FLOWSERVE

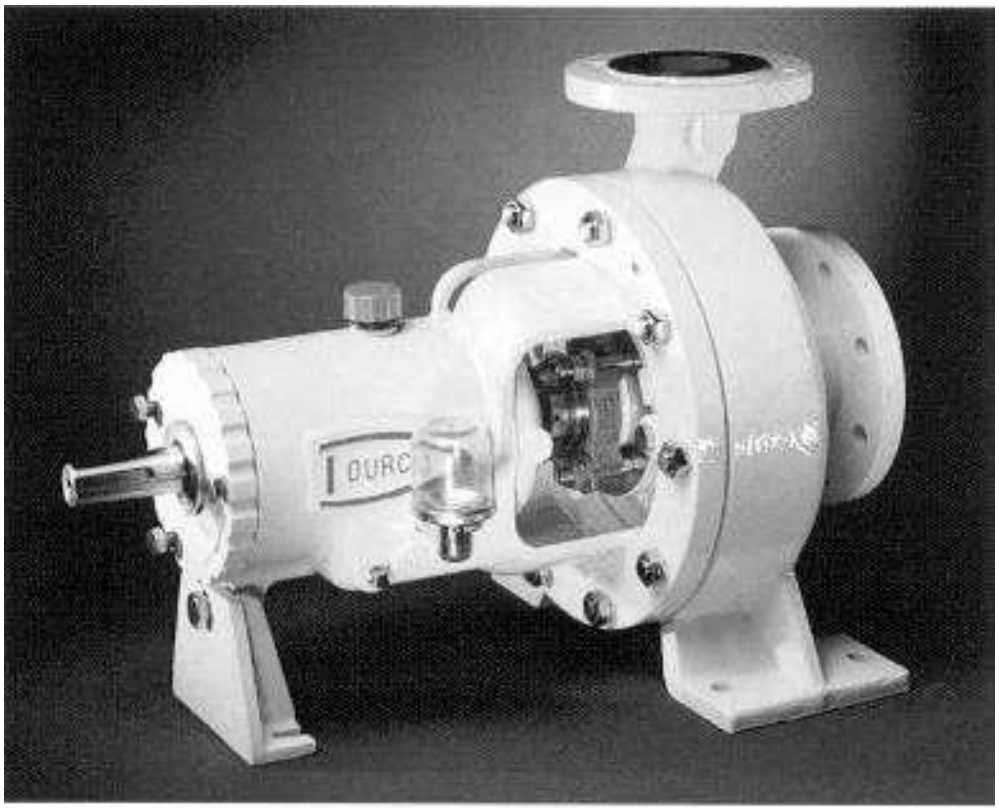
USER INSTRUCTIONS

Chemstar standard and repeller pumps

Frame mounted, heavy-duty, centrifugal chemical process pumps

PCN=71569185 02-10 (E) (Based on ISO-30-E.)
Original instructions.

Installation
Operation
Maintenance



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

Experience In Motion

CONTENTS

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 reliable. In spite of all the efforts of Flowserve Corporation to provide sound and all necessary information the content of this manual may appear insufficient and is not guaranteed by Flowserve as to its completeness or accuracy*.**

Flowserve manufactures products to exacting International Quality Management System Standards as certified and audited by external Quality Assurance organisations. Genuine parts and accessories have been designed, tested and incorporated into the products to help ensure their continued product quality and performance in use. As Flowserve cannot test parts and accessories sourced from other vendors the incorrect incorporation of such parts and accessories may adversely affect the performance and safety features of the products. The failure to properly select, install or use authorised Flowserve parts and accessories is considered to be misuse. Damage or failure caused by misuse is not covered by 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

1.5 Duty conditions

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

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

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

1.6 Safety

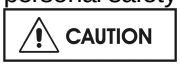
1.6.1 Summary of safety markings

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

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

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

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

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

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

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

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

1.6.2 Personnel qualification and training

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

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

1.6.3 Safety action

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

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

 GUARDS MUST NOT BE REMOVED WHILE THE PUMP IS OPERATIONAL

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

 FLUORO-ELASTOMERS (When fitted.)
When a pump has experienced temperatures over 250 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.

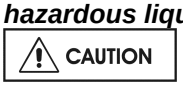
 NEVER APPLY HEAT TO REMOVE IMPELLER
Trapped lubricant or vapour could cause an explosion.

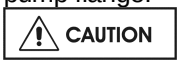
 HOT (and cold) PARTS
If hot or freezing components or auxiliary heating supplies can present a danger to operators and persons entering the immediate area action must be taken to avoid accidental contact. If complete protection is not possible, the machine access must be limited to maintenance staff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

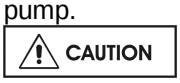
If the temperature is greater than 80 ºC (175 ºF) or below -5 ºC (20 ºF) in a restricted zone, or exceeds local regulations, action as above shall be taken.

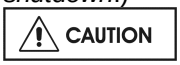
 HAZARDOUS LIQUIDS
When the pump is handling hazardous liquids care must be taken to avoid exposure to the liquid by appropriate siting of the pump, limiting personnel access and by operator training. If the liquid is flammable and or explosive, strict safety procedures must be applied.

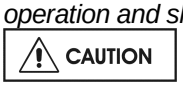
Gland packing must not be used when pumping hazardous liquids.

 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.

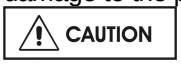
 ONLY CHECK DIRECTION OF MOTOR ROTATION WITH COUPLING ELEMENT/ PINS REMOVED
Starting in reverse direction of rotation will damage the pump.

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

 START THE PUMP WITH OUTLET VALVE PART OPENED
(Unless otherwise instructed at a specific point in the User Instructions.)
This is recommended to minimize the risk of overloading and damaging the pump or 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*.)

 NEVER RUN THE PUMP DRY

 INLET VALVES TO BE FULLY OPEN WHEN PUMP IS RUNNING
Running the pump at zero flow or below the recommended minimum flow continuously will cause damage to the pump and mechanical seal.

 DO NOT RUN THE PUMP AT ABNORMALLY HIGH OR LOW FLOW RATES
Operating at a flow rate higher than normal or at a flow rate with no back pressure on the pump may overload the motor and cause cavitation. Low flow rates may cause a reduction in pump/bearing life, overheating of the pump, instability and cavitation/vibration.

1.6.4 Products used in potentially explosive atmospheres

 Measures are required to:

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

The following instructions for pumps and pump units when installed in potentially explosive atmospheres must be followed to help ensure explosion protection. For ATEX, both electrical and non-electrical equipment must meet the requirements of European Directive 94/9/EC. Always observe the regional legal Ex requirements eg Ex electrical items outside the EU may be required certified to other than ATEX eg IECEx, UL.

1.6.4.1 Scope of compliance

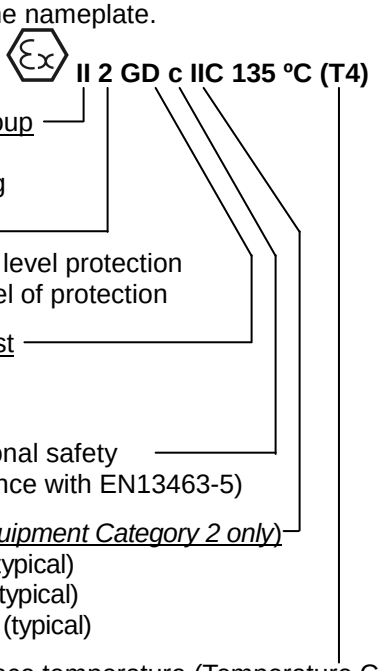
 Use equipment only in the zone for which it is appropriate. Always check that the driver, drive coupling assembly, seal and pump equipment are suitably rated and/or certified for the classification of the specific atmosphere in which they are to be installed.

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

The output from a variable frequency drive (VFD) can cause additional heating effects in the motor and so, for pump 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 temperatures

ENSURE THE EQUIPMENT TEMPERATURE CLASS IS SUITABLE FOR THE HAZARD ZONE

Pumps have a temperature class as stated in the ATEX Ex rating on the nameplate. These are based on a maximum ambient of 40 ºC (104 ºF); 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 ℃ (185 ℉)	Consult Flowserve
T5	100 ℃ (212 ℉)	Consult Flowserve
T4	135 ℃ (275 ℉)	115 ℃ (239 ℉) *
T3	200 ℃ (392 ℉)	180 ℃ (356 ℉) *
T2	300 ℃ (572 ℉)	275 ℃ (527 ℉) *
T1	450 ℃ (842 ℉)	400 ℃ (752 ℉) *

* 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.

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

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

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

In dirty or dusty environments, make regular checks and remove dirt from areas around close clearances, bearing housings and motors.

1.6.4.4 Preventing the build up of explosive mixtures

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

Ensure the pump and relevant suction and discharge pipeline system is totally filled with liquid at all times during the pump operation, so that an explosive atmosphere is prevented. In addition it is essential to make sure that seal chambers, auxiliary shaft seal systems and any heating and cooling systems are properly filled.

If the operation of the system cannot avoid this condition, fit an appropriate dry run protection device (for example liquid detection or a power monitor).

To avoid potential hazards from fugitive emissions of vapour or gas to atmosphere the surrounding area must be well ventilated.

1.6.4.5 Preventing sparks

To prevent a potential hazard from mechanical contact, the coupling guard must be non-sparking and anti-static for Category 2.

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.

The coupling must be selected to comply with 94/9/EC and correct 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.

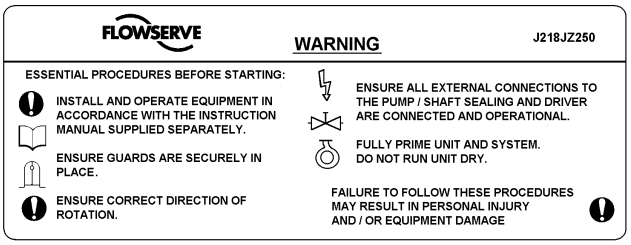
It is recommended that a maintenance plan and schedule is adopted. (See section 6, *Maintenance.)*

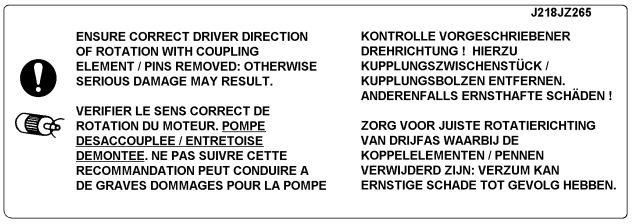
1.7 Nameplate and safety labels

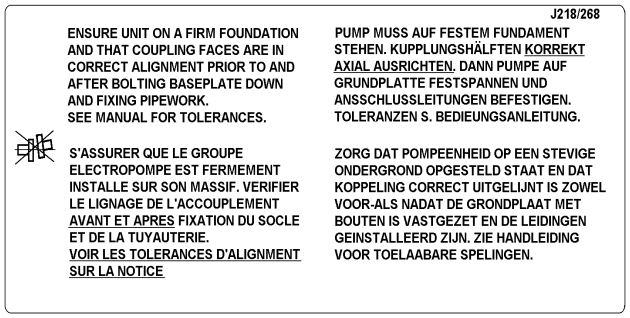
1.7.1 Nameplate

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

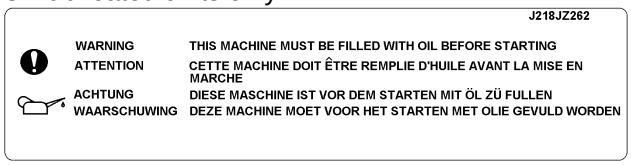
1.7.2 Safety labels



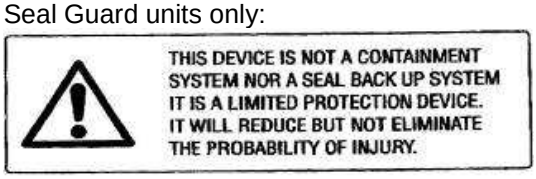




Oil lubricated units only:



Seal Guard units only:



1.8 Specific machine performance

For performance parameters see section 1.5, *Duty conditions*. Where performance data has been supplied separately to the purchaser these should be obtained and retained with these User Instructions if required.

1.9 Noise level

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

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

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

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

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

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

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

For estimating sound power level L_{WA} (re 1 pW) then add 14 dBA to the sound pressure value.

Motor size and speed 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
<0.55(<0.75)	72	72	64	65	62	64	62	64
0.75 (1)	72	72	64	66	62	64	62	64
1.1 (1.5)	74	74	66	67	64	64	62	63
1.5 (2)	74	74	66	71	64	64	62	63
2.2 (3)	75	76	68	72	65	66	63	64
3 (4)	75	76	70	73	65	66	63	64
4 (5)	75	76	71	73	65	66	63	64
5.5 (7.5)	76	77	72	75	66	67	64	65
7.5 (10)	76	77	72	75	66	67	64	65
11(15)	80	81	76	78	70	71	68	69
15 (20)	80	81	76	78	70	71	68	69
18.5 (25)	81	81	77	78	71	71	69	71
22 (30)	81	81	77	79	71	71	69	71
30 (40)	83	83	79	81	73	73	71	73
37 (50)	83	83	79	81	73	73	71	73
45 (60)	86	86	82	84	76	76	74	76
55 (75)	86	86	82	84	76	76	74	76
75 (100)	87	87	83	85	77	77	75	77
90 (120)	87	88	83	85	77	78	75	78
110 (150)	89	90	85	87	79	80	77	80
150 (200)	89	90	85	87	79	80	77	80

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/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 must be received in writing within one month of receipt of the equipment. Later claims cannot be accepted.

