumstances strainers are not recommended in inlet piping. If considerable foreign matter is expected a screen installed at the entrance to the wet well is preferable.
h) Inlet strainers, when used, should have a net 'free area' of at least three times the inlet pipe area.
i) Fitting an isolation valve will allow easier maintenance.
j) Never throttle pump on suction side and never place a valve directly on the pump inlet nozzle.

4.6.3.1 Suction strainer

In a new installation, great care should be taken to prevent dirt, scale, welding beads and other items from entering the pump, as it is particularly important to protect the numerous close running fits from abrasive matter present in new piping

The suction system should be thoroughly flushed before installing the suction strainer and making up suction piping to the pump. The suction strainer should be installed between 5 to 20 pipe diameters upstream from the pump suction flange.

Note: ***The open area of the strainer should have a minimum of a 3 to 1 ratio to the area of the pump suction.***



Cone type strainer

The Flowserve recommendation for suction strainers consists of a conical shaped steel plate. The plate has 1.6 mm ($^{1}/_{16}$ in.) perforations and is of sufficient size and thickness for the required flow. (See figure above.)

Other type of strainers may be used as long as they conform to the requirements stated above.

Pressure gauges should be installed on both sides of the screen so that the pressure drop across the screen can be measured.

When the unit is being started, the gauges on each side of the screen should be carefully watched. An increase in the differential pressure between the two gauges indicates that the screen is becoming clogged with dirt and scale. At this point, the pump should be shut down, and the screen cleaned and/or replaced.

The strainer must be removed after the initial run-in time if the process does not allow its permanent use.

Note: ***A spool piece should be installed in the suction line so that the suction strainer may be installed and removed with a pressure gauge between the strainer and pump.***

4.6.4 Discharge piping

See section 4.6.3 for typical pipe work design.

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

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

Fitting an isolation valve will allow easier maintenance.

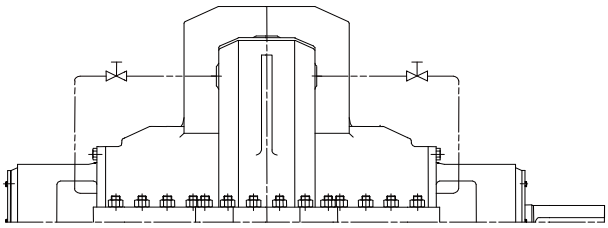
4.6.5 Auxiliary piping

4.6.5.1 Drains

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

4.6.5.2 Pumps fitted with gland packing

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. A control valve or orifice plate may have been fitted into the supply line to control the pressure to the gland/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 pipe work. 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. Check the identification nameplate 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

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

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

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

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

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

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

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

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

5 COMMISSIONING, START-UP, OPERATION AND SHUTDOWN

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

5.1 Pre-commissioning procedure

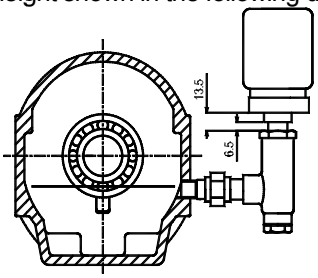
5.1.1 Lubrication

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. Approximate oil volumes are shown in section 5.2.4 *recommended fill quantities.*

Pumps with grease lubricated antifriction bearings are normally supplied fitted with grease nipples and with pre-greased bearings.

Grease lubricated electric motor bearings are generally pre-greased. Refer to the motor UI for information on the motor lubrication schedule. Other drivers and gearboxes, if appropriate, should be lubricated in accordance with their manuals.

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

5.2 Pump lubricants

5.2.1 Recommended oil lubricants

	Oil	Splash / force feed / purge and pure **oil mist lubrication		
Centrifugal pump lubrication	Viscosity cSt @ 40 ºC	32	46	68
	Oil temperature range *	-5 to 65 ºC (23 to 149 ºF)	-5 to 78 ºC (23 to 172 ºF)	-5 to 80 ºC (23 to 176 ºF)
	Designation to ISO 3448 and DIN51524 part 2	ISO VG 32 32 HLP	ISO VG 46 46 HLP	ISO VG 68 68 HLP
Oil companies and lubricants	BP Castrol †	Energol HLP-HM 32	Energol HLP-HM 46	Energol HLP-HM 68
	ESSO †	NUTO HP 32	NUTO HP 46	NUTO HP 68
	ELF/Total †	ELFOLNA DS 32 Azolla ZS 32	ELFOLNA DS 46 Azolla ZS 46	ELFOLNA DS 68 Azolla ZS 68
	LSC (for oil mist only – long life) †	LSO 32 (synthetic oil)	LSO 46 (synthetic oil)	LSO 68 (synthetic oil)
	ExxonMobil (mineral oil) †	Mobil DTE 24	Mobil DTE 25	Mobil DTE 26
	ExxonMobil (oil bath only – long life) †	Mobil SHC524 (synthetic oil) ***	Mobil SHC525 (synthetic oil)	Mobil SHC526 (synthetic oil)
	Q8 †	Q8 Haydn 32	Q8 Haydn 46	Q8 Haydn 68
	Shell †	Shell Tellus 32	Shell Tellus 46	Shell Tellus 68
	Chevron Texaco †	Rando HD 32	Rando HD 46	Rando HD 68
	Wintershall (BASF Group) †	Wiolan HS32	Wiolan HS46	Wiolan HS68
	Fuchs †	Renolin CL 32	Renolin CL 46	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 ºC (23 ºF).
** If preheated pure oil mist lubrication, LCS LSO 68 or LSO 100 synthetic oils are permitted.
† Use LSC for oil mist. Oil parameters provide flash point > 166 ºC (331 ºF), density >0.87@15 ºC (59 ºF), pour point of -10 ºC (14 ºF) or lower.
*** ExxonMobil SHC 524 synthetic oil has a pour point temperature of - 54 ºC. This oil can be used for ambient temperature as low as -50 ºC.

5.2.2 Recommended grease lubricants

Grease grade	NLGI 3**	NLGI 2*
Temperature range	-20 to 100 ºC (-4 to 212 ºF)	-20 to 100 ºC (-4 to 212 ºF)
Designation acc. to DIN	KP3K-20	KP2K-25
BP	Energrease LS-EP3	Energrease LS-EP2
Elf	Multis EP3	Multis EP2
Fuchs	RENOLIT EP3	RENOLIT EP2
Esso	Beacon EP3	Beacon EP2
Mobil	Mobilux EP3	Mobilux EP2
Q8	Rembrandt EP3	Rembrandt EP2
Shell	Alvania EP2	Alvania EP2
Texaco	Multifak EP3	Multifak EP2
SKF		LGEP 2

* NLGI 2 is an alternative grease and must not be mixed with other grades.
** Standard pre-packed grease for fitted antifriction bearings. NLGI 3 greases are preferred for pumps with vertically mounted shaft.

5.2.3 CAUTION Lubrication schedule

5.2.3.1 Oil lubricated bearings

Normal oil change intervals are 4 000 operating hours or at least every 6 months. Where Mobil SHC oils are used this will increase up to 12 000 operating hours where oil is kept below 60 ºC (140 ºF). 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 outer ring temperature may be allowed to rise to 50 ºC (90 ºF).above ambient, but should not exceed 93 ºC (200 ºF). If the oil temperature is monitored then it shall not exceed 82 °C (180 °F). A continuously rising temperature or an abrupt rise in temperature will indicate a fault.

5.2.3.2 Grease lubricated bearings

When grease nipples are fitted, one charge between grease changes is advisable for most operating conditions, i.e. 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 optimizing lubricant change intervals.

The bearing temperature may be allowed to rise to 55 ºC (99 ºF) above ambient but should not exceed 95 °C (204 °F).

5.2.4 Recommended fill quantities

Size (LNN, LNNV and LNNC)	Top-up grease g (oz)		Approx. oil capacity, both bearings litre (fl. oz.)
	Single row ball bearing	Angular contact thrust bearing double	
200-LNN-300 200-LNN-325 200-LNN-375	8 (0.28)	16 (0.56)	0.37 (12.5)
200-LNN-400 200-LNN-475 200-LNN-500 250-LNN-325 250-LNN-375 300-LNN-325	12 (0.42)	24 (0.84)	0.48 (16.2)
200-LNN-525 200-LNN-600 250-LNN-475 250-LNN-600 300-LNN-475 300-LNN-450 300-LNN-500 300-LNN-575 350-LNN-375	15 (0.53)	30 (1.06)	0.60 (20.3)
250-LNN-650 300-LNN-600 300-LNN-625 350-LNN-475 350-LNN-575 350-LNN-725 400-LNN-600	21 (0.74)	42 (1.48)	0.68 (23.0)
300-LNN-750 350-LNN-900 400-LNN-725 500-LNN-600 500-LNN-650 500-LNN-700 500-LNN-775 1000-LNN-750	34 (1.2)	68 (2.4)	2.00 (67.6)
400-LNN-800 400-LNN-875 400-LNN-900 400-LNN-925 500-LNN-950 600-LNN-750 600-LNN-950 600-LNN-975 1000-LNN-800	46 (1.63)	92 (3.26)	4.50 (152)
500-LNN-1150 500-LNN-1250 600-LNN-1200 700-LNN-1225 900-LNN-1200	70 (2.48)	140 (4.96)	7.00 (237)
500-LNN-1000	81 (2.86)	162 (5.72)	4.50 (152)

Note: where the pump is lubricated by oil mist the amount of oil mist supplied (m^3/h) is normally calculated to be at least the bearing bore diameter (mm) x the number of bearing rows / 25. The oil mist should consist of at least 0.025 - 0.04 % oil content. Where oil mist is utilized to lubricate bearings the pressure in the bearing housing must not exceed 0.01 bar (0.15 psi).

For most operating conditions a quality grease having a lithium soap base and NLGI consistency of No 2 or No 3 is recommended. The drop point should exceed 175 ºC (350 ºF).

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

5.3 Direction of rotation

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

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

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

5.4 Guarding

Guarding is supplied fitted to the pump set.

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.

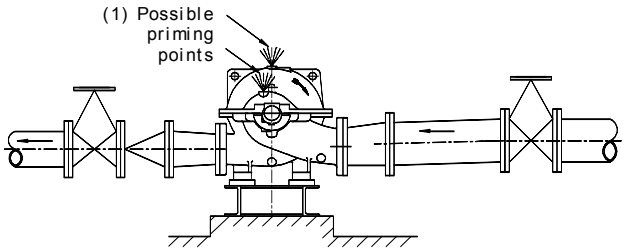
5.5 Priming and auxiliary supplies

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

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

5.5.1 Suction pressure above atmospheric pressure

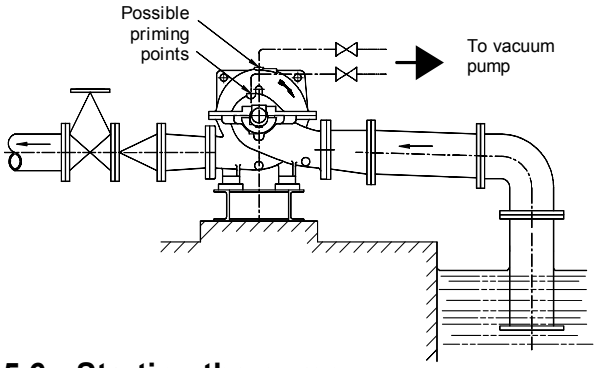
Horizontal pumps: open vent connection (1) on top of the pump upper casing to allow the trapped air to escape. Let liquid run out until free from air bubbles.



