FLOWSERVE®

Pump Division

D-814, D-824 Centrifugal Pumps

USER INSTRUCTIONS:
INSTALLATION, OPERATION, MAINTENANCE

PCN=75373613 – 05/04

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

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

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

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

1.2 CE marking and approvals

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

Where applicable, the Directives and any additional Approvals, cover important safety aspects relating to machinery and equipment and the satisfactory provision of technical documents and safety instructions. Where applicable this document incorporates information relevant to these Directives 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 Pump Division 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 organizations. Genuine parts and accessories have been designed, tested and incorporated into the products to help ensure 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 authorized Flowserve parts and accessories is considered to be misuse. Damage or failure caused by misuse is not covered by Flowserve's warranty. In addition, any modification of Flowserve products or removal of original components may impair the safety of these products in their use.

1.4 Copyright

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

1.5 Duty conditions

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

The product must not be operated beyond the parameters specified for the application. If there is any doubt as to the suitability of the product for the application intended, contact Flowserve for advice, quoting the serial number.
If the conditions of service on your purchase order are going to be changed (for example liquid pumped, temperature or duty) it is requested that the user seeks Flowserve's written agreement before start up.

1.6 Safety

1.6.1 Summary of safety markings

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

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

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

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

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

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

1.6.2 Personnel qualification and training

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

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

1.6.3 Safety action

This is a summary of conditions and actions to prevent injury to personnel and damage to the environment and to equipment.

DANGER NEVER DO MAINTENANCE WORK WHEN THE UNIT IS CONNECTED TO POWER (Lock Out)

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

FLUOROELASTOMERS (When fitted.)
When a pump has experienced temperatures over 250 ºC (482 ºF), partial decomposition of fluoroelastomers (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.

NEVER OPERATE THE PUMP WITHOUT THE COUPLING GUARD AND ALL OTHER SAFETY DEVICES CORRECTLY INSTALLED

GUARDS MUST NOT BE REMOVED WHILE THE PUMP IS OPERATIONAL

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

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

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

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

 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.

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

 NEVER EXCEED THE MAXIMUM DESIGN PRESSURE (MDP) AT THE TEMPERATURE SHOWN IN 3.4.4
See section 3 for pressure versus temperature ratings based on the material of construction.

 NEVER OPERATE THE PUMP WITH THE DISCHARGE VALVE CLOSED
(Unless otherwise instructed at a specific point in the user instructions.)
(See section 5, *Commissioning start-up, operation and shutdown*.)

 NEVER RUN THE PUMP DRY OR WITHOUT PROPER PRIME (Casing Flooded)

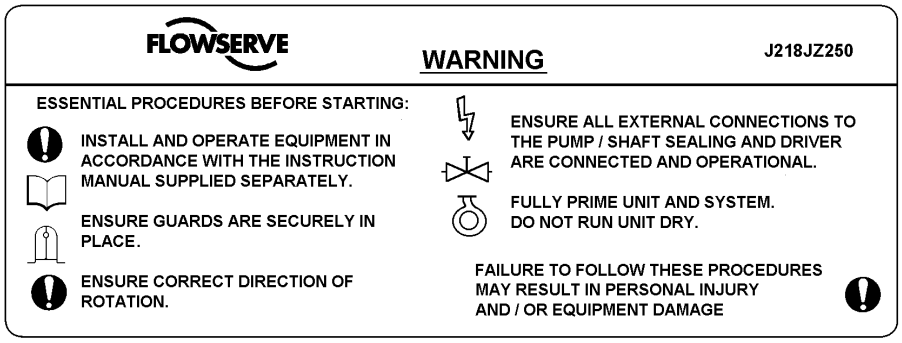
 NEVER OPERATE THE PUMP WITH THE SUCTION VALVE CLOSED
It should be fully opened when the pump is running.

 NEVER OPERATE THE PUMP AT ZERO FLOW OR FOR EXTENEDED PERIODS BELOW THE MINIMUM CONTINUOUS FLOW

 THE PUMP SHAFT MUST TURN CLOCKWISE WHEN VIEWED FROM THE MOTOR END
It is absolutely essential that the rotation of the motor be checked before starting the pump.