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

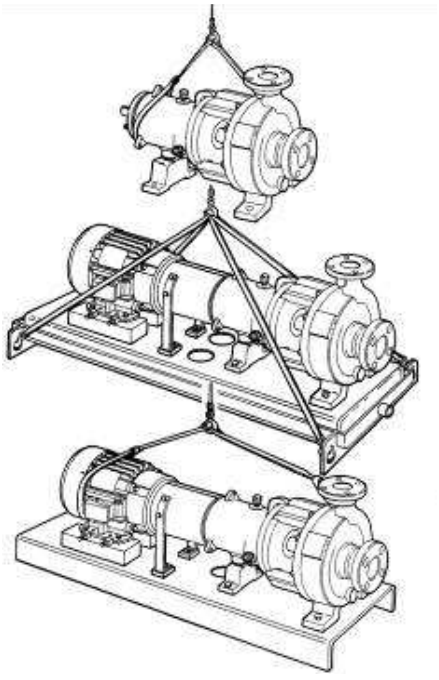
Each product has a unique serial number. Check that this number corresponds with that advised and always quote this number in correspondence as well as when ordering spare parts or further accessories.

2.2 Handling

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

2.3 Lifting

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



A crane must be used for all pump sets in excess of 25 kg (55 lb). Fully trained personnel must carry out lifting, in accordance with local regulations.

The driver weight is recorded on its nameplate.

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 requirements. 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 DESCRIPTION

3.1 Configurations

The Chemstar pump is a heavy-duty chemical service centrifugal pump that can be built to achieve many chemical liquid pumping requirements. (See 3.2 and 3.3 below.) The exclusive external micrometer shaft adjustment provides accurate and fast setting of impeller clearance.

3.2 Name nomenclature

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

125X100-315

Nominal suction branch size in mm

Nominal discharge branch size in mm

Nominal maximum impeller diameter in mm

The typical nomenclature above is the general guide to the Chemstar configuration description.

Identify the actual pump size and serial number from the pump nameplate. Check that this agrees with the applicable certification provided.

If it is a Chemstar pump with hydrodynamic sealing or repeller then the pump size will be engraved on the nameplate typically as below:

125X100M-315

M = repeller pump

3.3 Design of major parts

3.3.1 Pump casing
The pump casing is designed with a horizontal centreline end inlet and a vertical centreline top outlet, which makes it self venting. For ease of maintenance, the pump is constructed so that pipe connections do not have to be disturbed when internal maintenance is required.

3.3.2 Impeller
An exclusive reverse vane impeller is fitted giving important maintenance-reducing advantages. The reverse vane impeller is set against the rear cover. (On the hard-chrome iron material option the design of the impeller is front open and is set against the front of the casing.)

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

3.3.4 Bearing housing
The exclusive external micrometer shaft adjustment bearing housing design enables quick and accurate adjustment of impeller face clearance.

3.3.5 Pump bearings and lubrication
The pump is fitted with ball type bearings which may be configured differently dependent on use. The bearings may be oil or grease lubricated depending upon the arrangement specified.

3.3.6 Rear cover
The rear cover has spigots between the pump casing and bearing housing for optimum concentricity.

A fully confined gasket forms the seal between the pump casing and the seal housing.

The rear cover designs provide improved performance of mechanical seals. The design enables the optimum sealing solution for each application 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 the 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

Maximum ambient temperature	- 20 to + 40 ºC (- 4 to +104 ºF)
Maximum pump speed	refer to the nameplate

4 INSTALLATION

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

4.1 Location

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

4.2 Part assemblies

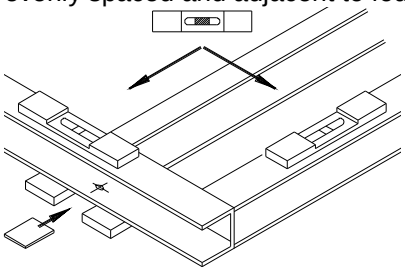
On baseplated pump sets the coupling elements are supplied loose. It is the responsibility of the installer to ensure that the pump set is finally lined up as detailed in section 4.5.2, *Alignment methods*.

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 and 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) Adjustable baseplates having stilt mount feet have no foundation bolts securing it to the floor. The feet are adjusted to maintain the top surface of the baseplate level.
c) The pump and driver have been aligned before dispatch within the permissible misalignment limits defined in section 4.5.2, *Alignment methods*.
d) Where the baseplate does not have stilt mount feet, install the baseplate onto packing pieces evenly spaced and adjacent to foundation bolts.



e) Level with shims between baseplate and packing pieces.
f) Check alignment of pump and motor half coupling. If this is not correct, it indicates that the baseplate has become twisted and should be corrected by re-shimming.

4.4 Grouting

Where applicable, grout in the foundation bolts.

After adding pipework connections and rechecking the coupling alignment, the baseplate should then be grouted in accordance with good engineering practice. Fabricated steel and cast iron 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.

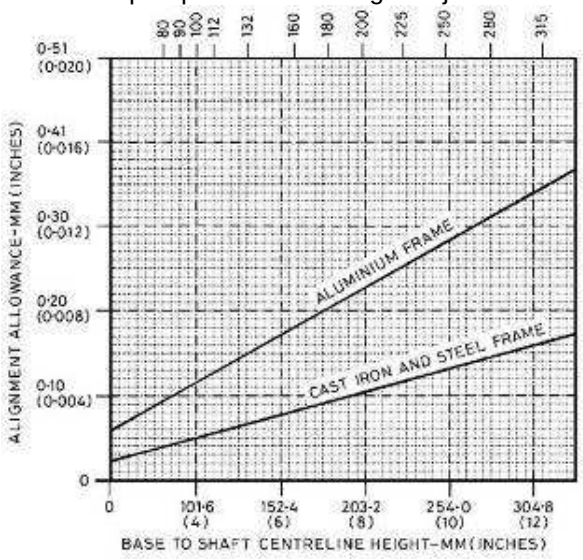
Foundation bolts should only be fully tightened when the grout has cured.

4.5 Initial alignment

4.5.1 Thermal expansion

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

Motor and pump centre line height adjustment:



Graph based on the assumptions that:

1. Operating temperature rise of the motor frame is 50 °C (90 °F).
2. Packing piece/motor stool is not affected.

Operation

1. Enter graph at base to shaft centre line height.
2. Read line for frame material.
3. Set motor shaft and coupling LOW by figure on left-hand side.

4.5.2 Alignment methods

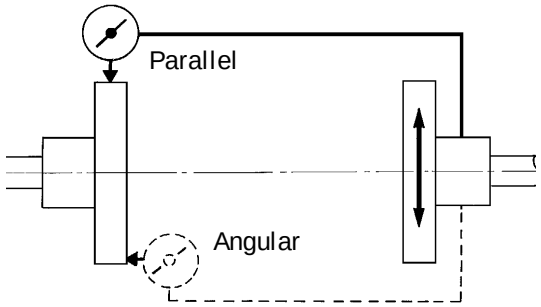
DANGER Pump and driver must be isolated electrically and the half couplings disconnected.

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.

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.

For couplings with narrow flanges use a dial indicator as shown. Rotate both shafts together so that the dial indicator probe keeps the same contact point onto the flange during 360 degree rotation. The alignment values are maximums for continuous service.



Permissible misalignment limits at working temperature:

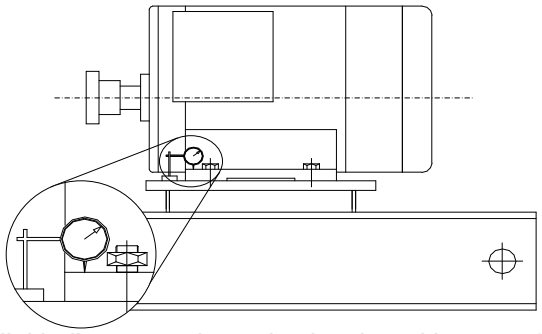
- *Parallel alignment*
  - 0.25 mm (0.010 in.) TIR maximum
- *Angular alignment*
  - 0.3 mm (0.012 in.) TIR maximum for couplings not exceeding 100 mm (4 in.) flange diameter
  - 0.5 mm (0.020 in.) TIR maximum for couplings over 100 mm (4 in.) diameter

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. Maximum pump reliability is obtained by near perfect alignment of 0.05 - 0.075 mm (0.002 - 0.003 in.) parallel and 0.05 mm (0.002 in.) per 100 mm (4 in.) of coupling flange diameter as angular misalignment.

4.5.3 Check for soft foot

This is a check to ensure that there is no undue stress on the driver holding down bolts; due to non-level baseplate or twisting. To check, remove all shims and clean surfaces and tighten down driver to the baseplate.



Set a dial indicator as shown in sketch and loosen off the holding down bolt while noting any deflection reading on the dial test Indicator - a maximum of 0.05 mm (0.002 in.) is considered acceptable but any more will have to be corrected by adding shims. For example, if the dial test indicator shows the foot lifting 0.15 mm (0.006 in.) then this is the thickness of shim to be placed under that foot. Tighten down and repeat the same procedure on all other feet until all are within tolerance

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

4.6 Piping

⚠ 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 pipework

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

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

⚠ CAUTION Never use pump as a support for piping.

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

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

CAUTION Ensure piping and fittings are flushed before use.

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

4.6.2 Suction piping

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) On suction lift the piping should be inclined up towards the pump inlet with eccentric reducers incorporated to prevent air locks.
c) On positive suction, the inlet piping must have a constant fall towards the pump.
d) The pipe next to the pump should be the same diameter as the pump suction and have a minimum of two pipe diameters of straight section between the elbow and the pump inlet flange. Where the NPSH margin is not large, it is recommended that the straight pipe is 5 to 10 times the pipe diameter. (See section 10.3, *Reference 1*.) Inlet strainers, when used, should have a net 'free area' of at least three times the inlet pipe area.
e) Fitting isolation and non-return valves will allow easier maintenance.
f) Never throttle pump on suction side and never place a valve directly on the pump inlet nozzle.

4.6.3 Discharge piping

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

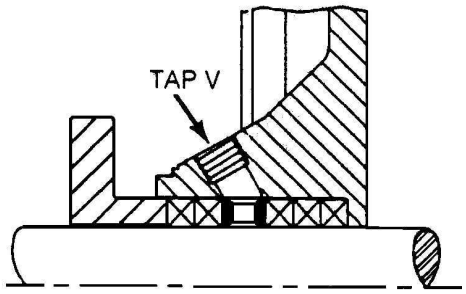
Fitting an isolation valve will allow easier maintenance.

4.6.4 Auxiliary piping

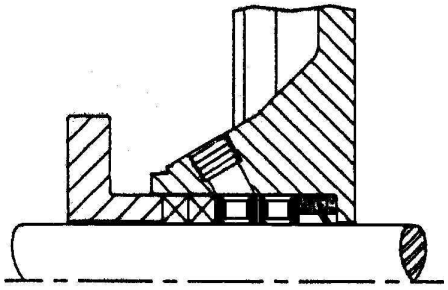
CAUTION The connections that are to be piped up will have been fitted with protective metal or plastic plugs which will need to be removed.

4.6.4.1 Pumps fitted with packed glands

a) Packing is to be fitted before use.
b) A temporary PTFE lip seal may have been installed against the face of the stuffing box for shipping. If so, discard this lip seal and slide the packing rings [4130] and lantern ring [4134] into the stuffing box in the order shown.



c) Always stagger the end gaps of the packing by 90 degrees apart to ensure the best seal.
d) To speed installation of each ring, have an assistant turn the pump shaft in the correct direction. This movement will tend to draw the rings into the stuffing box.
e) Lightly tighten the gland.
f) Final adjustments are covered in section 5.8, *Running the pump*.
g) When suction pressure is below ambient pressure and stuffing box head over total suction head is less than 10 m (33 ft), it may be necessary to feed gland packing with compatible liquid to the pumpage to provide lubrication and prevent the ingress of air. This is to be added through tap V shown above. The pressure of the feed liquid should be at least 1 bar (14.5 psi) above the stuffing box pressure, regulated to a flow rate of 0.25 to 0.5 m^3/h (1 to 2 USgpm). At lower speeds, grease lubrication may be used when compatible with the pumpage. In non-abrasive applications, where the pumpage itself is sufficient to lubricate the packing without an external pipeline, tap V should be plugged.
h) When a special abrasive liquid packing arrangement is specified, the installation procedures are the same as the standard packing with the following exceptions. The special lip seal is installed first, followed by two seal cage assemblies, then two of the packing rings provided as shown below. An external compatible liquid source line should be connected to tap V, in the top of the stuffing box.



Chemstar repeller pump only
In Chemstar pumps fitted with a repeller and with dry running gland packing as secondary sealing the packing is factory installed.

In some applications to limit the gland packing fouling, Chemstar repeller pumps could possibly have a 0.25 to 0.5 m³/h external clean compatible liquid flush injected into the stuffing box at 5 to 10 m head above ambient pressure prior to start up and prior to shut down.