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.



5.6 Starting the pump

a) CAUTION Ensure flushing and/or cooling/ heating liquid supplies are turned ON before starting the pump.
b) CLOSE the outlet valve.
c) OPEN all inlet valves.
d) Prime the pump.
e) Ensure all vent connections are closed before starting.
f) Start motor and check outlet pressure.
g) If the pressure is satisfactory, SLOWLY open outlet control valve.
h) CAUTION Do not run the pump with the outlet valve closed for a period longer than 30 seconds.
i) If NO pressure, or LOW pressure, STOP the pump. Refer to section 7, *Faults; causes and remedies*, for fault diagnosis.

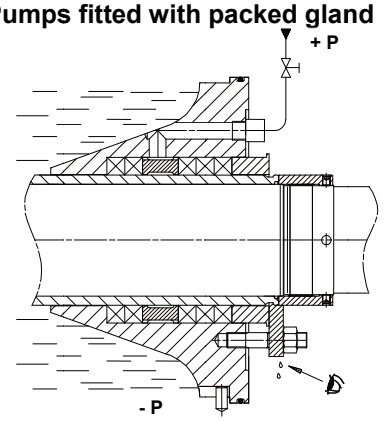
5.7 Running the pump

5.7.1 Venting the pump

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

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

5.7.2 Pumps fitted with packed gland



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

Ex The gland must be adjusted evenly to give visible leakage and concentric alignment of the gland ring [4131] 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 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

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

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

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

It is important, particularly with grease lubrication, to keep a check on bearing temperatures. After start up the temperature rise should be gradual, reaching a maximum after approximately 1.5 to 2 hours. This temperature should then remain constant or marginally reduce with time. (Refer to section 6.2.3.2 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 r.m.s.		Horizontal pumps mm/s (in./sec)	Vertical pumps mm/s (in./sec)
Normal	**N**	≤ 5.6 (0.22)	≤ 7.1 (0.28)
Alarm	**N** x 1.25	≤ 7.1 (0.28)	≤ 9.0 (0.35)
Shutdown trip	**N** x 2.0	≤ 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) CAUTION Close the outlet valve, but ensure that the pump runs in this condition for no more than a few seconds.
b) Stop the pump and Isolate the motor.
c) Switch off flushing and/or cooling/heating liquid supplies at a time appropriate to the process. If the pump is used on a water application keep it filled with water otherwise drain the pump completely.
d) CAUTION For prolonged shut-downs and especially when ambient temperatures are likely to drop below freezing point, the pump and any cooling and flushing arrangements must be drained or otherwise protected.
e) If the pump is to left to stand for an extended period the pump shaft needs to be turned manually one and one quarter (1 ¼) revolutions every week.

5.8.1 Flushing requirement

The hydraulic and or mechanical performance of pumps exposed to water containing more than 500 ppm of chloride can degrade due to accelerated corrosion effects. In order to minimize these effects, Flowserve recommend that the end user takes the following precautions:

a) If the pump is going to be idle for 48 hours or more, the suction and discharge valves on the pump must be closed to isolate the pump internals from the liquid pumped.

b) Open the casing drain connection (located on the bottom of the lower half casing) to drain all the water containing the chloride element from the inside of the pump.
c) Close the casing drain connection and open the casing fill connection (on the upper half of the casing) to allow the casing to be filled with fresh water containing no more than 50 ppm of chloride.
d) Once the casing is full of fresh water, partially close the drain connection while the fill connection remains connected to the source of fresh water. The casing must then be flushed for a period of 1 hour.
e) Once flushing is completed, the drain connection and fill connection must remain open. The inside of the pump will be open to the atmosphere.
f) If the pump remains idle for 30 days or more, the pump rotor must be turned.
g) When the pump is placed back into service, follow the normal startup procedure. Take care not to operate the pump with the suction valve closed.

CAUTION LIMITATIONS

- The system designer and or the end user must advise Flowserve of any chemical treatment that will be added to the water.
- If this process is not followed, the warranty terms of the contract will be voided.

5.9 Hydraulic, mechanical and electrical duty

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

5.9.1 Specific gravity (SG)

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

5.9.2 Viscosity

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

5.9.3 Pump speed

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

5.9.4 Net positive suction head ($NPSH_A$)

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

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

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

5.9.5 Pumped flow

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

6 MAINTENANCE

6.1 General

It is the plant operator's responsibility to ensure that all maintenance, inspection and assembly work is carried out by authorized and qualified personnel who have adequately familiarized themselves with the subject matter by studying this manual in detail. (See also section 1.6.)

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 lifting of the part to be serviced.

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

Do not spray air or compressed inert gas on skin.

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

Never use air or compressed inert gas to clean clothes.

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

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

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

6.2 Maintenance schedule

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

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

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

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

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

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

6.2.1 Routine inspection (daily/weekly)

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

6.2.2 Periodic inspection (six monthly)

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

CAUTION Maintaining the correct oil level is very important.

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

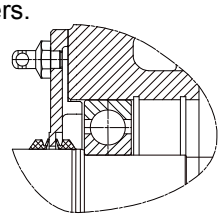
Refer to section 5.1.1 for methods of oil fill, section 5.2.1 for oil grade recommendations and 5.2.4 for the schedule and temperature limits.

6.2.3.2 Grease lubrication

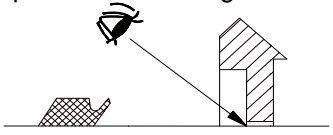
CAUTION See section 5.2.2 for grease recommendations.

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

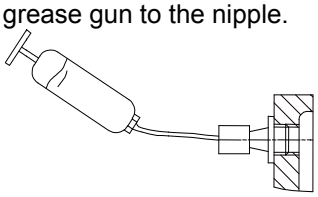
a) It is important not to under or over grease the bearings as this will lead to overheating and premature failure. Grease lubricated bearing housings have grease nipples fitted in the bearing covers.



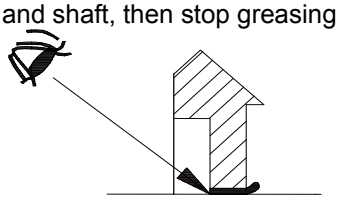
b) Move the axial seal ring back so the gap between the pump shaft and bearing cover can be seen.



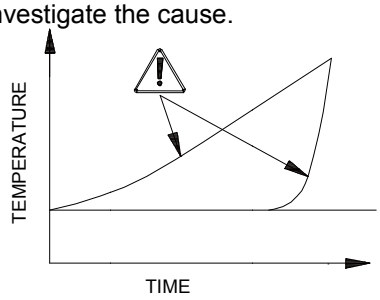
c) Connect grease gun to the nipple.



d) Press grease into the bearing housing until the first signs of it appear in the gap between the housing and shaft, then stop greasing.

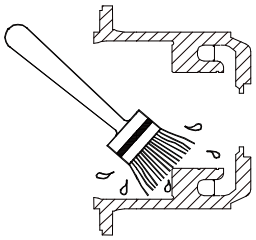


e) V-rings should be seated at the proper distance from the sealing surface to avoid overheating.
f) The maximum allowable operating temperatures for anti-friction bearings will vary from unit to unit, depending on ambient and fluid temperature. The rise above ambient should not normally exceed 55 °C (99 °F) or a combined maximum of 95 °C (204 °F).
g) A continuously rising temperature or an abrupt temperature rise indicates a problem. If these symptoms occur, stop the pump immediately and investigate the cause.



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

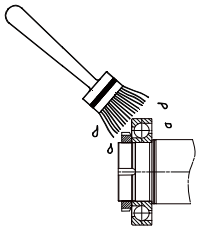
a) Remove the bearing housing from the rotor assembly.
b) Brush the bearing housing with hot kerosene (100 to 115 °C/212 to 240 °F) or other non-toxic solvent.
c) Clean and flush out the housing with a light mineral oil.



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

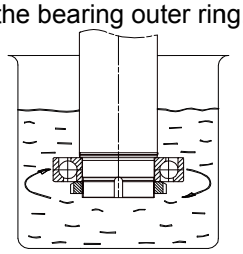
To clean the bearings:

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



To remove badly oxidized grease 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 overheating and premature failure. It is recommended that the bearings be filled with grease using a suitable spatula. In addition the housings should be no more than half filled.

6.2.4 Mechanical seals

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

6.2.5 Gland packing

The stuffing box split gland can be completely removed 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 pressurized flush to the centre of the packing. If not required, this can be replaced by an extra two 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 keep records of all pumps that have been supplied. When ordering spares the following information should be quoted:

1) Pump serial number.
2) Pump size.
3) Part name – taken from section 8.
4) Part number – taken from section 8.
5) Number of parts required.

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

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

6.3.2 Storage of spares

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

6.4 Recommended spares and consumable items

For start-up purposes:

1 - 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 48 screws/nuts
- Socket spanners (wrenches), up to M 48 screws
- Allen keys, up to 10 mm (A/F)
- Range of screwdrivers
- Soft mallet

More specialized equipment:

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

6.6 Fastener torques

6.6.1 Pump split case bolts and pump foot bolts

The standard bolt class is A4-80, 8.8 or higher with lubricated thread (600 MPa and 640 MPa yield strength respectively or higher). Unless otherwise specified on the pump GA drawing, the following torques shall be applied on the pump foot bolts and pump split case bolts:

Torque Nm (lbf•ft) for pump foot and split casing bolts				
Bolt size	Class 8.8	Duplex and super duplex	A193 Gr B7M	A4-80
M 16 (⅝ in.)	160 (120)	113 (90)	135 (100)	150 (120)
M 20 (¾ in.)	310 (230)	218 (170)	262 (200)	291 (220)
M 24 (⅞ in.)	535 (400)	376 (280)	451 (340)	502 (380)
M 27 (1 in.)	785 (580)	552 (410)	662 (490)	736 (550)
M 30 (1⅛ in.)	1 100 (820)	773 (580)	928 (690)	1 031 (770)
M 36 (1⅜ in.)	1 850 (1 370)	1 301 (960)	1561 (1 160)	1 734 (1 280)
M 42 (1⅝ in.)	3 000 (2 220)	2 109 (1 560)	2 531 (1 870)	2 813 (2 080)
M 48 (1⅞ in.)	4 500 (3 320)	3 164 (2 340)	3 797 (2 810)	4 219 (3 120)

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

6.6.2 Other bolt locations

Torque Nm (lbf•ft) for other bolt locations				
Bolt size	Class 8.8	Class 6.8 duplex	Class 5.8	A193 Gr B7M
M 16 (⅝ in.)	160 (120)	120 (90)	100 (80)	135 (100)
M 20 (¾ in.)	310 (230)	233 (180)	194 (150)	262 (200)
M 24 (⅞ in.)	535 (400)	401 (300)	334 (250)	451 (340)
M 27 (1 in.)	785 (580)	589 (440)	491 (370)	662 (490)
M 30 (1⅛ in.)	1 100 (820)	825 (610)	688 (510)	928 (690)
M 36 (1⅜ in.)	1 850 (1 370)	1 388 (1 030)	1 156 (860)	1 561 (1 160)
M 42 (1⅝ in.)	3 000 (2 220)	2 250 (1 660)	1 875 (1 390)	2 531 (1 870)
M 48 (1⅞ in.)	4 500 (3 320)	3 375 (2 490)	2 813 (2 080)	3 797 (2 810)

Note: For the tightening sequence also refer to good industry practice. See section 10.3, *Reference 6*, for more detail.