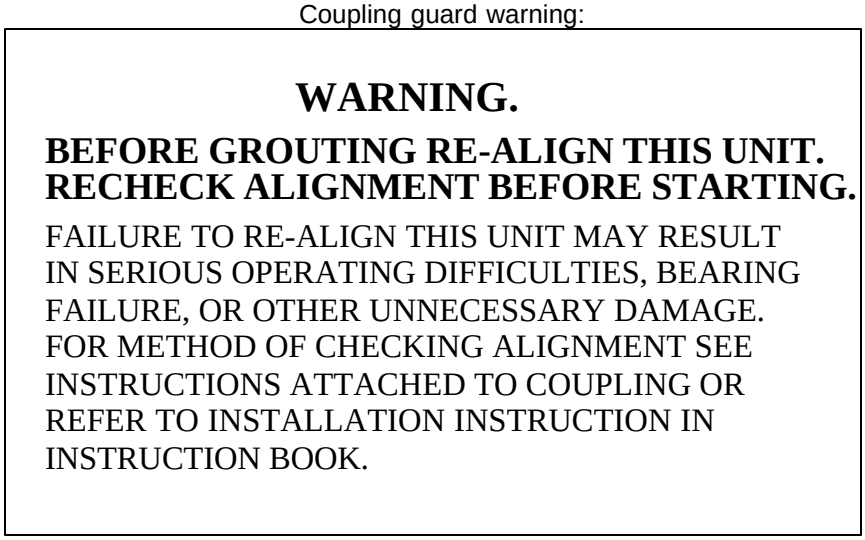
 HAZARDOUS LIQUIDS
When the pump is handling hazardous liquids care must be taken to avoid exposure to the liquid by appropriate pump placement, limiting personnel access and by operator training. If the liquid is flammable and/or explosive, strict safety procedures must be applied.

1.7 Warning labels



Alignment warning:

Coupling guard warning:



1.8 Noise level

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

Pump noise level is dependent on a number of factors - the type of driver, the operating capacity, piping design and acoustic characteristics of the building.

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

1.8.1 D-814 bare pump noise level information

Below is a tabulation of sound pressure readings for frame mounted D-814 pumps for general information and not to be subject to guarantee by Flowserve. Tests were conducted in accordance with the Standards of the Hydraulic Institute, 13th Edition, 1975. Pumps were tested in a spacious room (simulating an open field) with driver covered by a sound absorbing enclosure and with system valves, venturi's, and tanks behind a sound absorbing wall. Decibel readings do not include driver or system noise. Pumps were tested through a normal operating range of about 75% to 125% of the best efficiency point at all impeller diameters.

Bare Pump Noise Level

Pump Size	dBA @3550 RPM	dBA @ 1770 RPM
2 1/2x2 1/2x4T	70	-
3x3x4F	70	-
2 1/2x1 1/2x5T	70	60
3x1 1/2x5F	70	60
3x2x5F	70	60
3x2x5T	70	60
4x3x5F	70	60
1 1/2x1x6T	70	60
1 1/2x1x6F	70	60
2x1x6T	70	60
2 1/2x1 1/2x6T	70	60
3x1 1/2x6F	70	60
3x2x6F	72	60
3x2x6T	72	60
4x3x6F	75	60
6x4x6F	80	62
1 1/2x1x8F	75	60
2x1x8T	75	60
2 1/2x1 1/2x8T	75	60
3x1 1/2x8F	75	60
3x2x8F	75	60
3x2x8T	75	60
4x3x8F	77	62
6x4x8F	79	64
2x1 1/2x9F	80	70
3x2x9F	80	70
4x3x9f	80	70
2x1x10F	77	67
3x1 1/2x10F	79	70
3x2x10F	80	70
4x3x10F	81	70
6x4x10F	-	70
6x4x11F	-	72
5x4x12F	-	75
6x5x12F	-	75
3x1 1/2x13F	-	70
3x2x13F	-	70
4x3x13F	-	72
6x4x13F	-	75
5x4x15F	-	80
6x4x15F	-	80

Note: 9-inch, 12-inch, and 15-inch pumps have not been tested. These figures should be used as estimates only.

2 TRANSPORT AND STORAGE

2.1 Consignment receipt and unpacking

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

Check all crates, boxes or wrappings for any accessories or spare parts that may be packed separately from 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 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 depending on their size and construction.

2.3 Lifting

CAUTION Pumps and motors often have integral lifting lugs or eye bolts. These are intended for use in only lifting the individual piece of equipment.

CAUTION Do not use eye bolts or cast-in lifting lugs to lift pump, motor and baseplate assemblies.

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

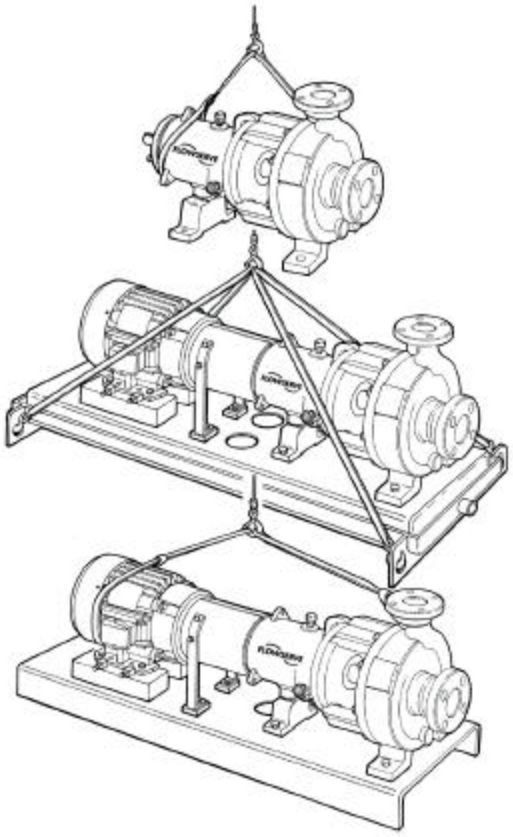
CAUTION Care must be taken to lift components or assemblies above the center of gravity to prevent the unit from flipping.