4.6.4.2 Pumps fitted with mechanical seals
The Seal Sentry design of the anti-vortex single internal rear cover provides excellent liquid circulation around the seal and will not normally require a separate flush.

Single seals requiring flush by re-circulation of pumped liquid will normally be provided with the auxiliary piping from pump casing already fitted. (Where an external compatible flush is specified, the piping to the pump is the responsibility of the pump installer.)

Rear covers with an auxiliary quench connection require connection to a suitable source of liquid, low pressure steam or static pressure from a header tank. Recommended pressure is 0.35 bar (5 psi) or less.

Double seals require a barrier liquid between the seals, compatible with the pumped liquid.

With back-to-back double seals, the barrier liquid should be at a minimum pressure of 1 bar (15 psi) above the maximum pressure on the pump side of the inner seal and at least 1 bar (15 psi) above ambient external pressure. The barrier liquid pressure must not exceed limitations of the seal on the atmospheric side.

For toxic service the barrier liquid supply and discharge must be handled safely and in line with local legislation.

Seal chamber pressure:

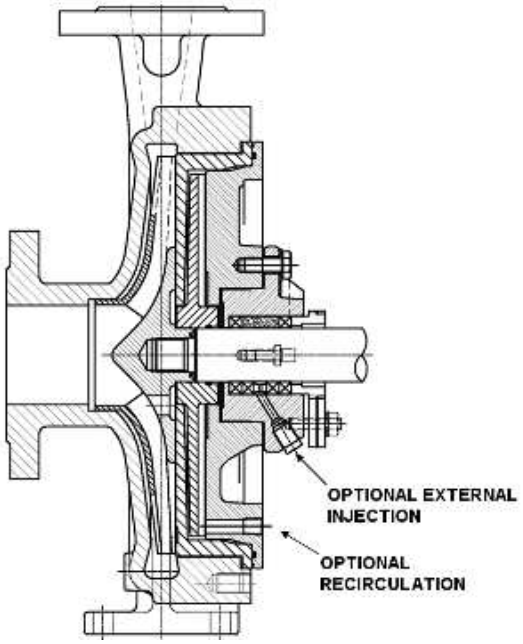
Mechanical seal	Use seal manufacturer's limits or ask seal manufacturer to verify seal pressure
Gland packing	Maximum stuffing box pressure = 5 bar (3 500 r/min), 7 bar (2 900 r/min) and 10 bar (1 450 and 1 750 r/min)

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.

4.6.4.3 External recirculation and flush for pumps fitted with repeller
Only dry running single mechanical seals or packing arrangement approved by Flowserve must be used. (Refer to section 8.3.) In some applications, to keep seal faces clean, pumps could possibly have a 0.25 to 0.5 m^3/h external clean compatible liquid flush injected into the seal cavity at 5 to 10 m head above atmospheric pressure prior to start up and prior to shut down. The Chemstar repeller chamber can have an auxiliary recirculation connection back to the suction side pipe.

Customers should always seek instructions from Flowserve if the pump is not supplied with the optional recirculation line or external flush and if it is planned to install these later.



4.6.4.4 Pumps fitted with heating/cooling jackets
Connect the heating/cooling pipes from the site supply. The top connection should be used as the outlet to ensure complete filling/venting of the jacket unless the heating medium is steam, when the bottom connection should be used as the outlet.

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

4.7 Final shaft alignment check

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

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

4.8 Electrical connections

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

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

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

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

A device to provide emergency stopping must be fitted.

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

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

CAUTION See section 5.4, *Direction of rotation* before connecting the motor to the electrical supply.

4.9 Protection systems

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

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. The oil level required is half way up in the sight glass. For approximate oil quantity refer to section 5.2.2, *Bearing sizes and capacities*.

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. The oil filled bottle should then be refitted so as to return it to the upright position. Filling of the bottle should be repeated until oil remains visible within the bottle. Oil must be visible in the oiler bottle at all times of operation.

Where an adjustable body oiler is fitted this should be set to the height shown in the figure below or in the lowest position in the case of the Trico oiler.

When fitted with a sight glass, fill the bearing housing with oil by unscrewing the oil filler/breather and fill through the hole.

Grease lubricated pumps and electric motors are supplied pre-greased. To regrease, remove the pipe plug from both the inboard and outboard bearing location. Apply grease through the grease nipples until it comes out of the vent holes then reinstall the pipe plugs. Do not over grease. Grease lubricated sealed bearings do not require relubrication and should be replaced on a regular maintenance scheme.

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

5.2 Pump lubricants

5.2.1 Recommended oil lubricants

	Oil	Splash / force feed / purge 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)	LSO 32 (Synthetic oil)	LSO 46 (Synthetic oil)	LSO 68 (Synthetic oil)
	ExxonMobil †	Mobil DTE 24	Mobil DTE 25	Mobil DTE 26
	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 greater viscosity index than the minimum acceptable of 95 (eg Mobil DTE13M) which may extend the minimum temperature capability of the oil. Always check the grade capability where the ambient is less than -5 ºC (23 ºF).
† 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.

5.2.2 Bearing sizes and capacities

Frame size	**Medium duty oil bearings**		**Regreasable bearings**		**Sealed grease bearings**		**Optional oil bearings**	**Approx oil capacity litre (fl.oz)**
	Inboard end	Outboard end	Inboard end	Outboard end	Inboard end	Outboard end	Outboard end	
	Ball bearing	Double row angular contact	Ball bearing	Double row angular contact	Ball bearing metallic shields	Double row angular contact	Duplex back-to-back AC	
A	6307 C3	3307 A C3	6307 C3 Z	3307 A C3 Z	6307 C3 2Z	3307A C3 2Z	7307	0.25 (8.5)
B	6309 C3	3309 A C3	6309 C3 Z	3309 A C3 Z	6309 C3 2Z	3309A C3 2Z	7309	0.5 (16.9)
C	6311 C3	3311 A C3	6311 C3 Z	3311 A C3 Z	6311 C3 2Z	3311A C3 2Z	7311	0.6 (20.3)
D	6315 C3	3314 A C3	6315 C3 Z	3314 A C3 Z	6515 C3 2Z	3314A C3 2Z	7314	1.8 (60.9)

Note: The bearing sizes do not constitute a purchasing specification.
'A' in the double row angular contact bearing nomenclature defines the requirement of no filling slot.
Duplex back-to-back bearings at drive end may be required depending upon operating conditions and pump model.

5.2.3 Recommended grease lubricants

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

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

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

5.2.4 Recommended fill quantities

Refer to section 5.2.2, *Bearing sizes and capacities.*

5.2.5 CAUTION Lubrication schedule

5.2.5.1 Oil lubricated bearings

Normal oil change intervals are 4 000 operating hours or at least every 6 months. For pumps on hot service or in severely damp or corrosive atmospheres, 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 oil having oxidisation and foam inhibitors, or synthetic oil. Do not use detergent oil.

The bearing temperature may be allowed to rise to 50 ºC (90 ºF) above ambient, but should not exceed 82 ºC (180 ºF) (API 610 limit). A continuously rising temperature, or an abrupt rise, indicates a fault.

When oil mist lubrication is specified the bearing housings are furnished with a single top inlet tap, a vent hole at the outboard bearing and a bottom drain.

Pumps which handle high temperature liquids may require their bearings to be cooled to prevent bearing temperatures exceeding their limits. Oil cooling with regular ambient conditions is normally required for pumpage above 175 ºC (350 ºF) and up to 260 ºC (500 ºF). Temperature applications above 260 ºC (500 ºF) are normally not possible. Consult Flowserve if unsure of correct method or arrangement.

5.2.5.2 Grease lubricated bearings

When grease nipples are fitted, one charge between grease changes is advisable for most operating conditions; ie 2 000 hours interval. Normal intervals between grease changes are 4 000 hours or at least every 6 months.

The characteristics of the installation and severity of service will determine the frequency of lubrication. Lubricant and bearing temperature analysis can be useful in optimizing lubricant change intervals.

Sealed bearings are optional. These bearings are packed by the bearing manufacturer and should not be relubricated. These should be replaced on a regular maintenance schedule.

The bearing temperature may be allowed to rise to 95 ºC (203 ºF) maximum during the running-in period. This should be followed by a steady fall in temperature to around 50 ºC (90 ºF) above ambient after 1.5 to 2 hours of operation as the grease soap settles. A continuously rising temperature, or an abrupt rise, indicates a fault.

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 Impeller clearance

Impeller clearance was set at the factory based on the temperature given in the customer datasheet at the time the pump was purchased. For setting instructions, see section 6.7, *Setting impeller clearance*.

5.4 Direction of rotation

CAUTION Serious damage can result if the pump is started or run in the wrong direction of rotation. These pumps turn clockwise as viewed from the motor end.

CAUTION The pump is shipped with the coupling element removed. Ensure the direction of rotation of the motor is correct before fitting the coupling element. Direction of rotation must correspond to the direction arrow.

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.

5.5 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.

5.6 Priming and auxiliary supplies

5.6.1 Filling and priming

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

Priming may be carried out with an ejector, vacuum pump interceptor or other equipment, or by flooding from the inlet source.

When in service, pumps using inlet pipes with foot valves may be primed by passing liquid back from the outlet pipe through the pump.

5.6.2 Auxiliary supplies

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

5.7 Starting the pump

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

5.8 Running the pump

5.8.1 Pumps fitted with packed gland

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

Ex The gland must be adjusted evenly to give visible leakage and concentric alignment of the gland ring 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 [4130].

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

The pump should be run for 10 minutes with steady leakage and the gland nuts tightened by 10 degrees at a time until leakage is reduced to an acceptable level, normally 30 to 120 drops per minute. Bedding in of the packing may take another 15 minutes.

If the pump is equipped with a quench type packing gland follow the same adjustment procedure as above after closing the quench line valve. Re-open the quench line valve after adjusting the packing to an acceptable leakage rate.

If a grease lubricator is used for packing lubrication, give the lubricator handle one or two turns every 100 hours of operation.

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.

5.8.2 Pumps fitted with mechanical seal

Mechanical seals require no adjustment. Any slight initial leakage will stop when the seal is run in. Seals will always have leakage emission from the boundary film edge in operation.

Before pumping dirty liquids it is advisable, if possible, to run the pump in 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.

5.8.3 Pumps fitted with repeller and gland packing

Before starting the pump, flood the suction, ensure that the shaft can rotate freely and that the gland leaks to an acceptable level of 30 to 120 drops per minute.

If not, adjust the gland follower nut [6580.3] to make sure that the gland packing [4130.1] is wetted either by pumped liquid or by externally flushed clean liquid.

Leakage will stop completely as soon as the pump is started and the hydrodynamic sealing takes place.

5.8.4 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) ºC (t+tb-ta+10) ºF and the trip at 100 ºC (212 ºF) for oil lubrication and 105 ºC (220 ºF) 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 5.2.5 for further information.

5.8.5 Normal vibration levels, alarm and trip

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

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

Vibration velocity – unfiltered		Horizontal pumps ≤ 15 kW mm/sec (in./sec) r.m.s.	> 15 kW mm/sec (in./sec) r.m.s.
Normal	**N**	≤ 3.0 (0.12)	≤ 4.5 (0.18)
Alarm	**N** x 1.25	≤ 3.8 (0.15)	≤ 5.6 (0.22)
Shutdown trip	**N** x 2.0	≤ 6.0 (0.24)	≤ 9.0 (0.35)

Where a grease lubricated unit is utilised in a vertical shaft configuration with a duck-foot bend onto the pump suction, the following apply:

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

5.8.6 Stop/start frequency

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

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

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

5.9 Stopping and shutdown (all series)

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

e) For some applications, it may be recommended to provide an external compatible clean liquid injection into the seal cavity for some time before each pump switch off. If it is a repeller type pump, clean liquid may need to be flushed into the repeller chamber for some time before each pump stop.

5.10 Hydraulic, mechanical and electrical duty

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

5.10.1 Specific gravity (SG)

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

5.10.2 Viscosity

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

5.10.3 Pump speed

Changing pump speed effects flow, total head, power absorbed, $NPSH_R$, noise and vibration. Flow varies in direct proportion to pump speed, head varies as speed ratio squared 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.

Note: A Chemstar repeller pump must be run at the speed agreed in the contract. This speed is relative to the allowable speed range for which the pump has been designed. Please seek advice from your nearest Flowserve office first, if you consider driving the pump at a speed deviating from these requirements.

5.10.4 Net positive suction head ($NPSH_A$)

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

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

Note: Chemstar repeller pumps are designed for the particular suction head values that have been agreed in the contract. For any changes in the suction head please consult your nearest Flowserve office for advice.

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.

5.10.5 Pumped flow

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

Note: For Chemstar repeller pumps only. Please consult your nearest Flowserve office for advice if you intend to use the pump set at a flow rate outside the flow rate range for which it was sold.

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 5.9.

Guard fasteners must remain captive during dismantling of guards, as described in section 5.5.

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

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

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

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

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

Do not spray air or compressed inert gas on skin.

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

Never use air or compressed inert gas to clean clothes.

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

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

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

6.2 Maintenance schedule

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

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

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

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

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

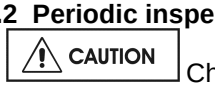
6.2.1 Routine inspection (daily/weekly)

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

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

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

6.2.2 Periodic inspection (six monthly)

a)  Check foundation bolts for security of attachment and corrosion.
b) Check pump running records for hourly usage to determine if bearing lubricant requires changing.

c) The coupling should be checked for correct alignment and worn driving elements.