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 to 0.6 to 0.8 mm (0.024 to 0.032 in.), depending on pump size. On the LNNV it is recommended that the product lubricated bearing is renewed at a diametrical clearance of 0.5 mm (0.02 in.).

6.8 Disassembly

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

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

Refer to sectional drawings for part numbers and identification. See section 8, *Parts lists and drawings.*

6.8.1 Rotor unit

6.8.1.1 LNN and LNNC

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) Unscrew and remove bearing housing setscrews [6570.4].

f) Unscrew and remove nuts [6580.1 or 6580.4] above split flange on upper half casing. Drive out dowel pin [6810] (if fitted) from casing flange halves. Remove upper half casing [1214].
g) Take out complete rotor unit and place onto two support blocks.

6.8.1.2 LNNV

This pump is best removed from the system to carry out complete strip down. It should be set down with the shaft horizontal to enable the rotor to be removed.

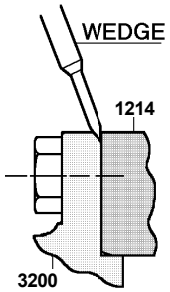
a) Isolate motor and lock off electrical supply in accordance with local regulations.
b) Isolate suction and discharge valves.
c) Remove coupling guards and disconnect the coupling halves.
d) Drain pump casing and, if applicable, remove any auxiliary piping.
e) Remove motor complete with motor stool and set down carefully in a safe location.
f) Retain any shimming between stool and pump casing.
g) Remove bolts securing pump suction and discharge flanges.
h) Sling pump as shown in section 2.3 and take the strain. Remove setscrews securing the pump baseplate to the pump casing.
i) Remove the pump to a safe location and manoeuvre the pump shaft into a horizontal position.
j) Unscrew and remove setscrews [6570.4 and 6570.5] securing the bearing housing and end cover [3200 and 3266]. Remove end cover.
k) Unscrew and remove nuts [6580.5] above split flange on upper half casing. If fitted to casing flange halves, drive out dowel pin [6810].
l) Using jacking screws, remove upper half casing.
m) Carefully remove non-drive end stuffing box housing [4110] complete with bearing housing [3200] and bearing bush [3300]. The impeller now rests on the casing ring.
n) Carefully take out complete rotor assembly. Protect the bearing surface on the outside diameter of the bearing sleeve [3400] from damage and place rotor on two support blocks.
o) If supplied with optional grease lubricated bottom line bearing, carefully remove the complete rotor assembly after l) above and the upper half casing has been removed.

6.8.2 Bearing housing

a) Remove bearing cover setscrews [6570.6] and remove key [6700.2] from shaft end.
b) Remove shaft seal ring [4305.2] and pull off bearing housing [3200] from the rotor. If optional bearing isolators or stationary labyrinths are fitted in the bearing covers they can be withdrawn complete with the covers. If replacement is necessary they can be pressed out of the respective covers. Take care not to damage O-ring seals, when fitted, on shaft keyways etc.

Note:

c) The bearing housings, ball bearings, and shaft seals can be removed without removal of the upper half casing, providing the pump is fitted with a spacer coupling.
d) After unbolting the bearing housing, move it back using a wedge as below.



6.8.3 Line bearing

6.8.3.1 LNN and LNNC – drive end

Remove bearing [3011.2] from shaft using a bearing puller ensuring pulling force is applied to the inner race only.

6.8.3.2 LNNV – non-drive end

If the bearing bush is showing signs of wear it must be removed by pressing out of the lower bearing housing [3200].

If the non-drive end is fitted with the grease lubricated ball bearing option, dismantle circlip [6544] and disc spacer [3645] from the shaft and remove ball bearing, [3011.2] for LNN or [3011.1] for LNNV, using a bearing puller ensuring pulling force is applied to the inner race only.

6.8.4 Thrust bearings

Unscrew and remove the self-locking bearing nut [3712] and remove the bearing [3011.1] using a puller as in 6.8.3.1 above.

Note:

On pumps with an un-sleeved shaft, check if a bearing distance ring is fitted between the bearing and the shaft shoulder. If so, this MUST be retained for refitting during assembly.

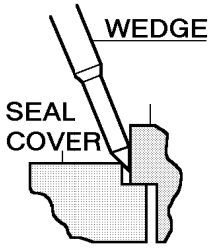
6.8.5 Shaft seal - gland packing

a) Remove gland nuts [6580.2] and gland [4120].
b) Lever out gland ring [4131] using its grip groove.
c) Remove gland packing [4130] and lantern rings [4134] using a bent wire.

6.8.6 Shaft seal - component mechanical seal

Refer to any special instructions supplied with the mechanical seal.

a) Remove seal cover screws [6570.7] and pull off seal cover [4213] complete with the stationary seal ring that is held in place by the O-ring seal.
b) The mechanical seal cover can also be removed by placing a wedge between the seal cover and the impeller, as below:



c) Mechanical seal assembly [4200.1] can now be removed.

6.8.7 Shaft seal – cartridge mechanical seal

If fitted with optional cartridge mechanical seal, refer to any separate user instructions supplied.

Remove nuts [6580.2] to detach seal assembly from stuffing box housing [4110] and slide off complete seal assembly [4200].

6.8.8 Shaft sleeve

6.8.8.1 LNN, LNNC both ends and LNNV drive end

a) Loosen grub screw [6814.2] and unscrew shaft nut [2910]. Remove shaft sleeve [2450] using its pulling groove.
b) If after removing the seal cover, or cartridge seal, there is no shaft nut [2910] visible, this means that an unsleeved shaft is fitted. See sectional drawing for details.
c) The shaft nut and spacer are accessible after removing the stuffing box housing [4110] and should be removed as described in a) above.

6.8.8.2 LNNV non-drive end

a) Remove capscrew [6579] and end cap [6415] from shaft end.
b) Remove lower bearing sleeve [3400] and lower sleeve [2400].
c) If fitted with optional grease lubricated ball bearing the shaft sleeve should be removed as detailed in *Section 6.8.8.1.*

6.8.9 Impeller and wear rings

a) The impeller and wear rings can now be removed if required.
b) When removing the rotor unit, the casing wear rings [1500] will be attached to it as they are fixed by two diametrically opposite pins [6811.1] inserted into the casing ring and located in grooves in the lower half casing.
c) If impeller rings [2300] are also fitted, they are shrunk onto the impeller and fixed with grub screws [6814.1] between their diametral mating surfaces.
d) To remove the impeller rings, remove the locking screws and heat up the ring until it slides off easily.

6.9 Examination of parts

CAUTION Used parts must be inspected before assembly to ensure the pump will subsequently run properly. In particular, fault diagnosis is essential to enhance pump and plant reliability.

6.9.1 Casing, 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 bearing sleeve show no sign of wear, grooving or corrosion attack. (It is recommended that both the bush and sleeve are replaced at the same time.)

6.9.5 Bearing isolators, labyrinths or lip seals (if fitted)

a) The lubricant, bearings and bearing housing seals are to be inspected for contamination and damage. If oil bath lubrication is utilized, these provide useful information on operating conditions within the bearing housing.
b) If bearing damage is not due to normal wear and the lubricant contains adverse contaminants, the cause should be corrected before the pump is returned to service.
c) Labyrinth seals and bearing isolators should be inspected for damage but are normally non-wearing parts and can usually be re-used.
d) Bearing seals are not totally leak free devices. Oil from these may cause staining adjacent to the bearings.

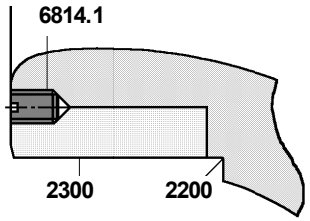
6.10 Assembly

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

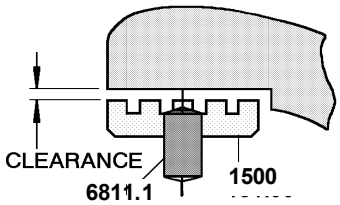
Ensure threads, gasket and O-ring mating faces are clean and that ball bearings are C3 fit. Apply thread sealant to non-face sealing pipe thread fittings.

6.10.1 Wear rings

a) Impeller rings (when fitted) should be heated up 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 diameter between the mating faces of the ring and impeller and insert grub screws. (The existing half tapped holes from the removed impeller

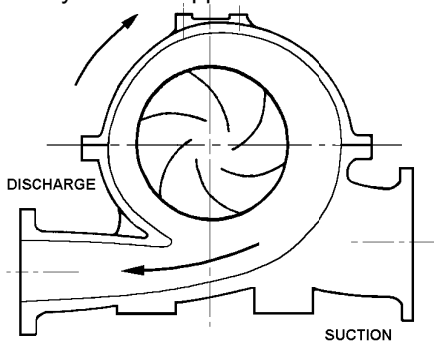


c) Slip the casing wear rings over the impeller hubs before mounting the rotor unit into the lower half casing, ensuring the pins in the rings locate into the holes in the casing.
d) Check the running clearance between impeller and casing ring against the appropriate pump size in section 3.4.2.

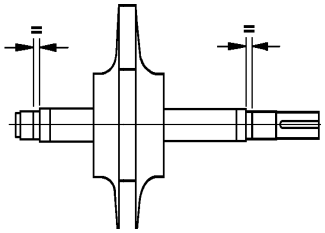


6.10.2 Impeller setting

a) When re-assembling the impeller on the shaft, it is important to mount the impeller so that the vane tips point away from the apparent flow direction.



b) The rotor always rotates towards the expanding section of the volute.
c) The two shaft sleeves and shaft nuts clamping the impeller define its position on the pump shaft and hence in the pump casing.
d) The correct axial position of the impeller and mechanical seals can be checked with the grooved checking marks on the pump shaft.