Lifting bare pump

Horizontal Pumps: Sling around the pump discharge nozzle and around the outboard end of the bearing housing with separate slings. Choker hitches must be used at both attachment points and pulled tight. Make sure the completion of the choker hitch on the discharge nozzle is toward the coupling end of the pump shaft as shown in Figure 2-1. The sling lengths should be adjusted to balance the load before attaching the lifting hook.

⚠ 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.

FIGURE 2-1



Lifting pump, motor and baseplate assembly

Horizontal: If the baseplate has lifting holes cut in the sides at the end, insert lifting S hooks at the four corners and use slings or chains to connect to the lifting eye as shown in Figure 2-1. Do not use slings through the lifting holes.

For other baseplates, sling around the pump discharge nozzle, and around the outboard end of the motor frame using choker hitches pulled tight (Figure 2-1).

The sling should be positioned so the weight is not carried through the motor fan housing. Make sure the completion of the choker hitch on the discharge nozzle is toward the coupling end of the pump shaft as shown in Figure 2-1.

2.4 Storage

CAUTION Store the pump in a clean, dry location away from vibration. Leave flange covers in place to keep dirt and other foreign material out of pump casing. Turn the pump shaft at regular intervals to prevent brinelling of the bearings and the seal faces, 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.

Short term storage

Normal packaging is designed to protect the pump and parts during shipment and for dry, indoor storage for up to six months or less.

Normal packaging:

a) All loose unmounted items are packaged in a water proof plastic bag and placed under the coupling guard. Larger items are boxed and banded to the baseplate. For pumps not mounted on a baseplate, the bag and/or box is placed inside the shipping container.
b) Flange covers are secured to both the suction and discharge flanges.
c) Assemblies ordered with external piping, in some cases components may be disassembled for shipment.

2.5 Recycling and end of product life

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

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

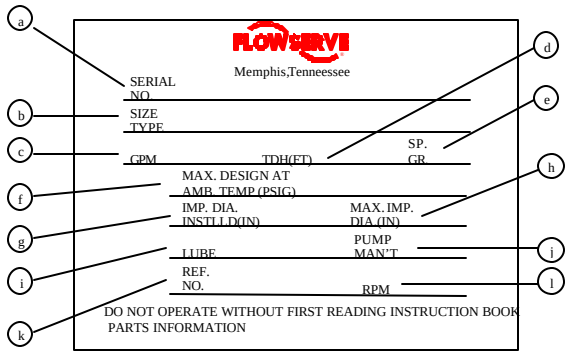
3 DESCRIPTION

3.1 Configurations

The D-814 Pump is a frame mounted volute type centrifugal pump designed to be coupled to a separate driver such as an induction motor. The D-824 Monobloc is the same type of pump but close coupled to a NEMA-Hydraulic Institute Standard Type JM Pump Motor. The shaft extension and mounting flange of the D-814 frame are identical to those of the same size JM motor shaft extension and mounting flange. The type of pump is of a standardized design with a minimum number of optional components. Design features are hydraulically balanced closed impeller and single mechanical seal. The D-814 utilizes standard sealed for life bearings. Available materials of construction are shown in section 3.4.5.

3.2 Nomenclature

FIGURE3-1 Nameplate



Details of nameplate

a) "SERIAL NO." This number corresponds to records that will enable your Flowserve Pump Division representative to determine the component parts of your pump so exact duplicate parts or specific technical assistance can be provided.
b) "SIZE TYPE" Suction pipe size X discharge pipe size X impeller. (not exact imp. dia.)
c) "GPM" Gallons per minute.*
d) "TDH(FT)" Total Head (FT).*
e) "SP. GR." Specific gravity of liquid being pumped.*
f) "MAX DESIGN AT AMB. TEMP (PSIG)" Maximum allowable design pressure.
g) "IMP. DIA INSTLLD(IN)" Diameter in inches, of installed impeller.
h) "MAX. IMP. DIA(IN)" Maximum available impeller diameter in inches.
i) "LUBE" Not applicable- sealed for life bearings.
j) "PUMP MAT'L" Major construction materials of the pump.
k) "REF. NO." Customer reference/item number.
l) "RPM" Motor RPM data.*

Note: *Only used if specified on factory job bill of material.

3.3 Design of major parts

3.3.1 Pump casing

Removal of the casing is not required when performing maintenance of the rotating assembly. The pump is designed with a gasket perpendicular to the shaft allowing the rotating assembly to be easily removed (back pull out).

3.3.2 Impeller

The impeller is the closed type.

3.3.3 Shaft / Sleeve

Sleeved shafts are supported on bearings, with keyed impeller and shaft coupling.