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

6.2.3 Re-lubrication

For general guidelines refer to section 5.2.5, *Lubrication schedule.*

Lubricant and bearing temperature analysis can be useful in optimizing lubricant change intervals.

6.2.4 Mechanical seals

When leakage becomes unacceptable the seal will need replacement.

6.2.5 Gland packing

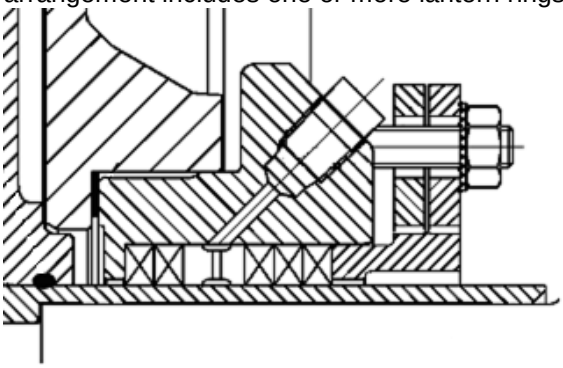
The stuffing box split gland can be completely removed for re-packing or to enable the addition of extra rings of packing. The stuffing box is normally supplied with a lantern ring to enable a clean or pressurised flush to the centre of the packing. If not required, this can be replaced by an extra 2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

6.2.6 Repeller pump with gland packing

When the pump is stopped there could be leakage exceeding the acceptable rate. This is due to the setting of the gland packing and the narrow leak path created at the shaft to soft packing interface. The instructions in section 5.8.3 must be followed during restarting of the pump.

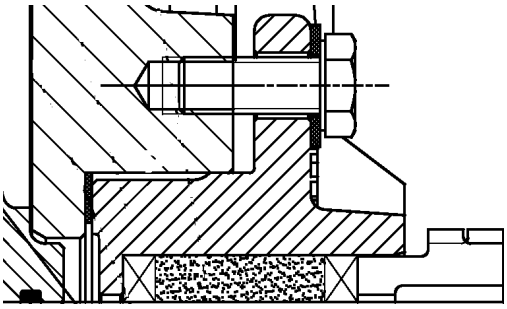
If the pumped liquid can solidify in the repeller chamber, an external clean liquid injection shall be provided into the chamber before restarting the pump. (Refer to optional recirculation in section 4.6.4.3.)

It is possible to flush the packing when the packing arrangement includes one or more lantern rings.



If the clearance between the shaft and packing is too large then the packing must be replaced. Special packing arrangements and assembly processes are explained in section 6.10.6.

Chemstar repeller pumps fitted with two packing rings and injectable packing cannot be flushed with external fluid in the stuffing box.



6.3 Spare parts

6.3.1 Ordering of spares

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

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

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

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

For two years operation (as per VDMA 24296)

Part no.	Designation	Number of pumps (including stand-by)						
		2	3	4	5	6/7	8/9	10(+)
2200	Impeller	1			2		3	30%
2100	Shaft	1		2			3	30%
6541	Lockwasher	1		2		3	4	50%
2400	Shaft sleeve, if fitted	2			3		4	50%
3011	Bearing - inboard	1		2		3	4	50%
3013	Bearing - outboard	1		2		3	4	50%
4590.1	Gasket - cover	4	6	8		9	12	150%
4590.4	Gasket seal follower, if fitted	4	6	8		9	10	100%
4610.1	O-ring - impeller	4	6	8		9	12	150%
4610.3	O-ring - carrier	4	6	8		9	10	100%
4310.1	Oil seal - inboard	4	6	8		9	10	100%
4310.2	Oil seal - outboard	4	6	8		9	10	100%
4130	Gland packing ring - set	2		3			4	40%
4120	Gland halves	1	2			3		30%
2540	Deflector	1	2			3		30%
-	Mechanical seals	1	2			3		30%
-	Power end	-	-	-	-	-	1	2
4130.2	Injectable packing	2		3			4	40%
4610.1	O-ring - repeller	4	6	8		9	12	150%
4610.5	Gasket - repeller cover	4	6	8		9	10	100%

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
- Thickness feeler gages

More specialized equipment:

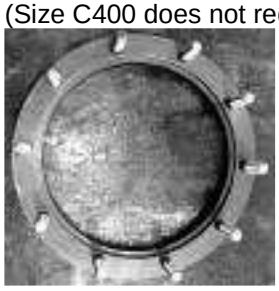
- Bearing pullers
- Bearing induction heater
- Dial test indicator
- C-spanner (wrench) - for removing shaft nut. (If difficulties in sourcing are encountered, consult Flowserve.)
- Coupling grip/shaft spanner
- Nose cone for shaft impeller side

To simplify maintenance, it is recommended that the Flowserve Chemstar tool kit (shown below) be used. [Flowserve Part # MISCRK00068AA]. This tool kit can be ordered from your local Flowserve sales engineer or from a Flowserve distributor or representative.

The tool kit contains “nose cones” (shown below) which protect shaft threads and O-rings during maintenance.

The following tools are required for disassembly and assembly of repeller pumps.

- Mounting ring (see below). Rings are available for sizes B250, B315 and C250/315 pumps. (Size C400 does not require a mounting ring.)



- Bar diameter 43 and 53 mm. To facilitate setting injectable packing in stuffing box of repeller covers. (Refer to section 6.10.6.)

6.6 Fastener torques

Fastener position	Fastener size	Torque Nm (lbf ft)
Casing, rear cover, repeller cover and bearing housing foot	M8 M10 M12 M16 M20	16 (12) 25 (18) 35 (26) 80 (59) 130 (96)
Mechanical seal follower (gasket type seal only). (Others as rear cover)	 M10 M12	 13 (10) 34 (25)
Bearing carrier	M10 M12	15 (11) 35 (26)
Bearing retainer lock ring capscrews	3/16 5/16	3 (2) 8 (6)

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

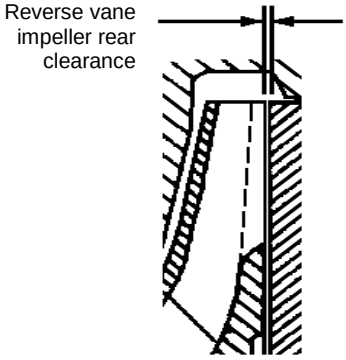
6.7 Setting impeller clearance

This procedure may be required after the pump has been dismantled or a different clearance is required.

Before carrying out this procedure ensure that the mechanical seal(s) fitted can tolerate a change in their axial setting, otherwise it will be necessary to dismantle the unit and reset the seal axial position after adjusting the impeller clearance.

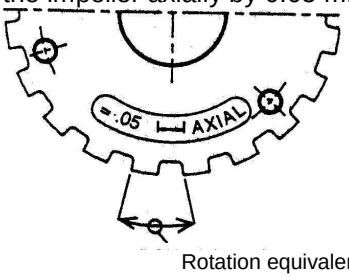
a) Disconnect the coupling if it has limited axial flexibility.
b) The impeller adjustment on the Chemstar is easily made externally by loosening the set screws [6570.3] and rotating the bearing carrier [3240] to obtain the proper clearance.

6.7.1 Setting reverse vane impeller rear clearance



Temperature	Impeller clearance setting
	All impeller diameters
50 ºC (120 ºF)	0.45 mm (0.018 in.)
100 ºC (210 ºF)	0.55 mm (0.022 in.)
150 ºC (300 ºF)	0.65 mm (0.026 in.)
200 ºC (390 ºF)	0.75 mm (0.030 in.)
260 ºC (500 ºF)	0.85 mm (0.033 in.)

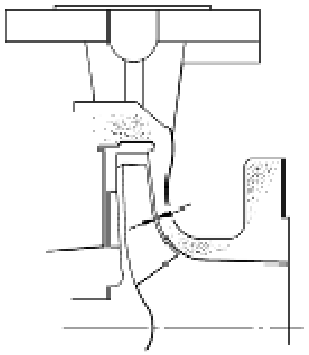
a) Turn the bearing carrier counter-clockwise until the impeller comes into light contact with the rear cover. Rotating the shaft at the same time will accurately determine when a detectable rub is obtained. This is the zero clearance setting.
b) Rotating the bearing carrier the width of one notch on the bearing carrier, as shown below, moves the impeller axially by 0.05 mm (0.002 in.).



Rotation equivalent to 0.1 mm (0.004 in.) axial movement

Example: for an impeller setting of 0.45 mm (0.018 in.) simply move the carrier clockwise nine notches for the required clearance.
c) Use the notch closest the parting line on the top centre of the bearing housing as the reference point to begin adjustment.
d) After obtaining the proper clearance, listed in the table above, tighten the set-screws evenly to lock the impeller and shaft assembly. Because of the slight draw as the carrier/housing threads lock it may be necessary to allow for this change. If possible, check results with a feeler gauge.
e) If a cartridge seal is fitted it should be reset at this point.
f) Check that the shaft can turn freely without binding.
g) Ensure the coupling distance between shaft ends (DBSE) is correct. Reset/re-align if necessary.

6.7.2 Setting high chrome iron front open impeller clearance



a) Turn the bearing carrier clockwise until the impeller comes into light contact with the front profile on the casing. Rotating the shaft at the same time will accurately determine when a detectable rub is obtained. This is the zero clearance setting.

b) Rotating the bearing carrier the width of one notch on the bearing carrier, as shown above, moves the impeller axially by 0.05 mm (0.002in.). Example: for an impeller setting of 0.45 mm, (0.018 in.) simply move the carrier counter-clockwise nine notches for the required clearance.
c) Use the notch closest the parting line on the top centre of the bearing housing as the reference point to begin adjustment.

Temperature	Impeller clearance setting
	All impeller diameters
50 ºC (120 ºF)	0.45 mm (0.018 in.)
100 ºC (210 ºF)	0.55 mm (0.022 in.)
150 ºC (300 ºF)	0.65 mm (0.026 in.)
200 ºC (390 ºF)	0.75 mm (0.030 in.)
260 ºC (500 ºF)	0.85 mm (0.033 in.)

d) After obtaining the proper clearance, listed in the table, tighten the set-screws evenly to lock the impeller and shaft assembly. Because of the slight draw as the carrier/housing threads lock it may be necessary to allow for this change.
e) Check that the shaft can turn freely without binding.
f) If a cartridge seal is fitted it should be reset at this point.
g) Ensure the coupling distance between shaft ends (DBSE) is correct. Reset/re-align if necessary.

6.7.3 Installation and rotor clearance setting for repeller pumps

a) Install the secondary shaft sealing as applicable (see section 6.10.6 or 6.10.8). Attach the repeller cover [1220.2] to the bearing housing flange (see section 6.10.7) and place the repeller [2000.1] temporarily clamped by the impeller [2000] as described in section 6.10.9.
b) Set the repeller 0.35 to 0.55 mm (0.015 to 0.020 in.) off the repeller cover [1220.2].
c) Turn the bearing carrier counter-clockwise until the repeller comes into gentle contact with the repeller cover. Rotating the shaft at the same time will accurately determine when a detectable rub is obtained. This is the zero clearance setting.
d) Rotating the bearing carrier [3240] by the width of one notch, as shown above, moves the impeller axially by 0.05 mm (0.002 in.).
e) Uniformly tighten the set screws [6570.3] in incremental steps up to the final torque value to lock the bearing carrier in place.
f) Remove the impeller [2200] from the shaft, taking care that the now loose repeller [2200.1] does not slip off the shaft. Install the rear cover [1220.1] as shown in section 6.10.9.
g) Secure the impeller onto the shaft as shown in section 6.10.4.
h) Check the impeller setting with a feeler gage. The clearance should be 0.35 to 0.55 mm (0.015 to 0.020 in.). If the clearance falls outside the correct setting, it may be readjusted. For example, if the repeller is set at 0.55 mm, and the impeller clearance is 0.65 mm, then rotate the bearing carrier [3240] anti-clockwise to reduce the repeller clearance from 0.55 mm to 0.45 mm. This will bring the impeller clearance from 0.65 mm back to 0.55 mm, which is acceptable.

6.8 Disassembly

Refer to *Safety* section 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 Bearing housing assembly

To remove, proceed as follows:
a) Disconnect all auxiliary pipes and tubes where applicable.
b) Remove coupling guard and disconnect coupling.
c) If oil lubricated frame, drain oil by removing drain plug [6569.1].
d) Refer to sectional drawings in section 8.
e) Remove casing nuts [6580.1].
f) Remove bearing housing support foot [3134] to baseplate screws.
g) Remove bearing housing power end assembly to rear and out, leaving casing in place. The threaded holes in the bearing housing flange may be used for jacking to assist with removal.
h) Remove pump casing gasket and discard. A replacement gasket will be required for assembly.
i) Clean gasket mating surfaces.