6.10.3 Shaft seal - packed gland

a) Fit impeller key and slide impeller onto shaft.
b) Insert O-ring into shaft sleeves and slide sleeves along shaft and into the impeller hubs. Lightly lubricate the shaft and O-ring for easier assembly.
CAUTION No O-rings are fitted beneath LNNV product lubricated bearing sleeves (see sectional drawing). On unsleeved shaft versions an O-ring is fitted at each end of the spacer.
c) Tighten and adjust shaft nuts so that their distances to the grooved marks are equal at both ends.
d) Lock the shaft nuts in place with grubscrews. Tighten capscrew (LNNV).
e) Slide the stuffing box housings over the shaft and fit the O-ring [4610.6].
CAUTION This O-ring must be replaced at each and every dismantling.
f) Place the gland ring [4131] over the sleeve.

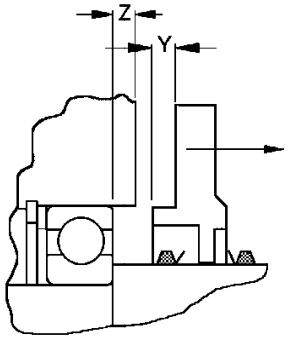
6.10.4 Shaft seal - component mechanical seal

Refer to any special instructions supplied with the mechanical seal.
a) Slide the rotating assembly of the mechanical seal along the shaft sleeve until the retaining ring has reached the correct setting distance along the sleeve. Tighten the grub screws to lock it into position.
b) Insert O-ring into shaft sleeves and slide sleeves along shaft and into the impeller hubs. Lightly lubricate the shaft and O-ring for easier assembly.
c) Tighten and adjust shaft nuts so that the distances to the grooved marks are equal at both ends.
d) Lock the shaft nuts in place with grub screws. Tighten cap 7screw (LNNV).
e) Slide the stuffing box housings over the shaft and fit the O-ring [4610.6].
CAUTION This O-ring must be replaced at each and every dismantling.

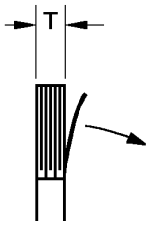
f) Slip the mechanical seal covers [4213] together with their installed stationary seal parts and O-rings over the shaft.
g) If cartridge mechanical seals are to be fitted.
Refer to any special instructions supplied with the mechanical seal. Cartridge seals are usually fitted direct to the pump shaft as shown in section 8.1.2.

6.10.5 Ball bearings - LNN, LNNC

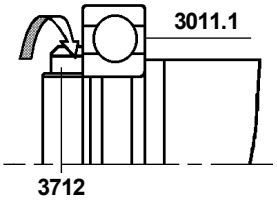
Before mounting the bearings, proceed as follows:
a) Fit the shaft seal rings [4305.1] onto the shaft and slide the bearing cover [3260.1] over the shaft. If supplied also fit shaft seal ring [4305.3] into shaft.
b) Pumps with grease lubricated bearings have V-ring seals on the outside of the bearing cover only. Pumps with oil lubricated bearings have, in addition, shaft seal rings [4305.3 and 4305.4] on the inside of the bearing covers. If V-rings are fitted, the inner V-rings have two small perforations in the lip. Inner V-rings engage in the grooves in the shaft.
c) If new optional bearing labyrinth seals are to be fitted, press them into their respective covers before the covers are assembled to the shaft. Take care not to damage O-ring seals. Ensure liquid flinger [2540] is fitted to shaft before bearing cover [3260.1] is slid onto the shaft.
d) If new optional bearing isolators are to be fitted in the bearing covers refer to separate instructions supplied with the isolators.
e) Determine the thickness of the laminated shim on the thrust bearing side. Provisionally position the bearing into the bearing housing seated against the circlip and thrust washer.
f) Measure distance 'Y' on the bearing cover.
g) Measure distance 'Z' to face of bearing housing.
h) Shim thickness to give correct clearance will be 'Y' minus 'Z' = 0.1 to 0.2 mm (0.004 to 0.008 in.) Place correct shims on the shaft.



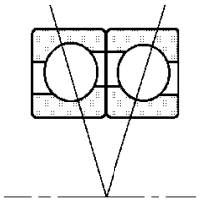
i) CAUTION The shim is laminated material with an original thickness (T) of 1.0 mm (0.039 in.) and laminate thickness of 0.05 mm (0.002 in.). This allows the thickness to be varied in 0.05 mm (0.002 in.) increments by peeling off layers to achieve the required axial clearance.



j) For oil lubricated units only, place shaft seal ring [4305.3] in the shaft grooves for correct positioning.
k) The bearing should be heated up to 100 °C (212 °F) using a hotplate, hot oil bath or induction heater and then slipped onto the shaft to the shoulder.
l) On the thrust bearing side, mount the self-locking ring type nut.



m) Bearing arrangements using a pair of angular contact bearings should be mounted with the shoulders of the inner rings arranged face to face as shown:



6.10.6 Bearings - LNNV

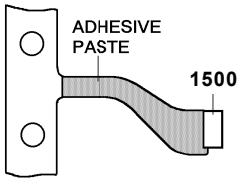
a) Proceed as Section 6.10.5 for the grease lubricated ball thrust bearing at the drive end, ensuring shim thickness is selected to give correct clearance.
b) If fitted with liquid lubricated bearing at non-drive end press a new bearing bush [3300] into the lower bearing housing [3200.1], making sure the face of the bush is flush with the end of the housing.
c) Secure the lower bearing housing into the stuffing box housing.
d) Slide the stuffing box housing, complete with bearing bush, over the shaft and fit the O-ring [4610.6].
e) If fitted with optional grease lubricated bottom bearing, slide liquid flinger assembly [2540.1; 4610.3; 6814.3] and bearing cover assembly [3260.1; 2500] onto shaft.
f) The bearing should be heated up to 100 °C (212 °F) using a hotplate, hot oil bath or induction heater and then slipped onto the shaft to the shoulder.
g) Secure to shaft with disc spacer [3645.1] and circlip [6544.1].

6.10.7 Rotor unit

a) After completion of preceding steps, carefully place the rotor into the lower half pump casing. Make sure the fixing pins of the casing rings fit correctly in the casing grooves and ensure correct fit of locating pins at the stuffing box housing.
b) Although both stuffing box housings are identical the locating pins in the lower half casing are different for drive and non-drive sides. The stuffing box housing should be rotated so that the correct slot engages with the pin. The long pin with small diameter must engage in the small deep slot whilst the short larger diameter pin engages in the shallower wider groove.

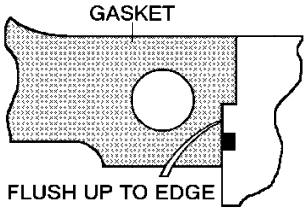
6.10.8 Casing gasket

a) The gasket must be cut from asbestos-free sheet material of 0.8 + 0.1/-0.05 mm ($^{1}/_{32}$ in.) thickness, by following the actual inner casing contour of the lower half casing.
b) Special care must be exercised at the bores and stuffing box housing.
c) The gasket must be accurately cut and fit flush with these bores to prevent leakage at the O-ring.
d) Position gasket carefully onto the cleaned surface of the lower half casing.
e) Coat the casing bottom half flange surface of the wall between suction and discharge side with a contact adhesive, as below:



Note: To assist assembly, particularly on larger sizes it may be advisable to use further adhesive at key points around this flange.

f) Push gasket flush against fit of stuffing box housing and secure gasket locally again using the above adhesive paste.

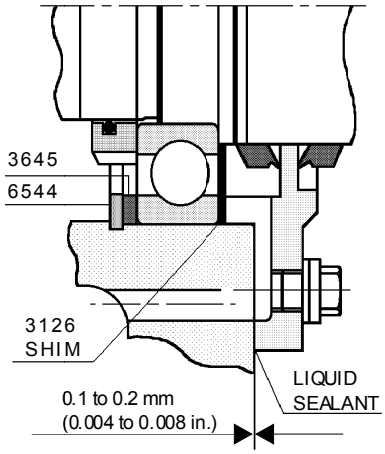


g) Place upper half casing onto pump, ensuring dowels or stuffing box and bearing housing make correct alignment.
h) Tighten upper half casing flange nuts/screws to correct torque.

6.10.9 Bearing housing

a) Insert the circlip [6544] and disc spacer [3645] at the thrust bearing end.

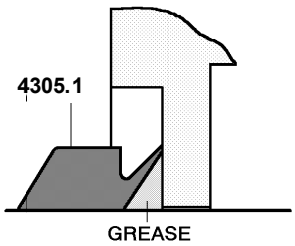
Note: The circlip and thrust washer must not be fitted at the line bearing end.
LNN and LNNC - thrust bearing at non-drive end.
LNNV - thrust bearing at drive end.



Clearance between bearing outer race and bearing cover

b) On oil lubricated units ensure that the shaft seal rings [4305.3] are located in the grooves in the shaft.
c) Slip the bearing housings over their respective bearings and insert them into the recesses of the pump casing.
d) Fit bearing housing setscrews [6570.4] and tighten.
e) Apply liquid sealant to bearing cover flange.
f) Ensure correct seating of shim.
g) Turn bearing cover to correct position:
For the grease lubricated units – the grease nipple can be found towards the top half of the bearing casing.
Oil lubricated units – the oil plug sits towards bottom half of the bearing casing.
h) Tighten bearing cover at bearing housing and push the shaft seal ring [4305.1] against the bearing cover.

Note: The sealing surface of the shaft seal ring must be covered with grease and pushed gently up[illegible]ise it may run hot!



i) Refit plugs, vents, oiler etc. as applicable.
j) On oil lubricated units at the drive end, place the shaft seal ring [4305.4] over the shaft and position in the groove to seal against the end cover.
k) Fit the end cover [3260.2] and the shaft seal ring [4305.2], lubricate it with grease and push it up to the end cover.
l) At the non-drive end, fit the bearing end cover [3266] and tighten the screws [6570.5].

6.10.10 Stuffing box assembly

6.10.10.1 Gland packing

Insert inner two rings of packing, then lantern ring halves and finally 2 or 3 more rings of packing. Loosely fit the gland [4120] and connect flush line.

6.10.10.2 Component mechanical seal [4200.1]

Refer to separate User instructions supplied with the mechanical seal.

Fasten seal covers [4213] complete with O-ring [4610.9] using screws [6570.7]. Connect flush line. Connect any auxiliary piping.

6.10.10.3 Cartridge mechanical seal [4200]

If optional cartridge seals are fitted, refer to separate User instructions supplied with the seal, for securing and activating the seal.