3.3.4 Pump bearing lubrication

Permanently lubricated ball bearings are fitted as standard.

3.3.5 Cover

The cover has a spigot (rabbet) fit between the pump casing and bearing housing (cover) for optimum concentricity.

3.3.6 Shaft seal

The mechanical seal, attached to the pump shaft, seals the pumped liquid from the environment.

3.3.7 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.

3.3.8 Accessories

Accessories may be fitted when specified by the customer.

3.4 Performance and operation limits

The following data is included as additional information to help with installation. Factors such as liquid being pumped, temperature, material of construction, and seal type may influence this data.

3.4.1 D-800 design information

Pump Size	Suction Size (in.)	Discharge Size (in.)	Maximum Working Pressure (psig)	Hydrotest Pressure (psig)	Minimum Casing Thickness (in.)	Casing / Impeller Hub Clearance (in.)
2 1/2x2 1/2x4T	2 1/2	2 1/2	175	265	0.25	0.012-0.017
3x3x4F	3	3	175	265	0.25	0.018-0.022
2 1/2x1 1/2x5T	2 1/2	1 1/2	175	265	0.25	0.012-0.017
3x1 1/2x5F	3	1 1/2	175	265	0.25	0.018-0.024
3x2x5F	3	2	175	265	0.25	0.012-0.017
3x2x5T	3	2	175	265	0.25	0.012-0.017
4x3x5F	4	3	175	265	0.30	0.021-0.025
1 1/2x1x6T	1	1	175	265	0.30	0.010-0.015
1 1/2x1x6F	1	1	175	265	0.30	0.018-0.024
2x1x6T	2	1	175	265	0.30	0.010-0.015
2 1/2x1 1/2x6T	2 1/2	1 1/2	175	265	0.30	0.012-0.017
3x1 1/2x6F	3	1 1/2	175	265	0.30	0.018-0.024
3x2x6F	3	2	175	265	0.30	0.018-0.024
3x2x6T	3	2	175	265	0.30	0.012-0.017
4x3x6F	4	3	175	265	0.35	0.021-0.027
6x4x6F	6	4	175	265	0.35	0.021-0.027
1 1/2x1x8F	1 1/2	1	175	265	0.28	0.018-0.024
2x1x8T	2	1	175	265	0.30	0.010-0.015
2 1/2x 1 1/2x8T	2 1/2	1 1/2	175	265	0.30	0.012-0.017
3x1 1/2x8F	3	1 1/2	175	265	0.30	0.018-0.024
3x2x8F	3	2	175	265	0.30	0.018-0.024
3x2x8T	3	2	175	265	0.30	0.012-0.017
4x3x8F	4	3	175	265	0.35	0.021-0.027
6x4x8F	6	4	175	265	0.38	0.021-0.027
2 1/2x1 1/2x9F	2	1 1/2	200	300	0.44	0.010-0.017
3x2x9F	3	2	200	300	0.44	0.010-0.017
4x3x9F	4	3	200	300	0.47	0.010-0.017
2x1x10F	2	1	220	330	0.35	0.012-0.017
3x1 1/2x10F	3	1 1/2	220	330	0.35	0.012-0.017
3x2x10F	3	2	220	330	0.35	0.010-0.017
4x3x10F	4	3	220	330	0.35	0.021-0.027
6x4x10F	6	4	175	265	0.47	0.021-0.027
6x4x11F	6	4	175	265	0.51	0.021-0.027
5x4x12F	5	4	125	185	0.50	0.010-0.017
6x5x12F	6	5	125	185	0.53	0.010-0.017
3x1 1/2x13F	3	1 1/2	175	265	0.55	0.018-0.024
3x2x13F	3	2	175	265	0.55	0.018-0.024
4x3x13F	4	3	175	265	0.55	0.021-0.027
6x4x13F	6	4	175	265	0.51	0.028-0.032
5x4x15F	5	4	150	225	0.56	0.010-0.017
6x5x15F	6	5	150	225	0.63	0.010-0.017

3.4.2 Temperature limitations

The maximum temperature of the liquid that can be pumped by a D-800 is dependent on the conduction of the heat along the pump / motor shaft to the bearings, design, and materials of the mechanical seal on the pump, and the characteristics of the fluid being pumped as it relates to the materials of construction.