6.8.2 Impeller removal

NEVER APPLY HEAT TO REMOVE THE IMPELLER. TRAPPED OIL OR LUBRICANT MAY CAUSE AN EXPLOSION.

a) Fit a chain wrench or bolt a bar to the holes in the coupling half, or fit a keyed shaft wrench directly to the shaft [2100], first removing the coupling. Preferably clamp the bearing housing foot of the subassembly to the work surface.
b) Grasp the impeller [2200] firmly with both hands (wear heavy gloves). Raise the wrench above the workbench to the 11 o'clock position by turning the impeller clockwise as viewed from the impeller end of the shaft.

c) Give the impeller a quick turn counter-clockwise to strike the wrench handle against the workbench surface or a hard surface on the left-hand side. Several sharp raps in this way will free the impeller from the shaft so it may be unscrewed.
d) The impeller has an O-ring that should be discarded. Use a new O-ring for assembly.

CAUTION Do not attempt to remove or place the impeller on the shaft by hitting the impeller with a hammer or using a poorly fitting pry bar between the impeller vanes. Serious damage to the impeller may result from such actions.

6.8.3 Rear cover and seal

The seal manufacturer's instructions should be followed for dismantling and assembly, but the following guidance should assist with most seal types:

a) Remove internal shaft guard or seal guard (if fitted).
b) Remove the seal follower nuts [6572.2], if a separate seal follower [4131] is fitted, and slide the follower away.
c) Remove the rear cover retaining screws [1220].
d) Loosen the grub screws (used in most mechanical seals) on some seal rotaries.
e) Carefully pull off the rear cover and mechanical seal rotating element(s) if not furnished with a hook type sleeve.
f) Remove the seal follower [4131]/complete cartridge seal (if fitted).
g) Remove shaft hooked sleeve (if fitted) together with seal rotary. Be certain to measure and record the position of the seal rotary unit on the sleeve. A replacement seal rotary of the same type may then be relocated at the same position on the same or a new hook type sleeve.
h) On non-cartridge seals the stationary seat remains in the seal follower/cover with its sealing member. Remove only if damaged or worn out.
i) On pumps fitted with gland packing, the packing [4130] and lantern ring [4134] should be removed only if the packing is to be replaced.

6.8.4 Bearing housing

a) Pull off the pump half of the coupling (if not previously removed) and remove the coupling key [6700].
b) Remove support foot (if necessary).
c) Loosen the three set screws [6570.3] in the bearing carrier [3240].
d) Remove bearing carrier and shaft assembly from the bearing housing [6700] by using a spanner wrench to engage the slots on the bearing carrier. Rotate this counter-clockwise a number of turns until the carrier outer threads disengage the bearing housing.
e) Because the O-ring [4610.3] may cause slight resistance to removing the bearing carrier assembly from the bearing housing [3200], hold the bearing carrier flange firmly and with slight rotation and pull it to the rear.
f) Remove the pump side deflector [2540] or labyrinth seal rotary half [4330.1], depending on option fitted.
g) The carrier assembly with shaft and bearings should come out towards the coupling end.
h) Remove bearing snap ring [2530] or clamp ring [3240.1].
i) Remove drive side liquid flinger or labyrinth seal rotary half [4330.2] if fitted.
j) Remove the bearing carrier from the bearing [3013].
k) When pressing bearings off the shaft, use even pressure force on the inner race only. An arbor or hydraulic press may be used to remove the bearings.
l) Now remove pump side bearing [3011].
m) The bearing locknut [3712] and lockwasher [6541] may now be removed from the shaft.
n) Remove drive side bearing [3013].

6.8.5 Repeller pump

a) Remove the casing [1100]. With Group C pumps remove the ring spacer [3126] and ring spacer gasket [4610.7], if used. Except for C400 pump sizes, the impeller [2200] cannot rotate freely as the repeller cover gasket [4610.5] is pressing the rear cover [1220.1] onto the impeller which closes in the impeller clearance. For C400 sizes proceed directly to c) below.
b) Install the mounting ring as described in section 6.10.9. The impeller will then rotate freely.
c) Remove the impeller as shown in section 6.8.2. For safety reasons, screw a nose cone into the shaft end to temporarily lock the repeller on the shaft.
d) If pump is C400 size, remove the mounting ring or the hold down screws [6570.5] and slide the rear cover [1220.1] away from the repeller cover [1220.2]. To help removal use a levering action by wedging a pry-bar into the groove formed at the outer rims of the assembled covers.

Proceed by removing the rear cover evenly in small increments around the circumference of the impeller cover.

e) For Group C400 pumps remove the capscrews [6570.5] that hold the rear cover [1220.1] to the bearing housing [3200] flange and slide the cover [1220.1] out of the repeller cover [1220.3].

f) The repeller [2200.1] is now exposed and should be free to slide from the shaft once the nose cone had been removed. Should it be stuck, the repeller can be pried off by using 2 screwdrivers wedged between the repeller [2200.1] and the repeller cover [1220.2].

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

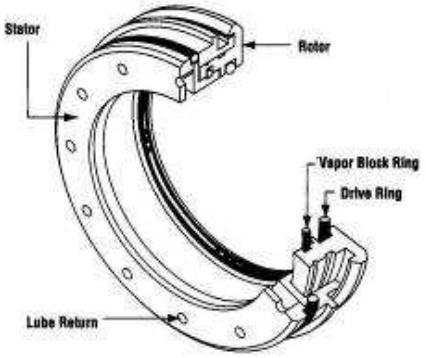
6.9.2 Shaft and sleeve (if fitted)
Replace if grooved or pitted. With the bearing mounting diameters (or bearing outer) supported by V-blocks, check that the shaft runouts are within 0.025 mm (0.001 in.) at the coupling end and 0.050 mm (0.002in.) at the sleeve end.

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.

6.9.5 Bearing isolators, labyrinths or lip seals (if fitted)
The lubricant, bearings and bearing housing seals are to be inspected for contamination and damage. If oil bath lubrication is utilised, these provide useful information on operating conditions within the bearing housing. If bearing damage is not due to normal wear and the lubricant contains adverse contaminants, the cause should be corrected before the pump is returned to service.

Labyrinth seals and bearing isolators are not intended to be separated from the bearing housing/adapter/ bearing carrier unless being replaced. One example of a variety of approved isolators that may be fitted is shown. These should be inspected for damage but are normally non-wearing parts and can be re-used. Check O-rings and external return passages. O-rings may require replacement when a labyrinth seal has been removed. Replacement O-ring sets are available for most designs.



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

6.9.6 Bearing housing and carrier
Inspect the bearing carrier circlip groove. Ensure it is free from damage and that housing lubrication passages are clear. Replace grease nipples or the filter breather (where fitted), if damaged or clogged.

On oil lubricated versions, the oil level sight glass should be replaced if oil stained.

6.10 Assembly

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

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

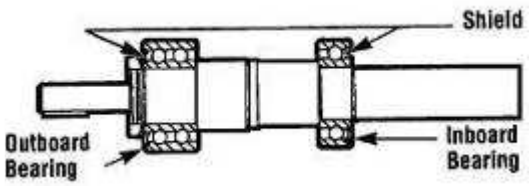
6.10.1 Bearing housing and rotating element assembly

a) Clean the inside of the bearing housing, bearing carrier and bores for bearings.

b) Attach bearing housing support foot.

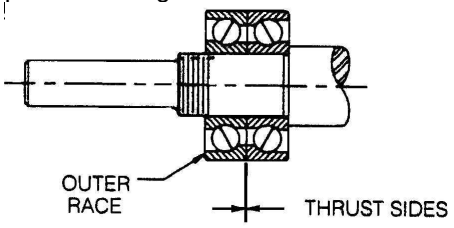
c) Before replacing bearings, the shaft [2100] should be carefully inspected. If the shaft is in good condition, new inboard [3011] and outboard bearings [3013] should be installed onto the shaft, otherwise use a new shaft.

d) If the bearing housing is equipped with regreasable bearings, the shields should be oriented facing outwards as shown below:



e) The double row thrust bearing must not have a filling slot, as such bearings are limited to taking thrust in only one direction.

f) If the optional pair of angular contact bearings are to be fitted, these must be mounted back-to-back, with the wide thrust faces of the outer races positioned together as shown below:



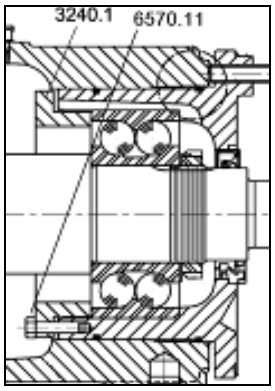
Note: Optional angular contact bearings are held in the bearing carrier by a snap ring [2530] or a screwed retainer ring [3240.1] as shown below.

g) The following methods are recommended for fitting the bearings onto the shaft:
Method 1: Use a hotplate, hot bath, oven or induction heater to heat the bearing race so it can easily be placed in position then allowed to shrink and grip the shaft. It is important that the temperature is not raised above 100 ºC (212 ºF).
Method 2: Press the bearing onto the shaft using equipment that can provide a steady, even load to the inner race. Take care to avoid damaging the bearing and shaft.

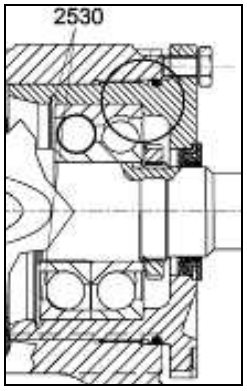
h) It is important that when installing the bearing it is drawn up tight to the shaft shoulder as all the bearings have a slight interference fit in their bore.

i) With double row thrust bearings place the inner bearing snap ring [2530] over the shaft, with the tapered face facing the impeller end before fitting the outboard bearing. Note that Group D pumps use the retainer [3240.1] as shown below.

j) With the optional pair of angular contact bearings, or with Group D pumps, the bearing retainer ring [3240.1] should be placed with the inner spigot facing towards the coupling.

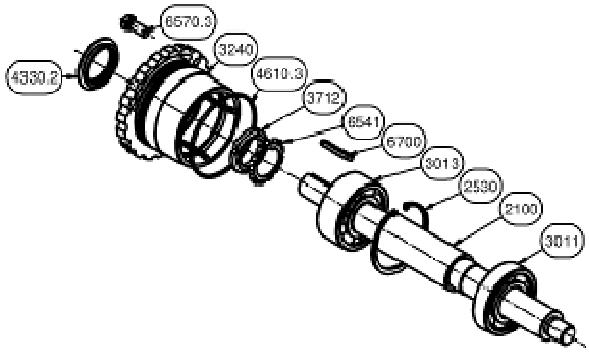


Group D

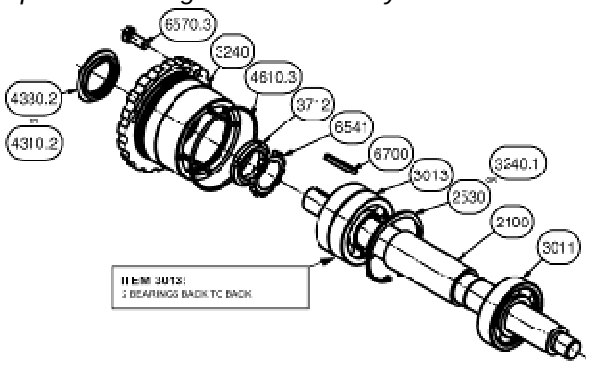


Group B & C

Standard bearing carrier assembly



Optional bearing carrier assembly



Part no.	Description
2100	Shaft
2530	Snap ring
3011	Ball bearing - inboard
3013	Ball bearing - outboard
3240	Bearing carrier
3712	Bearing locknut
4330.2	Outboard labyrinth
4610.3	O-ring - carrier
6541	Lock washer
6570.3	Screw
6700	Key
4310.2	Oil seal - outboard
6570.11	Socket head screws
3240.1	Bearing retainer - ring

Note: Item [3240] is specific to the bearing type and the way bearings are locked.

k) Press inboard bearing onto the shaft using Method 1 or 2 above.

l) With bearings at ambient temperature, and on the regreaseable lubricated pump only, the bearings should be 30 to 50% filled with approved grease on both sides of the races.

m) With the bearings at ambient temperature, fit the outboard bearing locknut [3712] and lockwasher [6541], tightening firmly. Bend the tab of the lockwasher that lines up with a slot in the locknut.

n) Great care should be taken to clean all parts and keep the unit free from dust and dirt.

o) Replacement of the radial lip seals (if fitted) and O-rings is highly recommended.

p) The bearing housing lip seals [4310.1 and 4310.2] are a double lip type and the cavity between the two lips should be packed with grease.
q) Fit O-ring on the bearing carrier. Lightly lubricate the bearing carrier bore and O-ring.
r) Ensure the shaft keyway edges are free of burrs. During installation, use shimming or tape over the keyway to avoid damaging the drive side bearing seals.
s) Slide the bearing carrier [3240] onto the shaft/ bearing assembly and insert bearing inner snap ring [2530] or locking ring [3240.1] depending upon size and bearing configuration.
t) Check shaft for free rotation.
u) Fit the pump side labyrinth into the bearing housing ensuring if a single drain hole that it faces the bearing and is at the 6 o'clock position.
v) Install the shaft assembly into the bearing housing.
w) Fit the bearing carrier screws.
x) Press inboard deflector [2540] onto shaft where applicable (lip seals fitted). These should be set 0.5 to 1 mm (0.02 to 0.04 in.) off the lip seal and must not contact the lip seal or bearing housing.
y) Temporarily fit the rear cover with the correct topmost position.