7 FAULTS; CAUSES AND REMEDIES

FAULT SYMPTOM

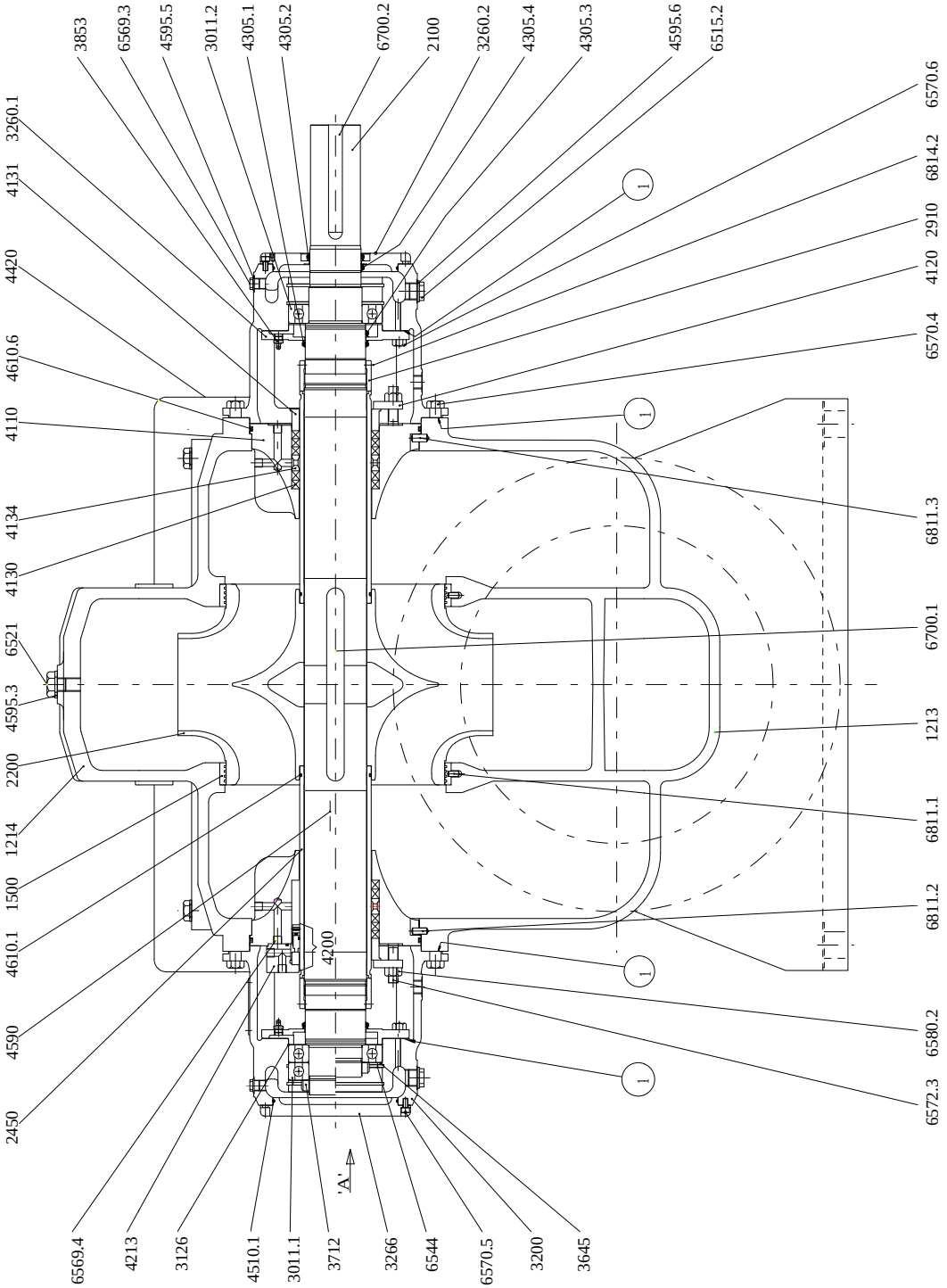
Pump overheats and seizes											
⇓	Bearings have short life										
	⇓	Pump vibrates or is noisy									
		⇓	Mechanical seal has short life								
			⇓	Mechanical seal leaks excessively							
				⇓	Pump requires excessive power						
					⇓	Pump loses prime after starting					
						⇓	Insufficient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

FAULT SYMPTOM

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

8 PARTS LISTS AND DRAWINGS

8.1 LNN and LNNC – grease lubricated, gland packed and component mechanical seal option – sizes up to 350 mm discharge



① Leak proofing material Casco 145 or Marston Hydrosil 100RTV silicone compound.

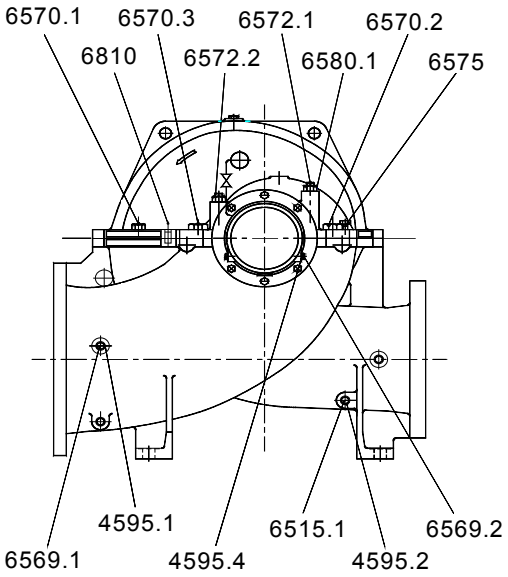
* Note: items 4305.3 and 4305.4 - oil lubricated arrangement only.

(Drawing taken from C751/010.)

8.1.1 Parts list - LNN and LNNC - sizes up to 350 mm discharge

Item	Description
1213	Casing half lower
1214	Casing half upper
1500	Casing wear ring
2100	Shaft
2200	Impeller
2450	Shaft sleeve
2910	Shaft nut
3011.1	Ball bearing
3011.2	Ball bearing
3126	Shim
3200	Bearing housing
3260.1	Bearing cover
3260.2	Bearing cover
3266	Bearing end cover
3645	Disc spacer
3712	Bearing nut
3853	Grease nipple
4110	Stuffing box housing
4120	Gland
4130	Gland packing
4131	Follower (gland ring)
4134	Lantern ring
4213	Mechanical seal cover
4305.1	Shaft seal ring
4305.2	Shaft seal ring
4305.3	Shaft seal ring
4305.4	Shaft seal ring
4420	Sealing pipe
4510.1	Joint ring
4590	Gasket
4595.1	Joint ring
4595.2	Joint ring
4595.3	Joint ring
4595.4	Joint ring
4595.5	Joint ring
4595.6	Joint ring
4610.1	O-ring
4610.6	O-ring
6515.1	Drain plug
6515.2	Drain plug
6521	Vent plug
6544	Circlip
6569.1	Plug
6569.2	Plug
6569.3	Plug
6569.4	Plug
6570.1	Screw
6570.2	Screw
6570.3	Screw
6570.4	Screw
6570.5	Screw
6570.6	Screw
6572.1	Stud
6572.2	Stud
6572.3	Stud
6575	Jack screw
6580.1	Nut
6580.2	Nut
6700.1	Key
6700.2	Key
6810	Dowel pin
6811.1	Cylindrical pin
6811.2	Cylindrical pin
6811.3	Cylindrical pin
6814.2	Grub screw

View on Arrow A

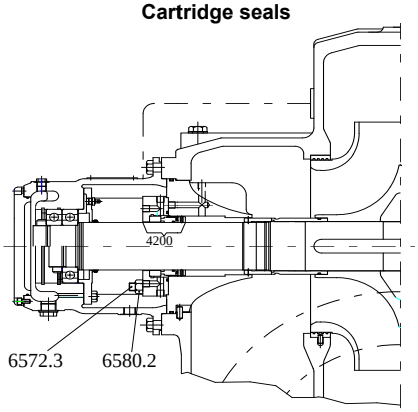


8.1.2 Options parts list - LNN and LNNC - sizes up to 350 mm discharge

Item	Description
2300	Impeller wear ring
2540	Flinger (liquid)
3855	Constant level oiler
4200	Mechanical seal (cartridge)
4305.1	Shaft seal ring
4305.3	Shaft seal ring
4330.1	Labyrinth ring
4330.2	Labyrinth ring
4330.3	Labyrinth ring
4330.4	Labyrinth ring
4510.3	Joint ring
4595.4	Joint ring
4595.6	Joint ring
4610.4	O-ring
4610.5	O-ring
6515.2	Drain plug
6529	Ventilation device (breather)
6569.2	Plug
6572.3	Stud
6580.3	Nut
6814.1	Grub screw
8161	Deflector heat sink