Temperature Limitations

Pump Type	Pump Fittings	Temperature Limit - °F	
		Maximum	Minimum
D814 Frame Mounted	All	225	-20
D824 Close Coupled	All	250	-20

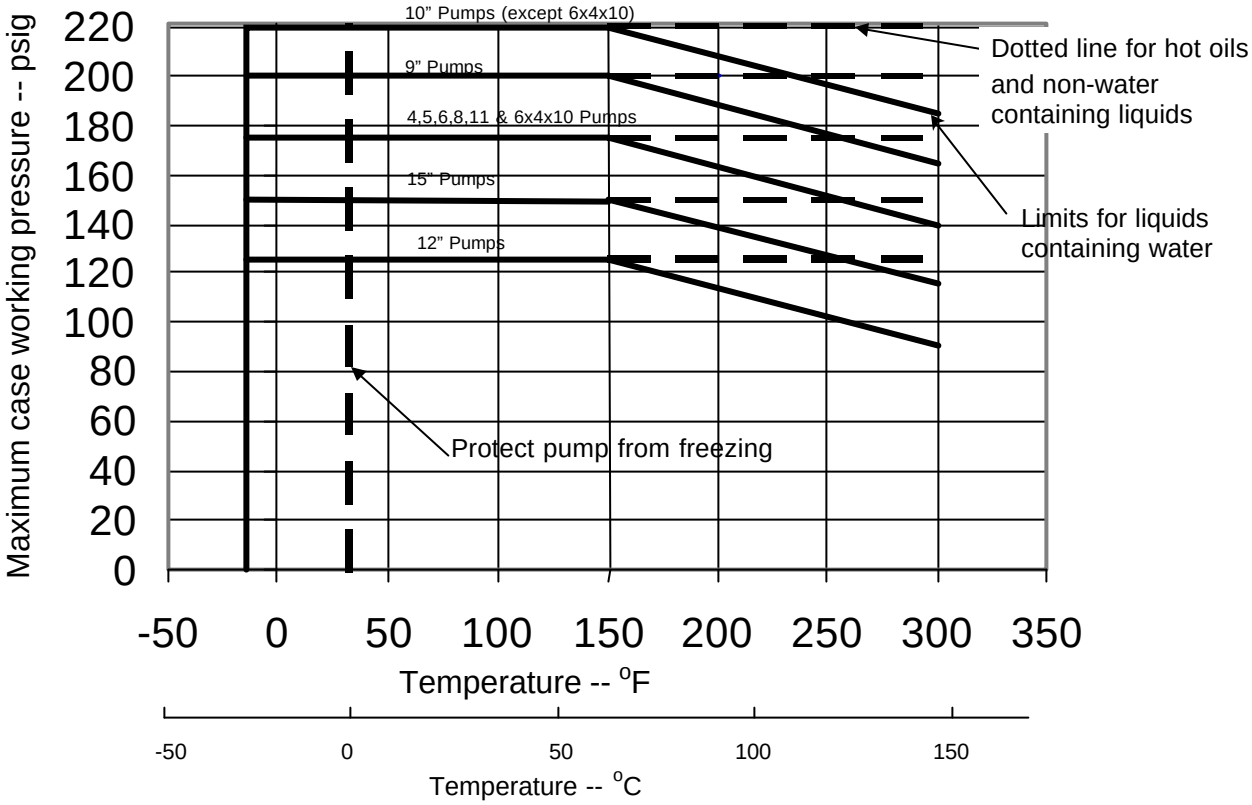
3.4.3 Maximum suction pressure limitations

Maximum Suction Pressure – 75 psig

CAUTION The sum of suction pressure and maximum head developed by the pump at shutoff should remain below the maximum allowable working pressure of the pump at rated temperature. Refer to section 3.4.4, *Maximum working pressure limitations,* for maximum allowable working pressure.

3.4.4 Maximum working pressure limitations

The maximum working pressure of a pump is determined by the physical strength of the casing and cover materials, material thickness, bolting and gaskets. The D-800 iron casing material is the primary factor limiting working pressure. Working pressure also varies with pumping temperature. The chart below indicates this variation.



Note: Final selection must be made based on mechanical seal limits given in General Data Section.

3.4.5 Standard materials of construction

Part	Standard Fitted		All Iron Fitted		316 Stainless Steel	
	D-814	D-824	D-814	D-824	D-814	D-824
Casing	ASTM A278 Class 25 Cast Iron[1]				ASTM A351 SS Grade CF8M Cast SS	
Casing Wear Ring	Bronze (optional)[2]		Steel (bar) (optional)[3]		------	
Casing Gasket	Syntheic Fibers with Nitrile Binder					
Impeller	C90300, C90500, C90700 Bronze			Cast Iron 25		ASTM A351 SS Grade CF8M Cast SS
Cover	ASTM A278 Class 25 Cast Iron					ASTM A351 SS Grade CF8M Cast SS
Cover Ring	Bronze			Cast Iron		316 SS
Sleeve	Bronze			416 SS		
Bolts	Carbon Steel					
Shaft	Carbon Steel					
Key	Carbon Steel					
Impeller Washer	316 SS					
Impeller Washer Gasket	Syntheic Fibers with Nitrile Binder					
Impeller Screw	304 SS					
Pump Bracket[4]	Ductile Iron	N/A	Ductile Iron	N/A	Ductile Iron	N/A
Bearing Frame	Cast Iron	N/A	Cast Iron	N/A	Cast Iron	N/A
Support Foot	Steel	N/A	Steel	N/A	Steel	N/A
Mechanical Seal (Type 21)	Faces: Carbon vs. Ceramic Buna-N Bellows 18-8SS Metal Parts					
Inducer (optional)	316 SS					

Note: Footnotes apply to these sizes only: 2 1/2x1 1/2x9, 3x2x9, 5x4x12, 6x5x12, 5x4x15, 6x5x15.