6.10.2 Rear cover and seal assembly - standard pump

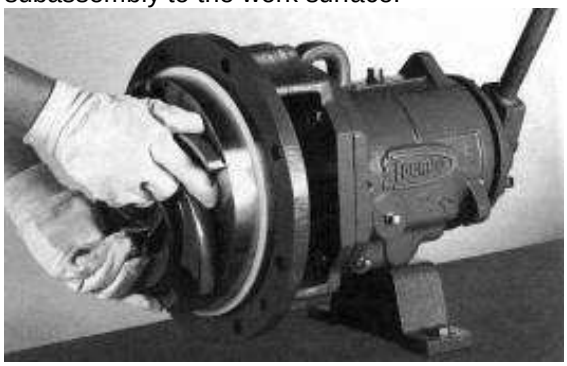
a) Extreme cleanliness is required. The sealing faces and shaft or sleeve surface must be free from scratches or other damage.
b) Refer to section 6.11, *Sealing arrangements,* for seal diagrams.
c) On non cartridge seals, carefully press the component stationary seat into the mechanical seal housing or cover, ensuring that the seating ring is not deformed.
d) Where an anti-rotation pin is fitted ensure that correct engagement with the slot is achieved.
e) Place any separate seal follower [4131] or the cartridge seal assembly over the shaft.
f) Refer to manufacturer's instructions to position the component or non-cartridge mechanical seal rotating elements.
g) Tighten any drive screws in the seal drive collar. For precise compression most cartridge seals should be set after complete pump assembly.
h) Fit the rear cover into the bearing housing and tighten all fasteners.

6.10.3 Gland packed stuffing box assembly

a) Assemble the gland packing into the stuffing box housing before fitting on to the shaft.
b) Stagger the joints in the gland packing by 90 degrees to each other.
c) The lantern ring halves (if required) should be positioned mid-way along the packing.
d) Position the gland squarely against the last ring and tighten the gland nuts finger-tight only.
e) Install into bearing housing assembly and fit the two screws to hold the cover in place.
f) Check that the shaft rotates freely.

6.10.4 Impeller assembly and setting

a) Fit a new O-ring [4610.1] into the impeller using a small amount of grease to hold it in place.
b) Apply anti-galling compound (which does not contain copper) to the impeller thread to help subsequent removal.
c) Assemble impeller onto the shaft.
d) Fit a chain wrench or bolt a bar to the holes in the coupling half, or fit a keyed shaft wrench directly to the shaft, first removing the coupling. Preferably clamp the bearing housing foot of the subassembly to the work surface.



e) Tighten the impeller. Grasp the impeller firmly with both hands (wear heavy gloves). Raise the wrench above the workbench to the 1 o'clock position by turning the impeller counter-clockwise as viewed from the impeller end of the shaft. This is the opposite direction of rotation to disassembly.
f) Give the impeller a quick turn clockwise to strike the wrench handle against the workbench surface or a hard surface on the right hand side. A few sharp raps in this way will tighten the impeller to the correct level.

6.10.5 Assembly of bearing housing into casing

a) Fit a new gasket [4590.1] on rear cover as shown above.
b) Install the bearing housing assembly into the pump casing. Coat the screws with anti-galling compound and tighten into casing.
c) Check impeller clearance against original setting, or process requirement and adjust as necessary. (See section 6.7, *Setting impeller clearance*.)
d) Ensure that all other items have been re-attached and all fasteners tightened, then follow the instructions in section 4, *Installation* and section 5, *Commissioning.*

6.10.6 Repeller pump: installation of gland packing

The stuffing box bore in which the gland packing is installed is either a separate stuffing box [1220.3] bolted into the large bore repeller cover or the stuffing box of the small bore repeller cover (1220.4). Both the options have identical stuffing box dimensions.

Large bore repeller cover assembled with separate bolt-on stuffing box

Small bore repeller cover with built in stuffing box

Note: Use disposable plastic gloves for the following actions:

a) Clean the stuffing box bore. Insert one packing ring [4130.1] and push it against the bottom of the stuffing box cavity.

b) Place a 43 or 53 mm diameter smooth bar or pipe (depending if Group B or C pump) at the centre of the bore and insert the injectable packing compound [4130.2] into the stuffing box.

Note: 85 g of injectable packing is required to fill the stuffing box chamber. Flowserve provides the exact amount of injectable packing required when it is ordered as a spare part.

c) Insert another packing ring into the stuffing box on top of the injectable packing

d) Assemble the two studs [6572.2] in the stuffing box of the repeller cover [1220.4] or in a separate stuffing box [1220.3] depending on the configuration.
e) Assemble the gland follower halves [4120.2], slide assembly into the stuffing box engaging the studs [6572.2] in holes. Tighten the nuts[6580.3] loosely. Using a thickness feeler gage blade in between the gland and stuffing box face, tighten the nuts alternately until 3 mm (⅛ in.) residual clearance is reached.
f) For repeller pumps with large bore repeller cover [1220.2], install the stuffing box assembly into the repeller cover.
g) For repeller pumps with small bore repeller cover mount the repeller cover assembly onto the bearing housing [3200].

6.10.7 Repeller pump - installation of repeller cover

See sectional drawing in section 8.3.

a) Install the packing as described in section 6.10.6.

b) For pumps supplied with a large bore repeller cover, place the flat gasket [4590.2] on the bottom of the cover bore and slide the stuffing box unit assembly into the bore and fasten it with screws [6570.6].

c) Lubricate the shaft and cone with a film of silicone. Screw the shaft guide or nose cone on the shaft end threads. Install the repeller cover [1220.2] over the shaft and push it all the way back until it contacts the flange face of the bearing housing and becomes piloted by the counterbore. Hold the repeller cover using two capscrews [6570.7].

Note: For Group B315 pumps there are two special capscrews [6570.9].

For Group C400 pumps, install the repeller cover [1220.2] to the bearing housing [3200] flange using capscrews [6570.5].

6.10.8 Reassembly - repeller pump with FXP seal (secondary sealing)

See sectional drawing in section 8.6.

a) Remove any sharpness of edge at wet end of shaft with #400 emery cloth.

b) Clean all exposed surfaces of the wet end of the shaft.

c) Install a shaft guide (or nose cone) tool from the Flowserve tool kit. (See section 6.5.)

d) Insert the O-rings into the grooves on the inside diameter of the seal rotor.

e) Lubricate the O-rings and shaft with non-abrasive liquid hand soap and slide the drive collar [4310.1] onto the shaft until it contacts the bearing housing.

f) Place repeller cover face down on workbench and set the Teflon disk [4310.2] against the gland surface (ie end of stuffing box). Attach gland [4310.3] to repeller cover and screw on gland nuts finger-tight.

g) Reinstall the repeller cover, repeller, rear cover, and impeller as described in section 6.7.3 and 6.10.9.

h) Tighten gland nuts fully. Slide the drive collar forward until it contacts the Teflon disk.

i) To preload the seal, push the drive collar against the Teflon disk by applying even pressure. The drive collar should be pushed into the Teflon disk approximately 3mm (⅛ in.). Tighten the drive collar setscrews while maintaining pressure on the drive collar.

j) Once the pump is flooded, check the seal to ensure it is not leaking. If the seal leaks, repeat step i) above, applying only enough pressure to the drive collar to stop the leak. Do not over tighten the seal.

6.10.9 Repeller pump - assembly of repeller, rear cover and impeller

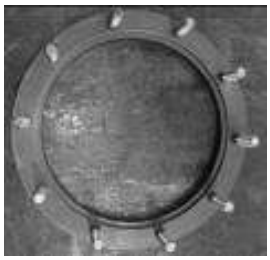
See sectional drawing in section 8.3.

a) Install a repeller O-ring [4610.6] into the groove in the central hollow in the repeller hub. Lubricate the O-ring with liquid soap or a grease compatible with the material of the O-ring.

b) Carefully slide the slip-on repeller [2200.1] onto the shaft, taking care not to damage the repeller O-ring with the shaft end edges. (Remove the nose cone before assembling the repeller.) Follow instructions in section 6.10.4 to screw in the impeller [2200] and strongly clinch the repeller onto the shaft. Set the repeller clearance as explained in section 6.7.3. Remove the impeller.

c) Lightly lubricate repeller cover gasket [4610.5] with non abrasive hand soap and install it in the dedicated groove. If repeller pump model is Group C size C100x65M-315A, C125x80M-400 or C150x125M-400, refer to the close-up views of the cover gasket joint in section 8.3 or 8.4. Assemble the metallic ring spacer [3126] so that the side without writing is placed in contact with the repeller cover gasket [4610.5]. Inspect the gasket ring spacer [4610.7] for any damage or defects; replace it with a new one if there are any doubts. Carefully slide the gasket ring spacer over the repeller cover [1220.4] and hand push it until it touches the metallic ring spacer in a complete circle.

d) Install the rear cover [1220.1] by sliding it over the repeller cover. Install the mounting ring (see section 6.5) and fasten it with nuts as shown in the following pictures.



Note: Tighten all the nuts on the mounting ring so that the repeller cover gasket [4610.5] is compressed evenly otherwise the nominal impeller clearances may not be achieved.

Note: Note that a mounting ring is not needed for the Group C sizes 400 repeller pumps

e) The impeller and impeller clearance can now be set following the instructions in section 6.7.3.

6.11 Sealing arrangements

6.11.1 Sealing arrangement assembly

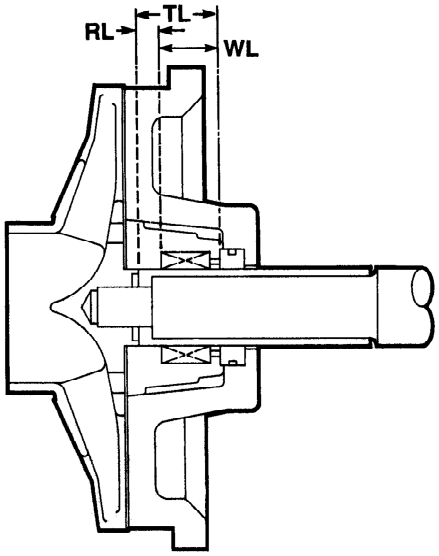
Contact your nearest Flowserve sales office or service centre if you require further information or are unsure of the specific seal arrangement supplied.

Refer also to section 4.6.5, *Auxiliary piping*.

6.11.2 Single seal in TE (FMI) rear cover

This section shows details of the basic seal arrangement with the Seal Sentry TE (FMI) rear cover. To assemble the arrangement:

a) Refer to the TE (FMI) rear cover drawing below.
b) Having checked the impeller clearance is correct, install mechanical seal stationary seat into the rear cover counterbore.
c) Measure the distance TL from the seal face on the stationary seat to the end of the hook sleeve, or equivalent position on a solid shaft (if fitted).
d) The seal working length, WL, is determined from the seal drawing provided by the seal manufacturer. Subtract the seal working length WL from TL.
e) The distance remaining, RL, is the distance from the end of the hook sleeve or solid shaft (if fitted) to the rotating unit. Install the rotating unit of the component seal at this location.
f) If a hooked sleeve is fitted, the rotating unit should be set in position on this. Install the hook sleeve assembly onto the shaft.
g) Reinstall the impeller onto the shaft, locking the hook sleeve into position.