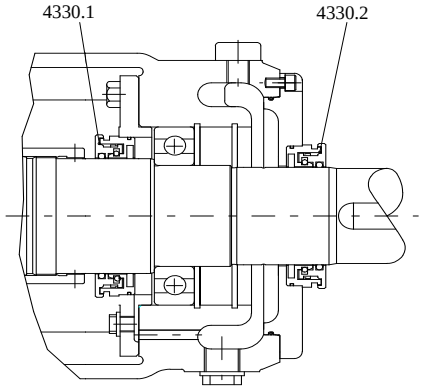
8.1.3 Scrap views options

Cartridge seals

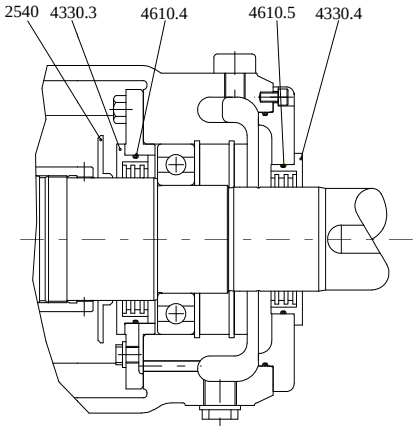


Scrap section showing cartridge seal fitted directly to pump shaft

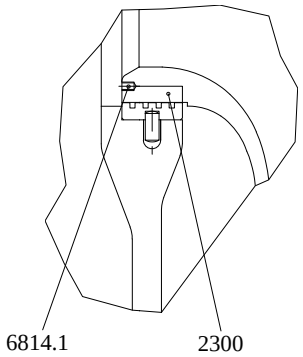
Bearing isolators



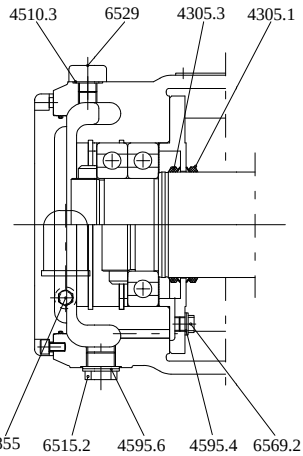
Bearing labyrinth seals



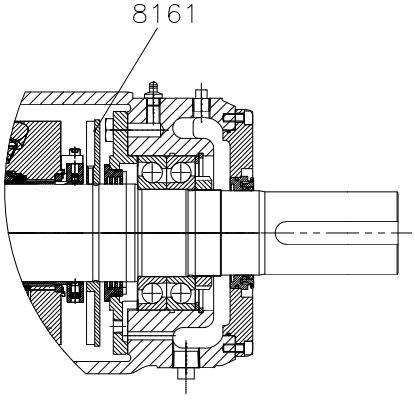
Impeller rings



Oil lubrication

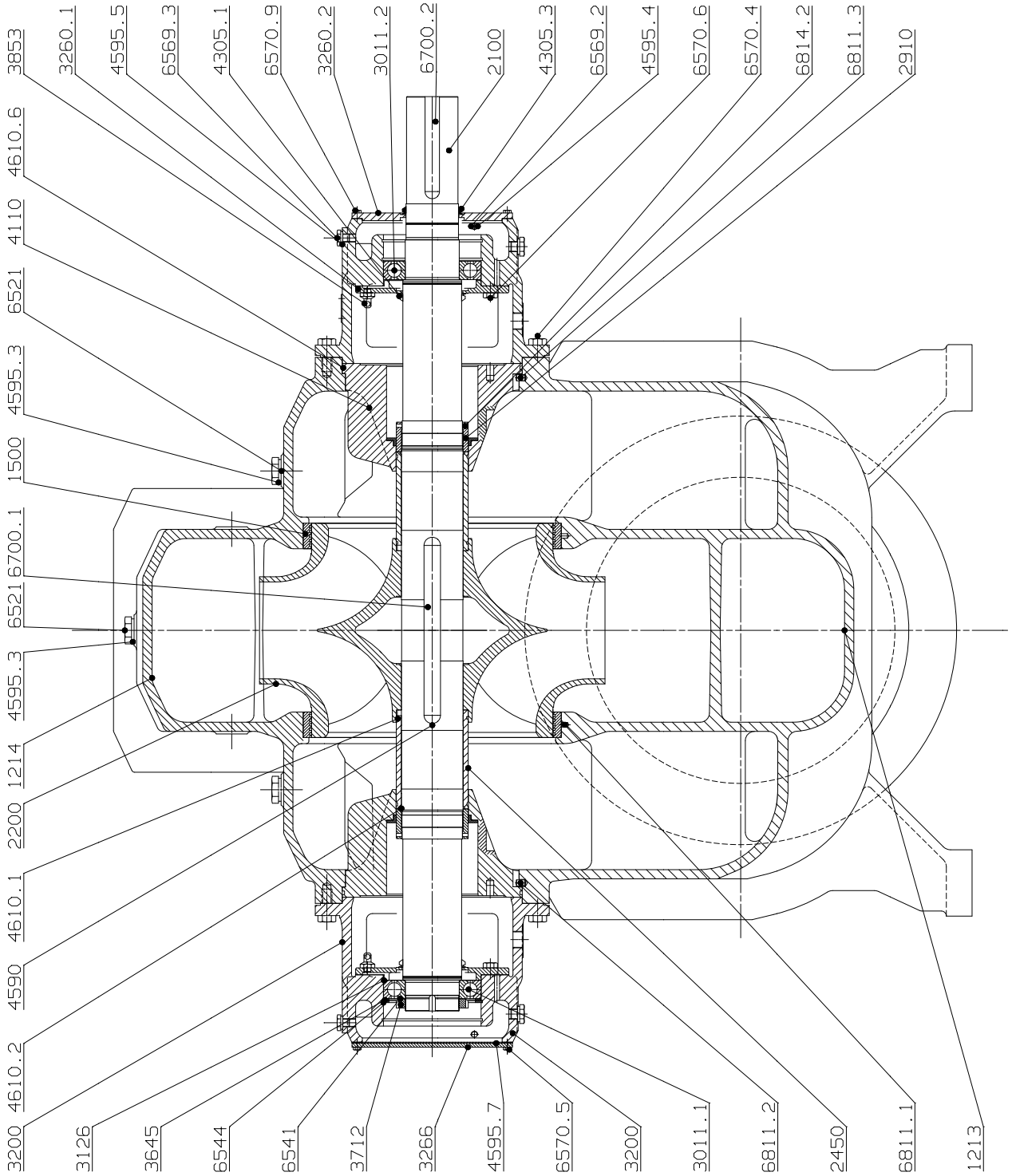


Deflector heat sink



See also section 8.1 for positioning of drive end shaft seal rings [4305.1, 4305.2, 4305.3 and 4305.4]

8.2 LNN and LNNC – grease lubricated and gland packed option – sizes greater than 350 mm discharge

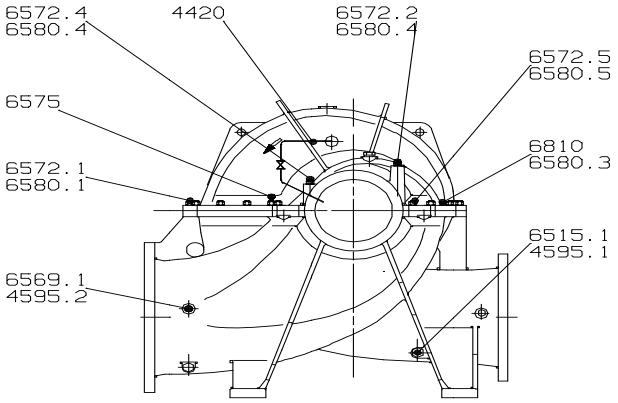


(Drawing taken from A-1975663.)

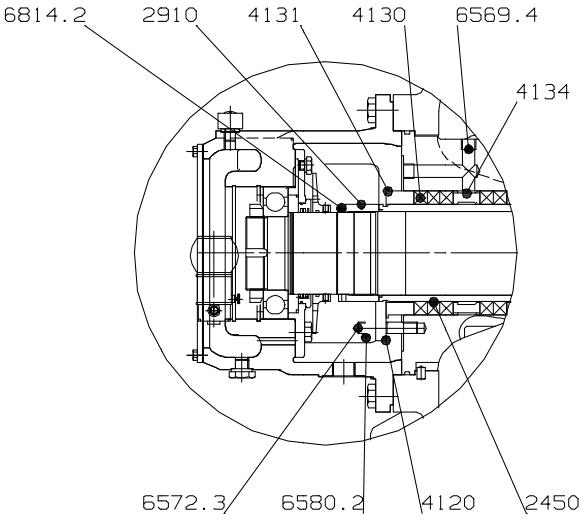
8.2.1 Parts list - LNN and LNNC - sizes greater than 350 mm discharge

Item	Description
1213	Casing half lower
1214	Casing half upper
1500	Casing wear ring
2100	Shaft
2200	Impeller
2450	Shaft sleeve
2910	Shaft nut
3011.1	Ball bearing
3011.2	Ball bearing
3126	Shim
3200	Bearing housing
3260.1	Bearing cover
3260.2	Bearing cover
3266	Bearing end cover
3645	Disc spacer
3712	Bearing nut
3853	Grease nipple
4110	Stuffing box housing
4120	Gland
4130	Gland packing
4131	Follower (gland ring)
4134	Lantern ring
4213	Mechanical seal cover
4305.1	Shaft seal ring
4305.3	Shaft seal ring
4420	Sealing pipe
4590	Gasket
4595.1	Joint ring
4595.2	Joint ring
4595.3	Joint ring
4595.4	Joint ring
4595.5	Joint ring
4595.6	Joint ring
4595.7	Joint ring
4610.1	O-ring
4610.2	O-ring
4610.6	O-ring
6515.1	Drain plug
6515.2	Drain plug
6521	Vent plug
6541	Lock washer
6544	Circlip
6569.1	Plug
6569.2	Plug
6569.3	Plug
6569.4	Plug
6570.4	Screw
6570.5	Screw
6570.6	Screw
6570.9	Screw
6572.1	Stud
6572.2	Stud
6572.3	Stud
6572.4	Stud
6572.5	Stud
6575	Jack screw
6580.1	Nut
6580.2	Nut
6580.3	Nut
6580.4	Nut
6580.5	Nut
6700.1	Key
6700.2	Key
6810	Dowel pin
6811.1	Cylindrical pin
6811.2	Cylindrical pin
6811.3	Cylindrical pin
6814.2	Grub screw

View on Arrow A



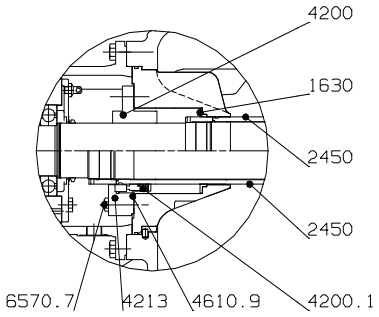
Stuffing box arrangement



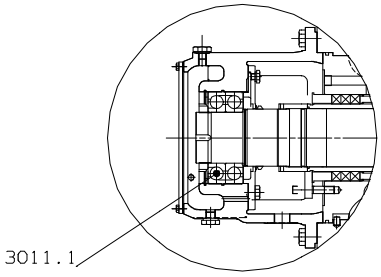
8.2.2 Options parts list - LNN and LNNC - sizes greater than 350 mm discharge

Item	Description
1630	Throttling bush
2300	Impeller wear ring
2450	Shaft sleeve
2540	Flinger (liquid)
3011.1	Ball bearing
3855	Constant level oiler
4200	Mechanical seal (cartridge)
4200.1	Mechanical seal
4213	Mechanical seal cover
4305.1	Shaft seal ring
4305.3	Shaft seal ring
4330.1	Labyrinth ring
4330.2	Labyrinth ring
4330.3	Labyrinth ring
4330.4	Labyrinth ring
4510.3	Joint ring
4595.4	Joint ring
4595.6	Joint ring
4595.8	Joint ring
4610.3	O-ring
4610.4	O-ring
4610.5	O-ring
4610.9	O-ring
6515.2	Drain plug
6529	Ventilation device (breather)
6569.2	Plug
6570.7	Screw
6572.3	Stud
6580.3	Nut
6814.1	Grub screw
6814.3	Grub screw

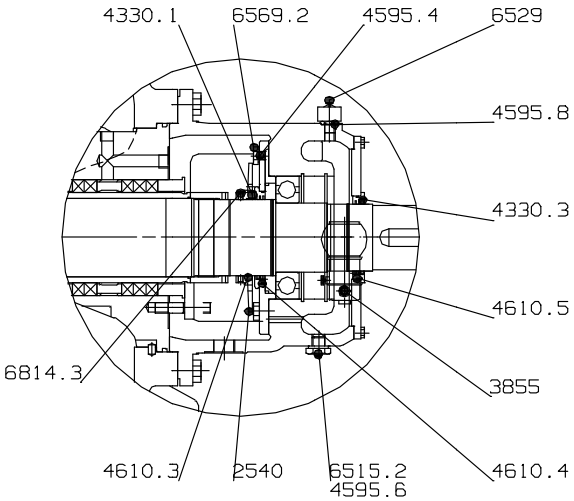
Mechanical seals and cartridge seals with and without shaft sleeve