[1] Casing Iron – 30.

[2] Bronze wear ring supplied as standard.

[3] Iron wear ring supplied as standard.

[4] Casing foot is an integral part of casing.

4 INSTALLATION

4.1 Cleaning prior to installation

Clean suction and discharge flange surfaces or pipe connections. If any debris has entered the motor through fan or cooling openings, remove it.

4.2 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 practical to the supply of liquid to be pumped.

4.3 Part assemblies

The supply of motors and baseplates are optional. As a result, it is the responsibility of the installer to ensure that the motor is assembled to the pump and aligned as detailed in section 4.6 and 4.9.

4.4 Foundation

4.4.1 Rigid baseplates - overview

The function of a baseplate is to provide a rigid foundation under a pump and its driver that maintains alignment between the two.

Baseplates intended for grouted installation are designed to use the grout as a stiffening member.

Regardless of the type of baseplate used, it must provide three functions to ensure a reliable installation.

a) The baseplate must provide sufficient rigidity to assure the assembly can be transported and installed, given reasonable care in handling, without damage. It must also be rigid enough when properly installed to resist operating loads.
b) The baseplate must provide a reasonably flat mounting surface for the pump and driver. Uneven surfaces will result in a soft-foot condition that may make alignment difficult or impossible. Flowserve's experience indicates that a baseplate that has a top surface flatness of ±1.6 mm ($\pm^{1}/_{16}$ in.) across the diagonal corners of the baseplate provides such a mounting surface. Therefore, this is the tolerance to which we supply our standard baseplate.
c) The baseplate must be designed to allow the user to final field align the pump and driver to within their own particular standards and to compensate for any pump or driver movement that occurred during handling. Normal industry practice is to achieve final alignment by moving the motor to match the pump. Flowserve's practice is to confirm in our shop that the pump assembly can be accurately aligned. Before shipment, the factory verifies that there is enough horizontal movement capability at the motor to obtain a "perfect" final alignment when the installer puts the baseplate assembly into its original, top leveled, unstressed condition.

4.4.2 Foundation D-814

Flowserve recommends mounting D-814 pumps on permanent foundations to prevent excessive strains from piping connections and coupling misalignment. Figure 4-1 shows a typical installation.

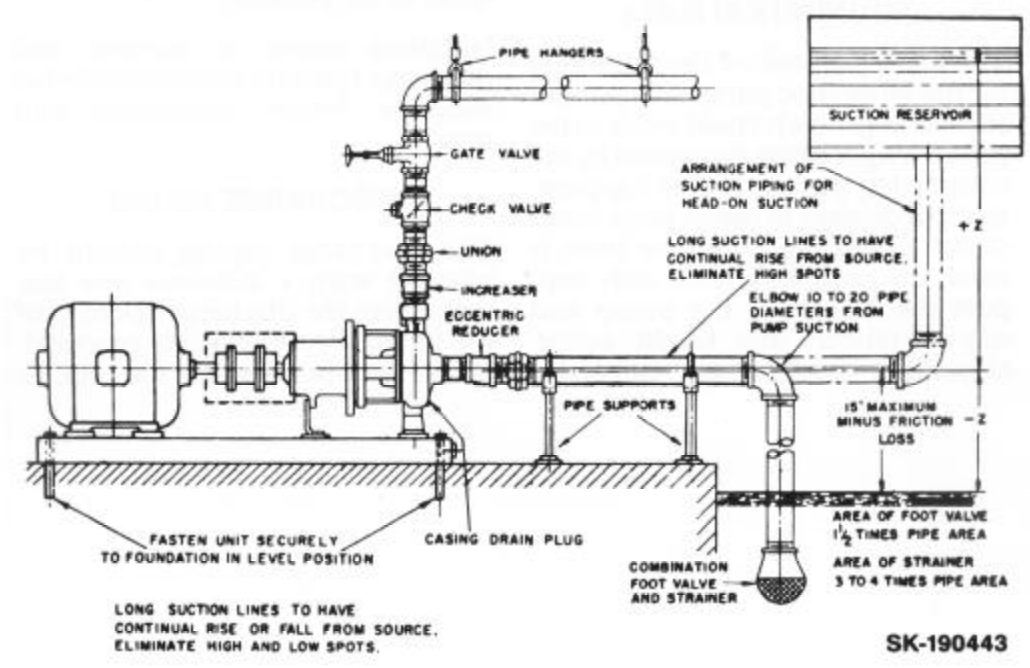
Ideally pumps should be installed in a horozontal position using steel baseplates on a permanent masonry or structural steel foundation of sufficient mass to absorb all normal vibrations. Foundation bolts should be located or embedded in the concrete by layout or template in relation to the suction and discharge piping. If concrete is used, foundation bolts of the specified size may be enclosed in a pipe sleeve two or three diameters larger than the bolts to compensate for minor vibration in lineup.