7 FAULTS; CAUSES AND REMEDIES

FAULT SYMPTOM

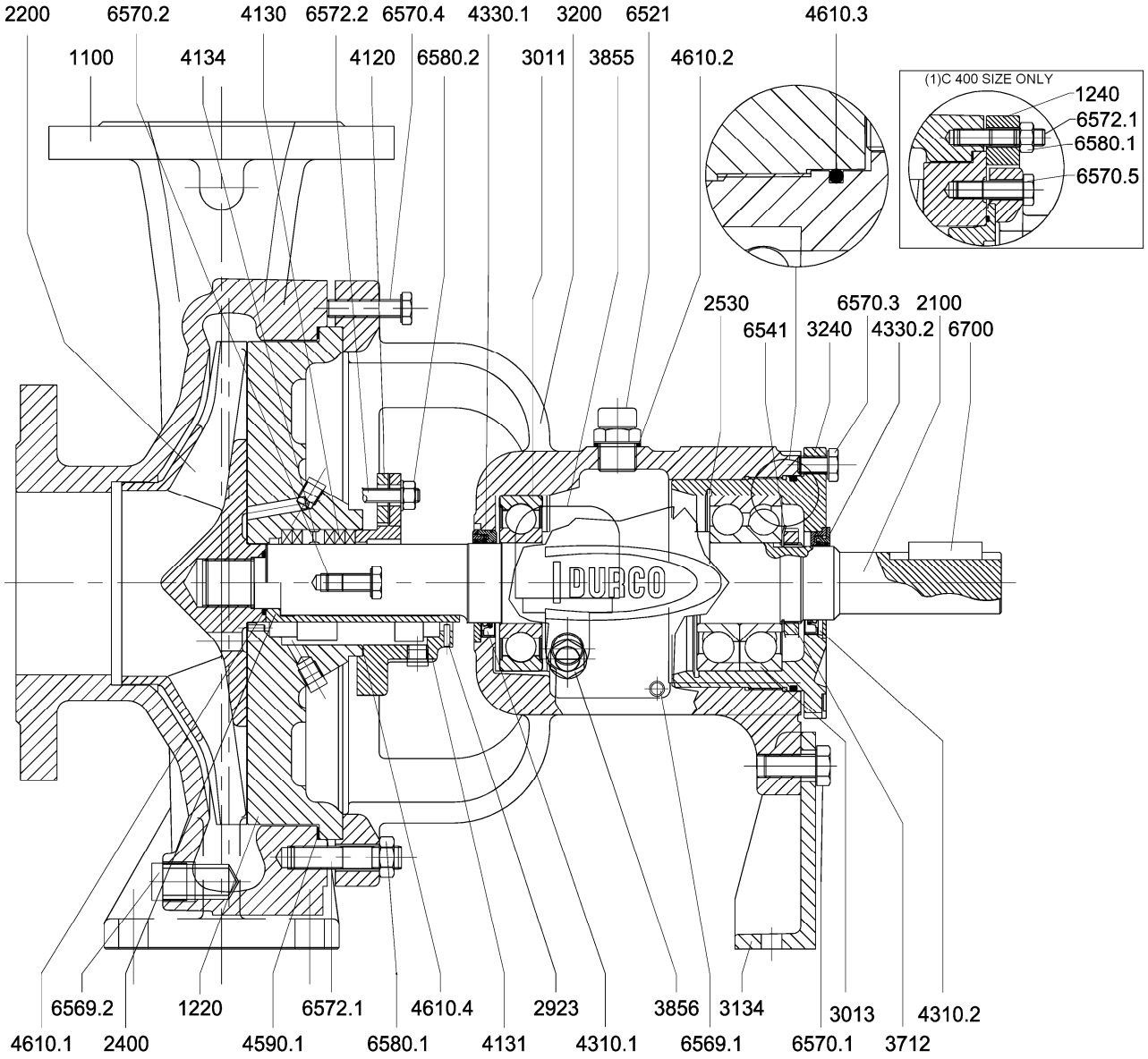
Pump overheats and seizes	Bearings have short life	Pump vibrates or is noisy	Mechanical seal has short life	Mechanical seal leaks excessively	Pump requires excessive power	Pump loses prime after starting	Insufficient pressure developed	Insufficient capacity delivered	Pump does not deliver liquid	PROBABLE 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 vapour pressure.	
						●	●	●		Excessive amount of air or gas in liquid.	Check and purge pipes and system.
						●		●	●	Air or vapour pocket in suction line.	Check suction line design for vapour pockets.
						●		●		Air leaks into suction line.	Check suction pipe is airtight.
						●		●		Air leaks into pump through mechanical seal, sleeve joints, casing joint or pipe lugs.	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 runouts 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 centre.	Check and renew defective parts.
			●	●	●					Mechanical seal improperly installed.	Check alignment of faces or damaged parts and assembly method used.
			●	●	●					Incorrect type of mechanical seal for operating conditions.	CONSULT FLOWSERVE.
●	●	●	●	●						Shaft running off centre because of worn bearings or misalignment.	Check misalignment and correct if necessary. If alignment satisfactory check bearings for excessive wear.
●	●	●	●	●						Impeller out of balance resulting in vibration.	Check and CONSULT FLOWSERVE.
			●	●	●					Abrasive solids in liquid pumped.	
			●	●						Internal misalignment of parts preventing seal ring and seat from mating properly.	
			●	●						Mechanical seal was run dry.	Check mechanical seal condition and source of dry running and repair.
			●	●						Internal misalignment due to improper repairs causing impeller to rub.	Check method of assembly, possible damage or state of cleanliness during assembly. Remedy or CONSULT FLOWSERVE, if necessary.
●	●	●								Excessive thrust caused by a mechanical failure inside the pump.	Check wear condition of impeller, its clearances and liquid passages.
	●	●								Excessive grease in ball bearings.	Check method of regreasing.
	●	●								Lack of lubrication for bearings.	Check hours run since last change of lubricant, the schedule and its basis.
	●	●								Improper installation of bearings (damage during assembly, incorrect assembly, wrong type of bearing etc).	Check method of assembly, possible damage or state of cleanliness during assembly and type of bearing used. Remedy or CONSULT FLOWSERVE, if necessary.
	●	●								Damaged bearings due to contamination.	Check contamination source and replace damaged bearings.
										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 Chemstar – Groups A, B and C

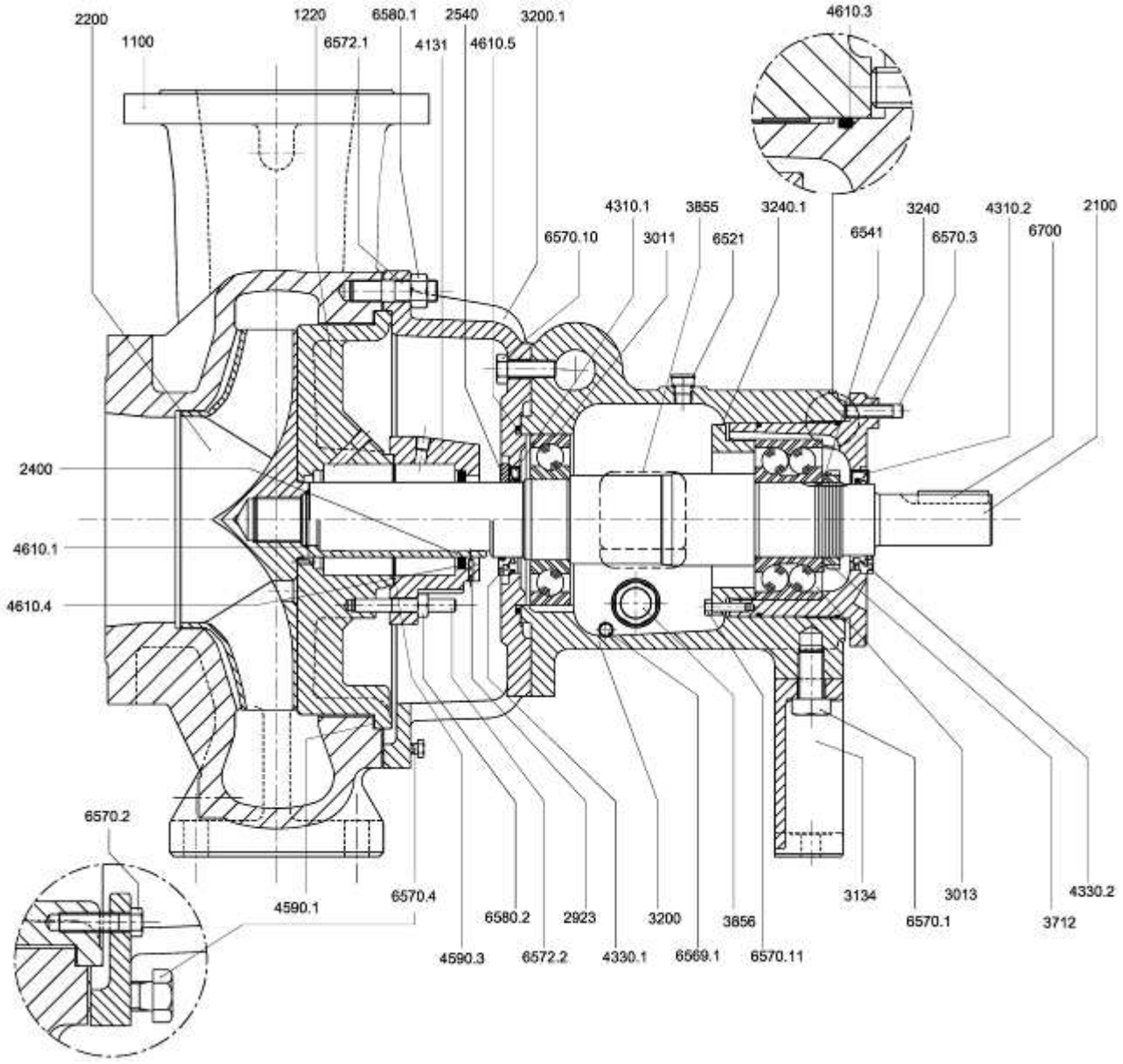


Part no.	Description
1100	Casing
1220	Rear cover
1240	Ring clamp (400 nominal size)
2100	Shaft
2200	Impeller
2400	Shaft sleeve
2530	Snap ring
2540	Deflector (not illustrated)
2923	Pin
3011	Ball bearing - inboard
3013	Ball bearing - outboard
3134	Foot
3200	Bearing housing
3240	Bearing carrier

3712	Bearing locknut
3855	Oiler
3856	Sight glass
4120	Gland halves
4130	Packing ring
4131	Follower flange
4134	Lantern ring
4310.1	Oil seal - inboard
4310.2	Oil seal - outboard
4330.1	Oil seal - inboard (not illustrated)
4330.2	Oil seal - outboard (option)
4590.1	Gasket - cover
4610.1	O-ring - impeller
4610.2	O-ring - filler and vent
4610.3	O-ring - bearing carrier

4610.4	O-ring/gasket - follower flange
6521	Plug - housing, fill/vent
6541	Lock washer
6569.1	Magnetic plug
6570.1	Screw - foot bearing housing
6570.2	Screw
6570.3	Screw
6570.4	Jackscrew
6570.5	Screw
6572.1	Stud
6572.2	Stud
6580.1	Nut
6580.2	Nut
6700	Key

8.2 Chemstar – Group D

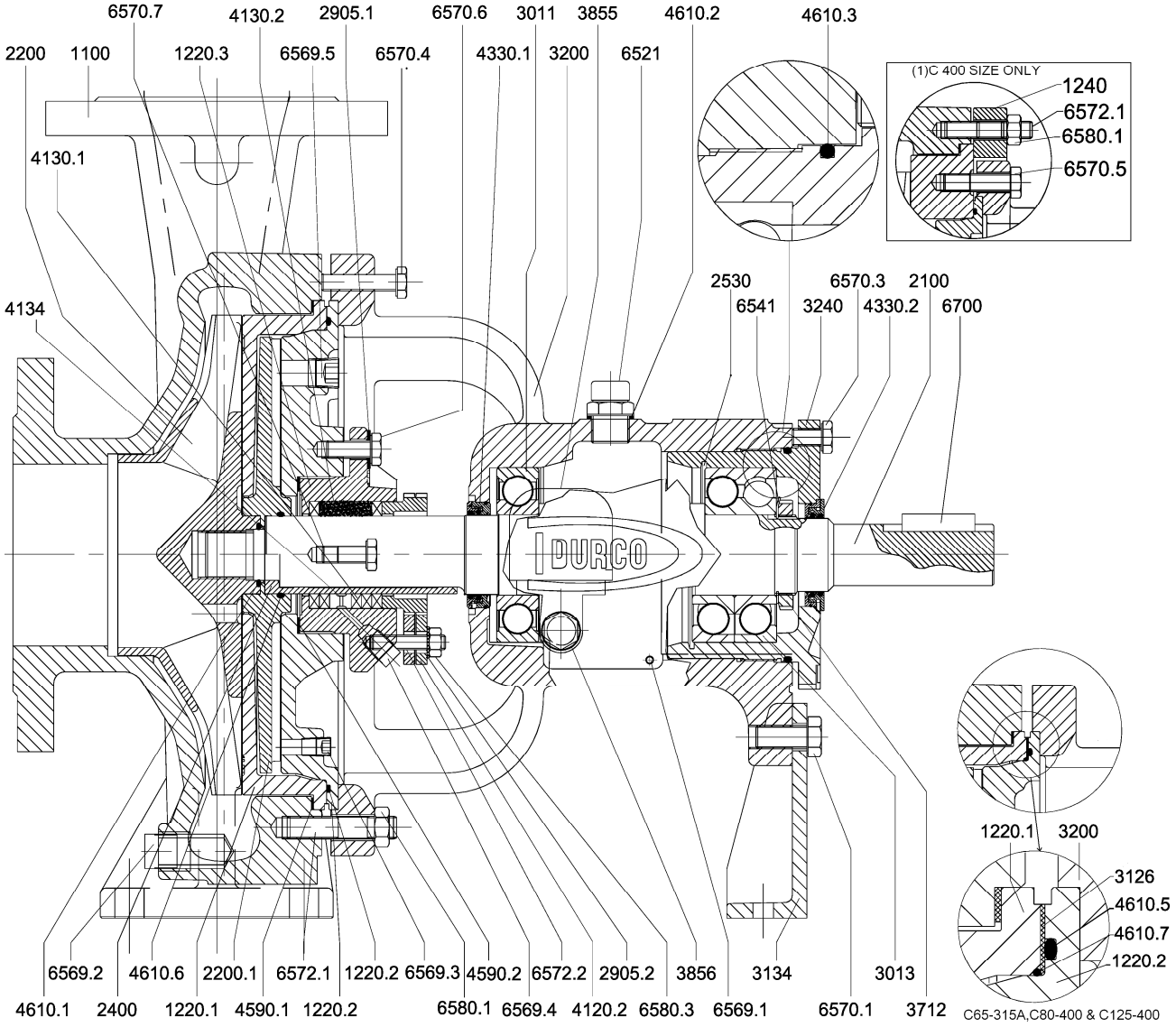


Part no.	Description
1100	Casing
1220	Rear cover
3134	Foot
2100	Shaft
2200	Impeller
2540	Deflector
3011	Bearing - inboard
3013	Bearing - outboard
3200	Bearing housing
3200.1	Bearing housing adapter
3240	Bearing carrier
3240.1	Bearing retainer - carrier
4590.1	Gasket - cover
4590.3	Gasket - follower flange