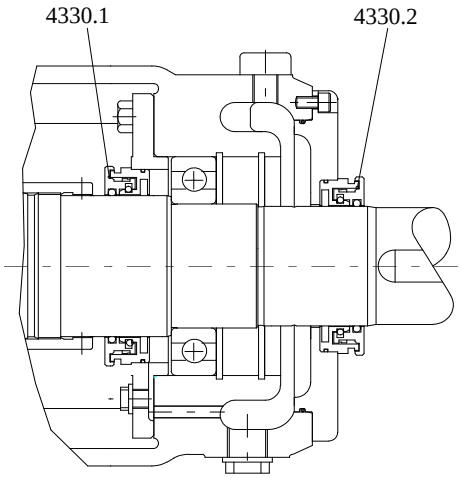
Two single row angular contact ball bearings



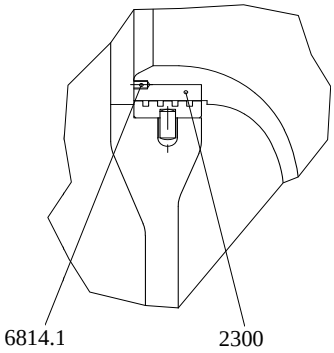
Oil lubrication



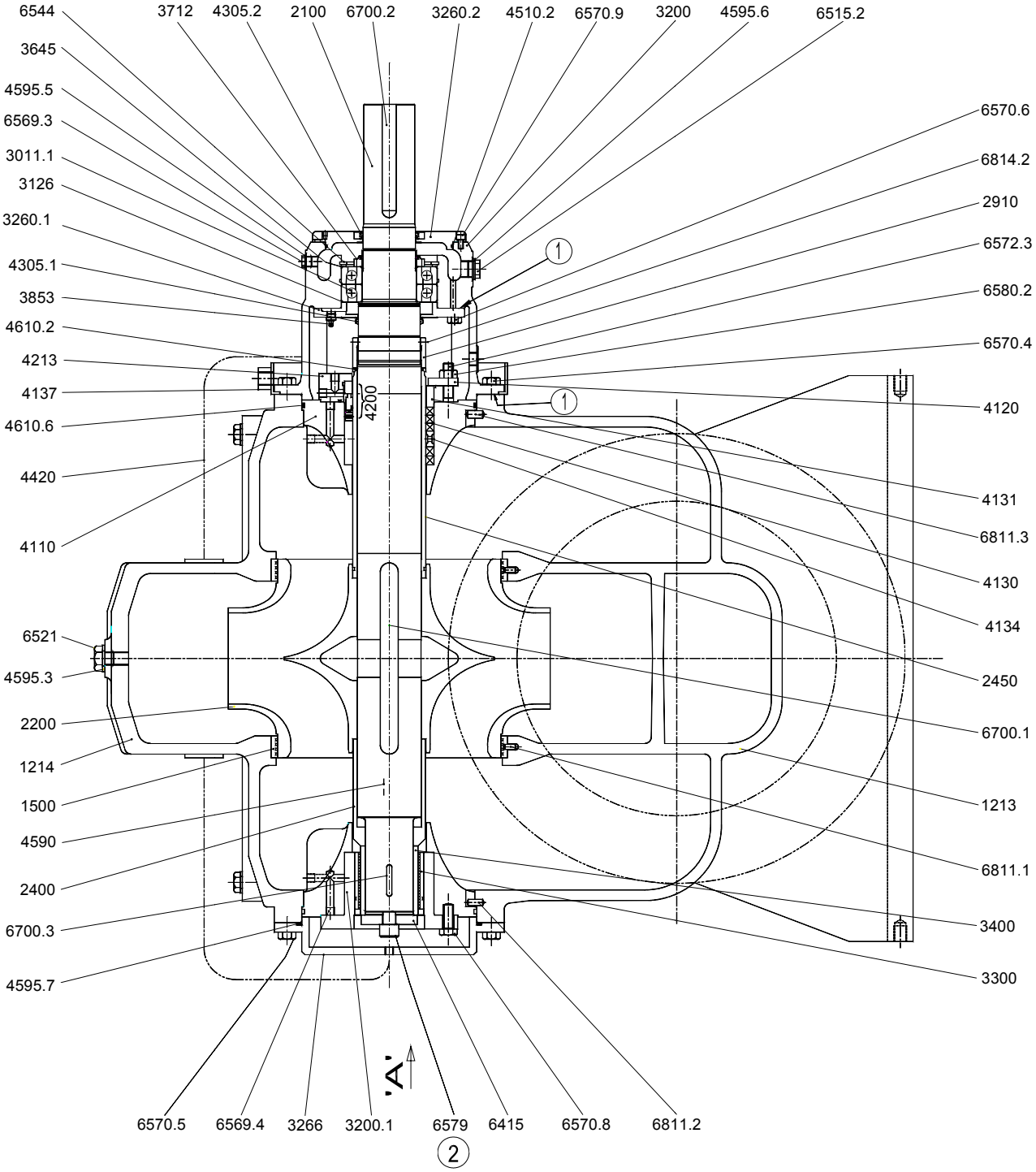
Bearing isolators



Impeller rings



8.3 LNNV sleeve bearing type – grease lubricated, component mechanical seal and gland packed option – sizes up to 350 mm discharge

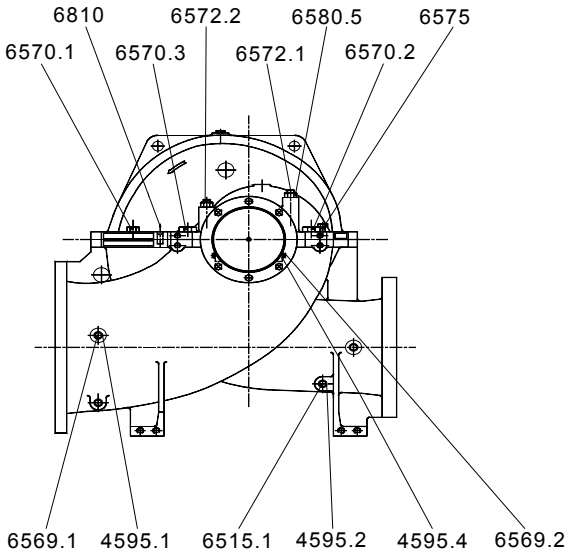


① Leak proofing material Casco 145 or Marston Hydrosil 100RTV silicone compound.
② Screw secured with Casco ML type 119 or Loctite 270.
(Drawing taken from C751/011.)

8.3.1 Parts list – LNNV - sizes up to 350 mm discharge

Item	Description
1213	Casing half lower
1214	Casing half upper
1500	Casing wear ring
2100	Shaft
2200	Impeller
2400	Sleeve
2450	Shaft sleeve
2910	Shaft nut
3011.1	Ball bearing
3126	Shim
3200	Bearing housing
3200.1	Bearing housing
3260.1	Bearing cover
3260.2	Bearing cover
3266	Bearing end cover
3300	Bearing bush
3400	Bearing sleeve
3645	Disc spacer
3712	Bearing nut
3853	Grease nipple
4110	Stuffing box housing
4120	Gland
4130	Gland packing
4131	Follower (gland ring)
4134	Lantern ring
4137	Drip pan
4213	Mechanical seal cover
4305.1	Shaft seal ring
4305.2	Shaft seal ring
4420	Sealing pipe
4510.2	Joint ring
4590	Gasket
4595.1	Joint ring
4595.2	Joint ring
4595.3	Joint ring
4595.4	Joint ring
4595.5	Joint ring
4595.6	Joint ring
4595.7	Joint ring
4610.2	O-ring
4610.6	O-ring
6415	Cap
6515.1	Drain plug
6515.2	Drain plug
6521	Vent plug
6544	Circlip
6569.1	Plug
6569.2	Plug
6569.3	Plug
6569.4	Plug
6570.1	Screw
6570.2	Screw
6570.3	Screw
6570.4	Screw
6570.5	Screw
6570.6	Screw
6570.8	Screw
6570.9	Screw
6572.1	Stud
6572.2	Stud
6572.3	Stud
6575	Jack screw
6579	Socket head cap screw
6580.2	Nut
6580.5	Nut
6700.1	Key
6700.2	Key
6700.3	Key
6810	Dowel pin
6811.1	Cylindrical pin
6811.2	Cylindrical pin
6811.3	Cylindrical pin
6814.2	Grub screw

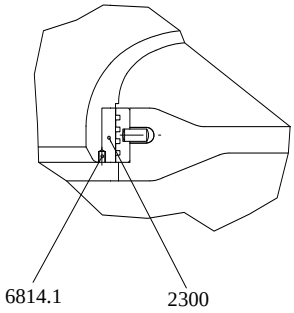
View on arrow A



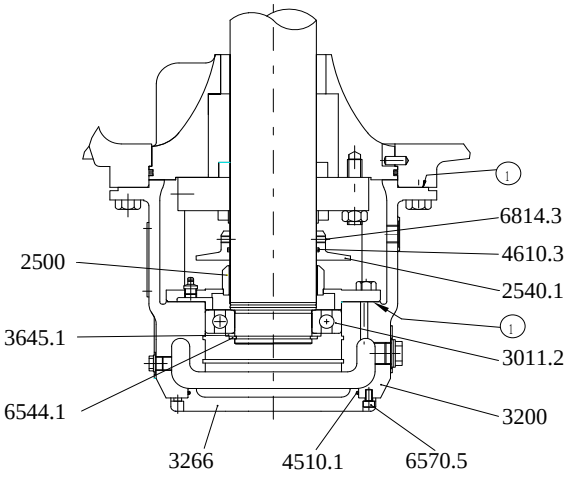
8.3.2 Options parts list – LNNV - sizes up to 350 mm discharge

Item	Description
2300	Impeller wear ring
2500	Ring
2540.1	Flinger (liquid)
3011.2	Ball bearing
3200	Bearing housing
3266	Bearing end cover
3645.1	Disc spacer
4510.1	Joint ring
4610.3	O-ring
6544.1	Circlip
6570.5	Screw
6814.1	Grub screw
6814.3	Grub screw