Channel steel bases are bolted in place. Drain rim steel bases may be grouted if desired.
Accessory steel baseplates furnished with these pumps and motors 10 hp and under may be bolted to machine or equipment structures, either rigidly or, if flexible piping is used, with properly designed vibration isolators.

Small units (10 hp and under) may be operated in tempory installations without permanent foundation attachments if mounted on standard channel steel or drain rim steel baseplates under the following conditions.

a) Use flexible piping connections such as hose which will not impose heavy pipe strains on pump casing but will not rupture or leak if unit shifts slightly due to vibration or external forces.
b) Connect motor with safe durable electrical connections which will not be affected by slight shifting of the unit.
c) Conditions of coupling misalignment may shorten life of motor and pump bearings.

FIGURE 4-1 Typical Installation



4.4.3 Foundation D-824

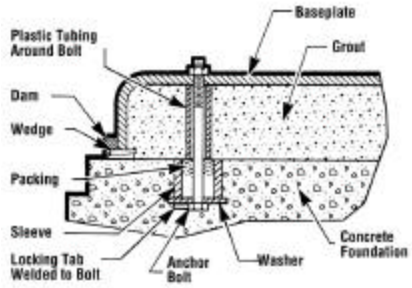
The main purpose of the mounting for the Monobloc pump is to prevent any shifting which could result in the pump weight being supported by the connection piping. If this happens, internal damage to pump parts could occur. If flexible piping or hose is used, the mounting need only support the weight of the pump and any vibrations that might occur. Monobloc pumps are normally mounted horizontally. However, they may be mounted vertically or in other positions. If the liquid end is above motor, any leakage from the pump may enter and damage the motor bearings. Monobloc pumps should be fastened to their foundations by using four of the mounting bolt holes in the motor feet. Do not depend upon piping to hold the pump in place even with the smallest units. Bolt pumps above 15 hp to masonry or structural steel foundations. Smaller units may be bolted to machine or equipment structures either rigidly or, flexible piping is used, with properly designed vibration isolators. Units with large casings and small motors require a builtup mounting under the motor feet. On some large units, an auxiliary foot is provided under the casing. The feet must match mounting surfaces exactly or it will be necessary to shim. Tighten the motor mounting bolts after the piping connections are securely attached to the pump.

4.5 Grouting

Note: This section applies only to drip rim of formed steel baseplates with grout holes.

a) The pump foundation should be located as close to the source of the fluid to be pumped as practical. There should be adequate space for workers to install, operate and maintain the pump. The foundation should be sufficient to absorb any vibration and should provide a rigid support for the pump and motor. Recommended mass of a concrete foundation should be three times that of the pump, motor and base. Refer to Figure 4-2. Note that foundation bolts are imbedded in the concrete inside a sleeve to allow some movement of the bolt.

FIGURE 4-2



b) Level the pump baseplate assembly. If the baseplate has machined coplanar mounting surfaces, these machined surfaces are to be referenced when leveling the baseplate. This may require that the pump and motor be removed from the baseplate in order to reference the machined faces. If the baseplate is without machined coplanar mounting surfaces, the pump and motor are to be left on the baseplate. The proper surfaces to reference when leveling the pump baseplate assembly are the pump suction and discharge flanges. DO NOT stress the baseplate. Do not bolt the suction or discharge flanges of the pump to the piping until the baseplate foundation is completely installed. If equipped, use leveling jackscrews to level the baseplate. If jackscrews are not provided, shims or wedges should be used (see Figure 4-2). Check for levelness in both the longitudinal and lateral directions. Shims should be placed at all base anchor bolt locations, and in the middle edge of the base if the base is more than 1.5 m (5 ft) long. Do not rely on the bottom of the baseplate to be flat. Standard baseplate bottoms are not machined, and it is not likely that the field mounting surface is flat.

c) After leveling the baseplate, tighten the anchor bolts. If shims were used, make sure that the baseplate was shimmed near each anchor bolt before tightening. Failure to do this may result in a twist of the baseplate, which could make it impossible to obtain final alignment. Check the level of the baseplate to make sure that tightening the anchor bolts did not disturb the level of the baseplate. If the anchor bolts did change the level, adjust the jackscrews or shims as needed to level the baseplate. Continue adjusting the jackscrews or shims and tightening the anchor bolts until the baseplate is level.

d) Check initial alignment. Pumps are given a preliminary alignment at the factory. This preliminary alignment is done in a way that ensures that, if the installer duplicates the factory conditions, there will be sufficient clearance between the motor hold down bolts and motor foot holes to move the motor into final alignment. If the pump and motor were properly reinstalled to the baseplate or if they were not removed from the baseplate and there has been no transit damage, and also if the above steps where done properly, the pump and driver should be within 0.38 mm (0.015 in.) FIM (Full Indicator Movement) parallel, and 0.0025 mm/mm (0.0025 in./in.) FIM angular. If this is not the case, first check to see if the driver mounting fasteners are centered in the driver feet holes. If not, re-center the fasteners and perform a preliminary alignment to the above tolerances by shimming under the motor for vertical alignment, and by moving the motor for horizontal alignment.