4610.1	Gasket - impeller
4610.5	O-ring - adapter/housing
4610.3	O-ring - bearing carrier
4610.4	O-ring - follower flange
4310.1	Oil seal - inboard
4310.2	Oil seal - outboard
4330.1	Oil seal - inboard (option)
4330.2	Oil seal - outboard (option)
4131	Follower flange
2540	Deflector
2400	Shaft sleeve
2923	Pin
3855	Oiler
3856	Sight glass or plug
6521	Plug - housing, fill/vent

6570.1	Screw
6570.2	Screw
6570.3	Screw
6570.10	Screw - adapter/housing
6572.1	Stud
6572.2	Stud
6570.4	Jackscrew
6569.1	Magnetic plug
6570.11	Screw
6580.1	Nut
6580.2	Nut
3712	Bearing locknut
6541	Lock washer
6700	Key

8.3 Chemstar repeller pump – Group B and C – large bore repeller cover – bolt-on stuffing box

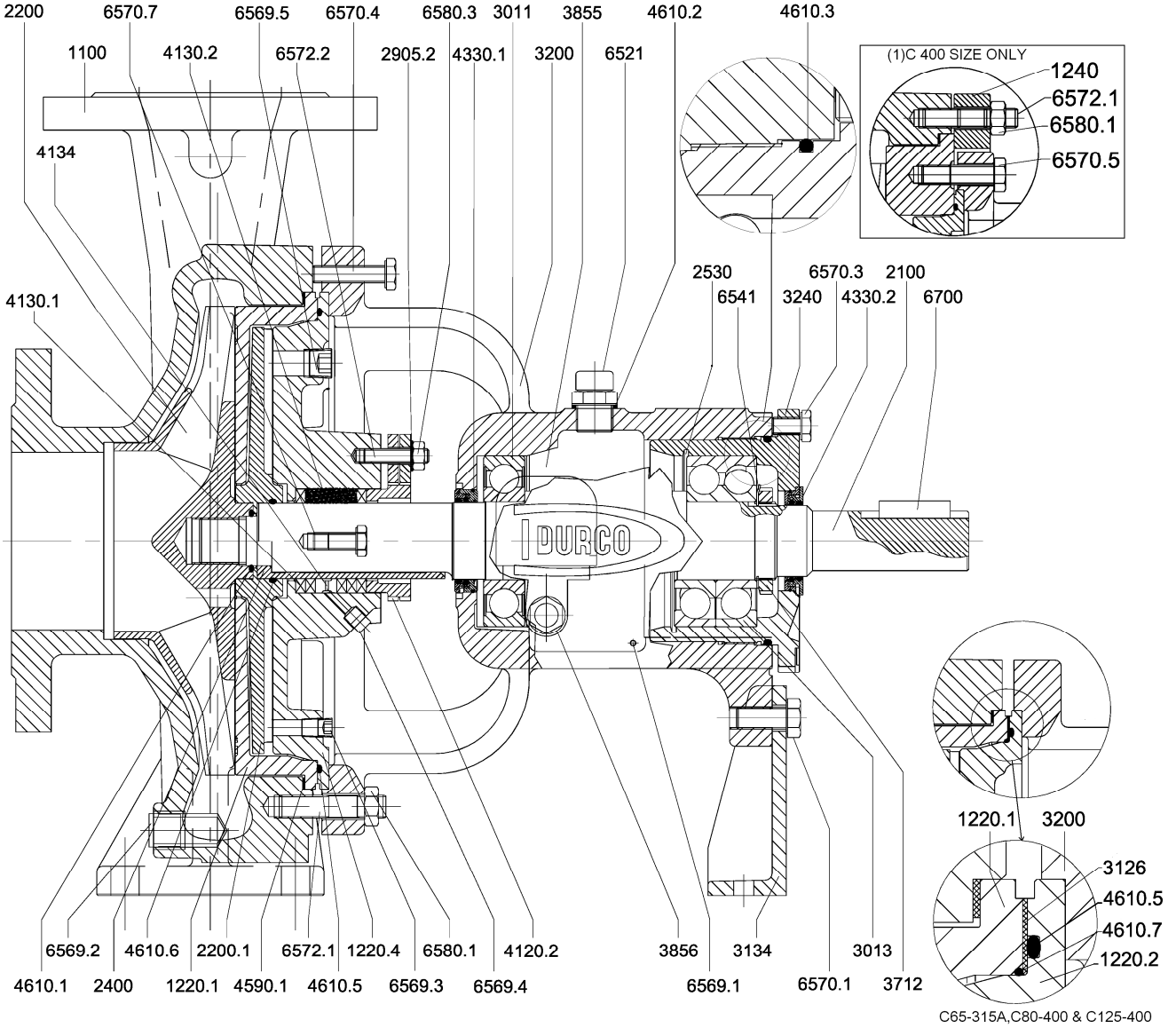


Part no.	Description
1100	Casing
1220.1	Cover
1220.2	Cover - repeller
1220.3	Stuffing box
1240	Ring - clamp C400
2100	Shaft
2200	Impeller
2200.1	Repeller
2400	Shaft sleeve
2530	Snap ring
2905.1	Washer - stuffing box
2905.2	Washer - gland follower
3011	Bearing - inboard
3013	Bearing - outboard
3013	Bearing - paired duplex outboard
3126	Ring spacer
3134	Foot
3200	Bearing housing

3240	Bearing carrier
3712	Bearing locknut
3855	Oiler
3856	Sight glass
4120.2	Gland follower halves
4130.1	Packing ring
4130.2	Packing - injectable
4134	Lantern ring
4330.1	Bearing isolator - inboard
4330.2	Bearing isolator - outboard
4590.1	Gasket - rear cover
4590.2	Gasket - stuffing box
4610.1	Gasket - impeller
4610.2	O-ring - filler and vent
4610.3	O-ring - carrier
4610.5	Gasket - repeller cover
4610.6	O-ring - repeller
4610.7	Gasket - ring spacer
6521	Plug - housing, fill/vent

6541	Lock washer
6569.1	Plug - drain, magnetic
6569.2	Plug - casing drain
6569.3	Plug - repeller cover
6569.4	Plug - stuffing box
6569.5	Plug - drain, repeller cover
6570.1	Screw - foot, bearing housing
6570.3	Screw – set, bearing carrier
6570.4	Jackscrew
6570.5	Screw - C400 rear cover
6570.6	Screw - stuffing box/repeller cover
6570.7	Screw - repeller cover
6572.1	Stud - casing
6572.2	Stud - gland
6580.1	Nut
6580.3	Nut - gland
6700	Key - shaft/coupling

8.4 Chemstar repeller pump – Group B and C – small bore repeller cover – integral stuffing box

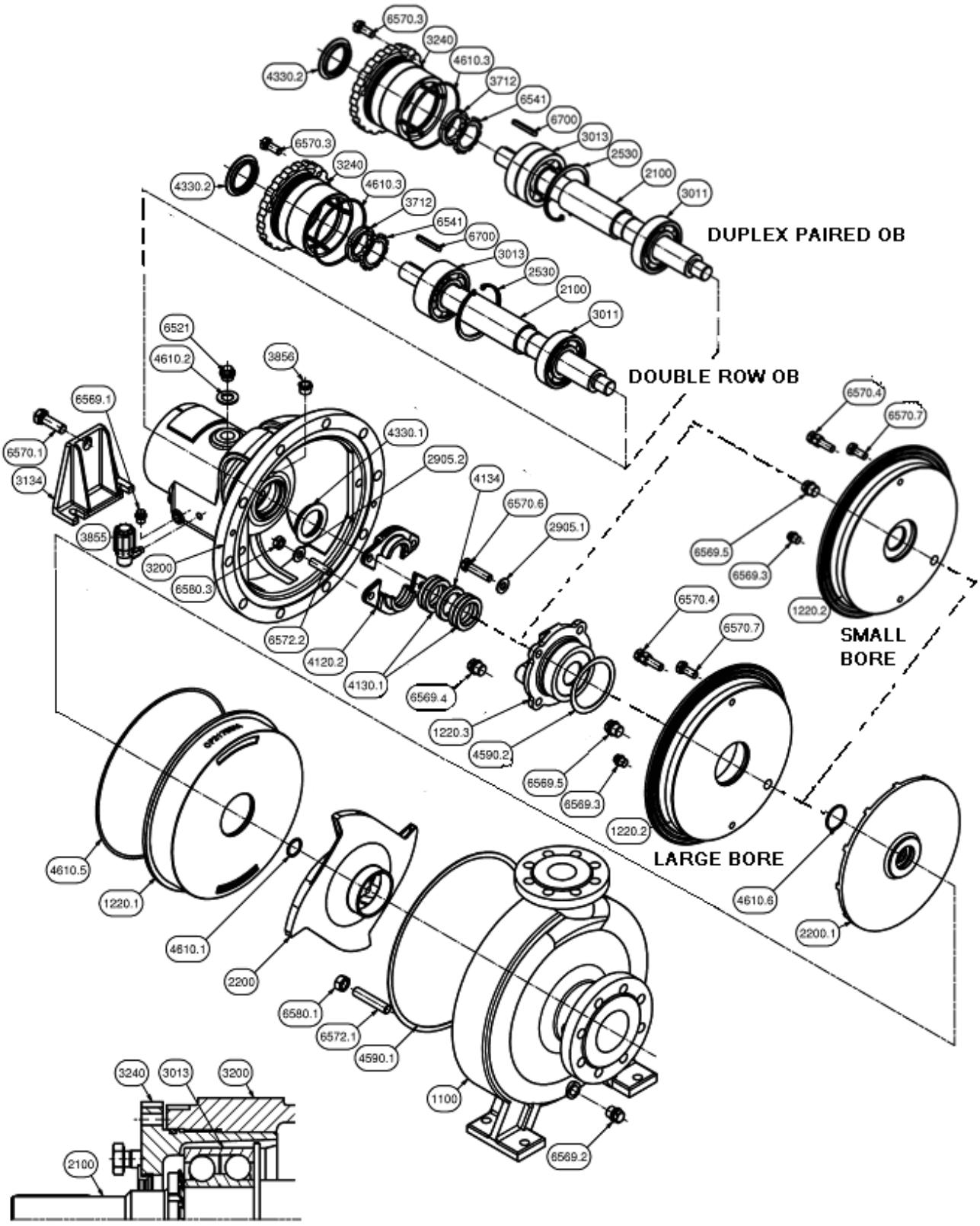


Part no.	Description
1100	Casing
1220.1	Cover
1220.4	Cover - repeller, small bore
1240	Ring clamp C400
2100	Shaft
2200	Impeller
2200.1	Repeller
2400	Shaft sleeve
2530	Snap ring
2905.2	Washer - gland follower
3011	Bearing - inboard
3013	Bearing - outboard
3013	Bearing - paired duplex outboard
3126	Ring spacer
3134	Foot
3200	Bearing housing
3240	Bearing carrier

3712	Bearing locknut
3855	Oiler
3856	Sight glass
4120.2	Gland follower halves
4130.1	Packing ring
4130.2	Packing - injectable
4134	Lantern ring
4330.1	Bearing isolater - inboard
4330.2	Bearing isolater - outbaord
4590.1	Gasket - rear cover
4590.2	Gasket - stuffing box
4610.1	Gasket - impeller
4610.2	O-ring – filler/vent
4610.3	O-ring - carrier
4610.5	Gasket - repeller cover
4610.6	O-ring - repeller
4610.7	Gasket ring spacer
6521	Plug - housing, fill/vent

6541	Lock washer
6569.1	Plug - drain, magnetic
6569.2	Plug - casing drain
6569.3	Plug - repeller cover
6569.4	Plug - stuffing box
6569.5	Plug - drain, repeller cover
6570.1	Screw - foot, bearing housing
6570.3	Screw - set, bearing carrier
6570.4	Jackscrew
6570.5	Screw - C400 rear cover
6570.7	Screw - repeller cover
6572.1	Stud - casing
6572.2	Stud - gland
6580.1	Nut
6580.3	Nut - gland
6700	Key - shaft/coupling

8.5 Chemstar repeller pump – Group B and C with bolt-on stuffing box – exploded view



8.6 General arrangement drawing

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

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 Instruction manuals

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

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

10.2 Change notes

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

10.3 Additional sources of information

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

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

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

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

Reference 5:
ANSI B31.3 - Process Piping.

Notes:

Notes:

Notes:

Your Flowserve factory contact:

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

Your local Flowserve representative:

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

FLOWSERVE REGIONAL SALES OFFICES:

USA and Canada
Flowserve Corporation
5215 North O'Connor Blvd.,
Suite 2300
Irving, Texas 75039-5421, USA
Telephone +1 972 443 6500
Fax +1 972 443 6800

Europe, Middle East, Africa
Worthing S.P.A.
Flowserve Corporation
Via Rossini 90/92
20033 Desio (Milan), Italy
Telephone +39 0362 6121
Fax +39 0362 303 396

Latin America and Caribbean
Flowserve Corporation
6840 Wynnwood Lane
Houston, Texas 77008, USA
Telephone +1 713 803 4434
Fax +1 713 803 4497

Asia Pacific
Flowserve Pte. Ltd
10 Tuas Loop
Singapore 637345
Telephone +65 6771 0600
Fax +65 6779 4607