Impeller rings

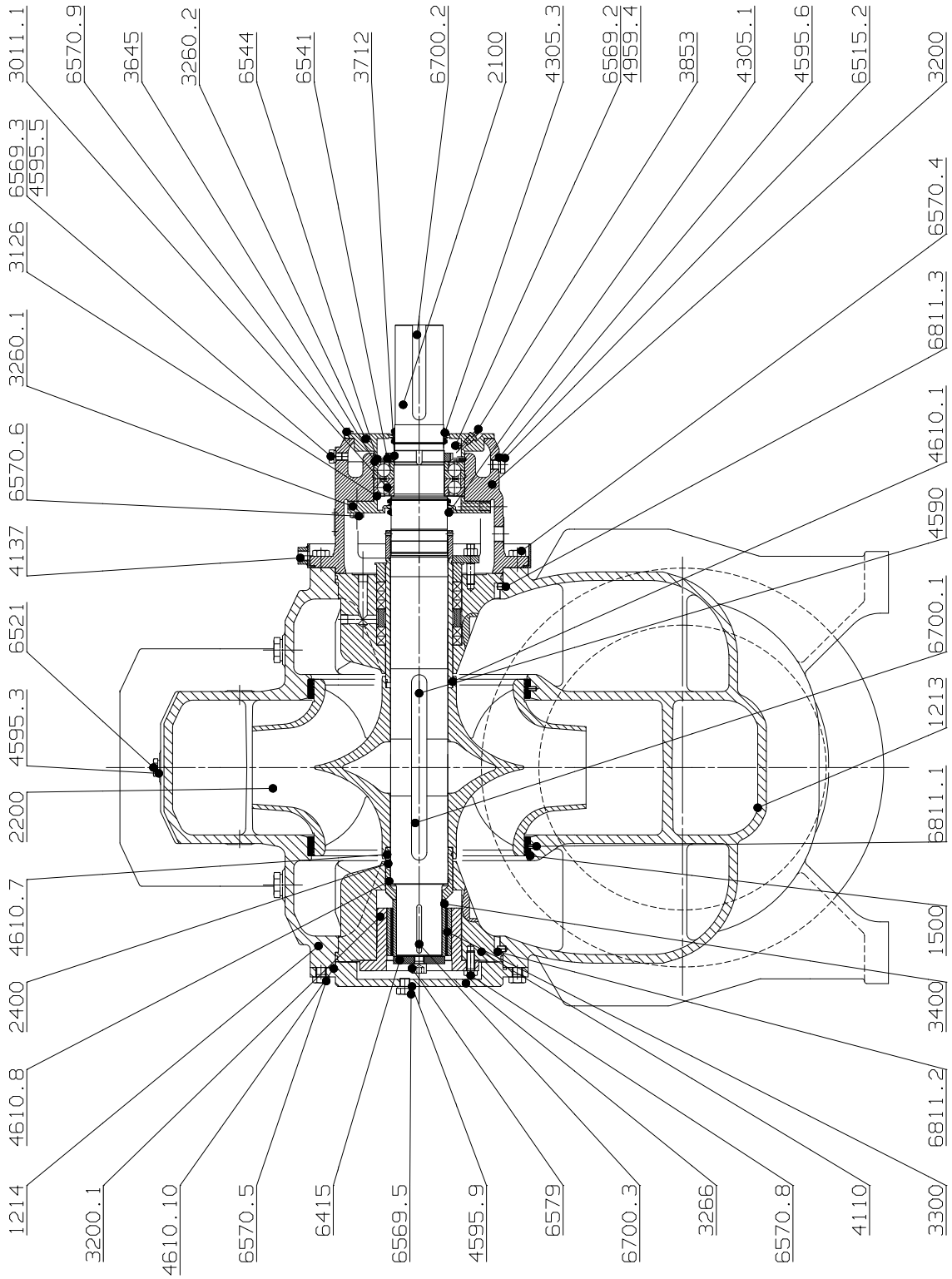


Grease lubricated bottom bearing



Note: Cartridge seal, bearing isolators and bearing labyrinth seals may also be fitted as options to the LNNV. See section 8.1.2 above for details.

8.4 LNNV sleeve bearing type – grease lubricated and gland packed option – sizes greater than 350 mm discharge

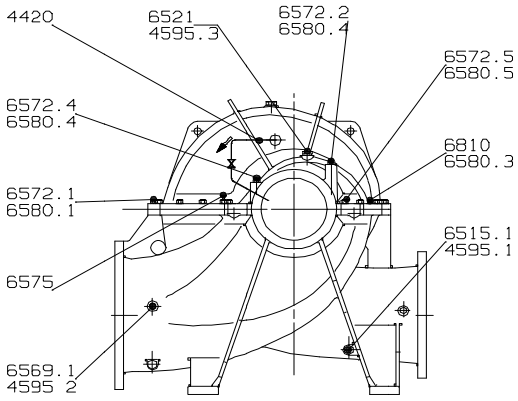


(Drawing taken from A-1975665.)

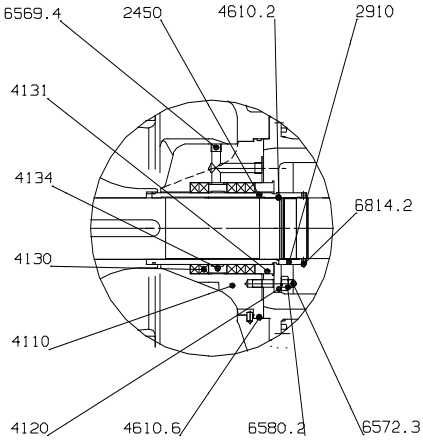
8.4.1 Parts list – LNNV - sizes greater than 350 mm discharge

Item	Description
1213	Casing half lower
1214	Casing half upper
1500	Casing wear ring
2100	Shaft
2200	Impeller
2400	Sleeve
2450	Shaft sleeve
2910	Shaft nut
3011.1	Ball bearing
3126	Shim
3200	Bearing housing
3200.1	Bearing housing
3260.1	Bearing cover
3260.2	Bearing cover
3266	Bearing end cover
3300	Bearing bush
3400	Bearing sleeve
3645	Disc spacer
3712	Bearing nut
3853	Grease nipple
4110	Stuffing box housing
4120	Gland
4130	Gland packing
4131	Follower (gland ring)
4134	Lantern ring
4137	Drip pan
4305.1	Shaft seal ring
4305.2	Shaft seal ring
4305.3	Shaft seal ring
4420	Sealing pipe
4590	Gasket
4595.1	Joint ring
4595.2	Joint ring
4595.3	Joint ring
4595.4	Joint ring
4595.5	Joint ring
4595.6	Joint ring
4595.9	Joint ring
4610.1	O-ring
4610.2	O-ring
4610.6	O-ring
4610.7	O-ring
4610.8	O-ring
4610.10	O-ring
6415	Cap
6515.1	Drain plug
6515.2	Drain plug
6521	Vent plug
6541	Lock washer
6544	Circlip
6569.1	Plug
6569.2	Plug
6569.3	Plug
6569.4	Plug
6569.5	Plug
6570.4	Screw
6570.5	Screw
6570.6	Screw
6570.8	Screw
6570.9	Screw
6572.1	Stud
6572.2	Stud
6572.3	Stud
6572.4	Stud
6572.5	Stud
6575	Jack screw
6579	Socket head cap screw
6580.1	Nut
6580.2	Nut
6580.3	Nut
6580.4	Nut
6580.5	Nut
6700.1	Key
6700.2	Key
6700.3	Key
6810	Dowel pin
6811.1	Cylindrical pin
6811.2	Cylindrical pin
6811.3	Cylindrical pin
6814.2	Grub screw

View on arrow A



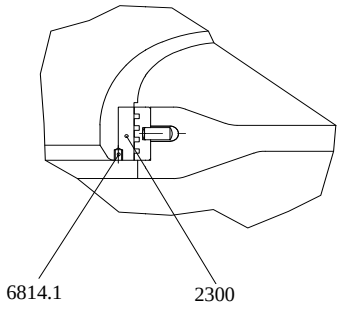
Stuffing box arrangement



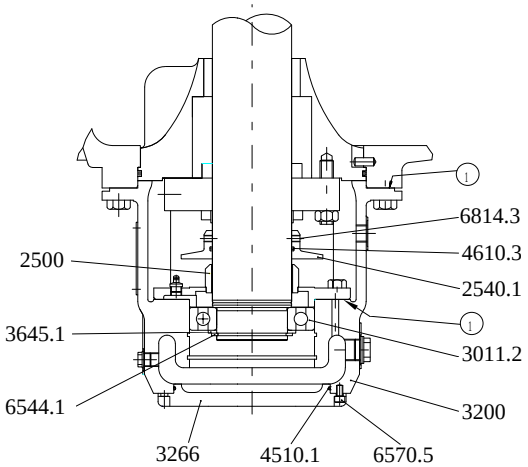
8.4.2 Options parts list – LNNV - sizes greater than 350 mm discharge

Item	Description
1630	Throttling bush
2300	Impeller wear ring
2450	Shaft sleeve
2500	Ring
2540.1	Flinger (liquid)
3011.2	Ball bearing
3200	Bearing housing
3266	Bearing end cover
3645.1	Disc spacer
4200	Mechanical seal, cartridge
4200.1	Mechanical seal
4213	Mechanical seal cover
4510.1	Joint ring
4610.3	O-ring
4610.9	O-ring
6544.1	Circlip
6570.5	Screw
6570.7	Screw
6814.1	Grub screw
6814.3	Grub screw

Impeller rings

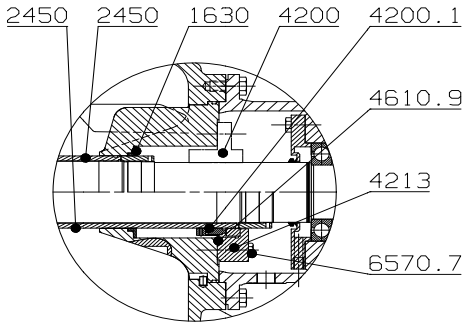


Grease lubricated bottom bearing



Note: Component seal and cartridge seal, bearing isolators and bearing labyrinth seals may also be fitted as options to the LNNV. See section 8.2.2 above for details.

Mechanical seals and cartridge seals with and without shaft sleeve



8.5 General arrangement drawing

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

9 CERTIFICATION

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

10 OTHER RELEVANT DOCUMENTATION AND MANUALS

10.1 Supplementary User Instructions

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

10.2 Change notes

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

10.3 Additional sources of information

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

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

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

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

Reference 5:
ANSI B31.3 - Process Piping.

Reference 6:
ESA – Guidelines for safe seal usage (Flanges and gaskets).

Notes:

Notes:

Your Flowserve factory contacts:

Nominal pump discharge <= 350:
Flowserve Pumps
Flowserve GB Limited
Lowfield Works, Balderton
Newark, Notts NG24 3BU
United Kingdom

Telephone (24 hours) +44 1636 494 600
Sales & Admin Fax +44 1636 705 991
Repair & Service Fax +44 1636 494 833
Email newarksales@flowserve.com

Nominal pump discharge > 350:
Flowserve Pompes
13 Rue Maurice Trintignant, CS10001
72234 Arnage Cedex, France

Telephone (24 hours) +33 43 40 57 75
Sales & Admin +33 43 40 57 57
Repair & Service Fax +33 43 40 58 17

Your local Flowserve representative:

North America:
Flowserve Pump Division
5310 Taneytown Pike, PO Box 91
Taneytown, MD 21787-0091, USA

Telephone +1 410 756 2602
Customer Service Fax +1 410 756 2615
Parts inquiry/order PH +1 800 526 3569

South America:
Flowserve do Brasil Ltda
Av. Don Hélder Camara 5451
20771-001 Rio de Janerio, Brasil

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

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