e) Grout the baseplate. A non-shrinking grout should be used. Make sure that the grout fills the area under the baseplate. After the grout has cured, check for voids and repair them. Jackscrews, shims and wedges should be removed from under the baseplate at this time. If they were to be left in place, they could rust, swell, and cause distortion in the baseplate.

f) Run piping to the suction and discharge of the pump. There should be no piping loads transmitted to the pump after connection is made. Recheck the alignment to verify that there are no significant loads.

4.6 Initial alignment

Mounting and alignment

Pumps operate most reliably when carefully aligned on permanent rigid foundations. Strains which will cause wear of internal parts of the pump and excessive noise and vibration are eliminated this way.

Pump-driver combinations are aligned at the factory but must be rechecked for coupling alignment because they may be sprung in shipment or distorted by tightening of foundation bolts.

The best procedure to follow is to remove the coupling guard and check coupling alignment before tightening any foundation bolts.

If the pump is mounted on a permanent foundation, tighten the bolts now and recheck coupling alignment. Also turn the shaft by hand to assure that it turns freely.

If unit is to be grouted do it now. After the grout has been poured and allowed to set for 48 hours tighten foundation bolts evenly and securely. Recheck coupling alignment. Replace coupling guard.

Pumps on hot survice should have final coupling alignment made with the unit at its operating temperature.

4.6.1 Factory alignment procedure.
The purpose of factory alignment is to ensure that the user will have full utilization of the clearance in the motor holes for final job-site alignment. To achieve this, the factory alignment procedure specifies that the pump be aligned in the horizontal plane to the motor, with the motor foot bolts centered in the motor holes. This procedure ensures that there is sufficient clearance in the motor holes for the customer to field align the motor to the pump, to zero tolerance. This philosophy requires that the customer be able to place the base in the same condition as the factory. Thus the factory alignment will be done with the base sitting in an unrestrained condition on a flat and level surface. This standard also emphasizes the need to ensure the shaft spacing is adequate to accept the specified coupling spacer.

The factory alignment procedure is summarized below:

a) The baseplate is placed on a flat and level workbench in a free and unstressed position.
b) The baseplate is leveled as necessary. Leveling is accomplished by placing shims under the rails of the base at the appropriate anchor bolt hole locations. Levelness is checked in both the longitudinal and lateral directions.
c) The motor and appropriate motor mounting hardware is placed on the baseplate and the motor is checked for any planar soft-foot condition. If any is present it is eliminated by shimming
d) The motor feet holes are centered on the motor mounting fasteners.
e) The motor is fastened in place by tightening the nuts on two diagonal motor mounting studs.
f) The pump is put onto the baseplate and leveled. The foot piece under the bearing housing is adjustable. It is used to level the pump, if necessary.
g) The spacer coupling gap is verified.
h) The parallel and angular vertical alignment is made by shimming under the motor.
i) The motor feet holes are again centered on the motor mounting studs using the centering nut. At this point the centering nut is removed and replaced with a standard nut. This gives maximum potential mobility for the motor to be horizontally moved during final, field alignment. All four motor feet are tightened down.
j) The pump and motor shafts are then aligned horizontally, both parallel and angular, by moving the pump to the fixed motor. The pump feet are tightened down.
k) Both horizontal and vertical alignment is again final checked as is the coupling spacer gap.

See section 4.9 for Final shaft alignment

4.7 Piping

CAUTION The protective covers fitted to both the suction and discharge of the casing must be removed prior to connecting the pump to any pipes.

Isolation valves on suction and discharge lines are recommended to facilitate future inspection and repairs.

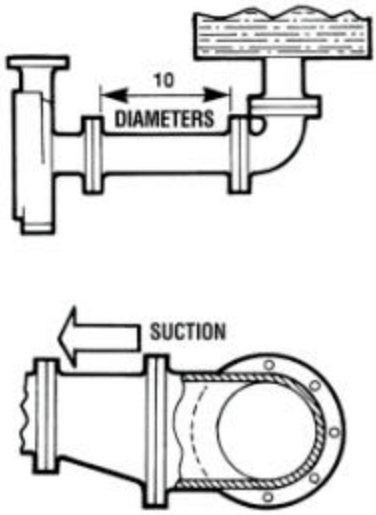
4.7.1 Suction and discharge piping
All piping must be independently supported, accurately aligned and preferably connected to the pump by a short length of flexible piping. The pump should not have to support the weight of the pipe or compensate for misalignment. It should be possible to install suction and discharge bolts through mating flanges without pulling or prying either of the flanges. All piping must be tight. Pumps may air-bind if air is allowed to leak into the piping. If the pump flange(s) have tapped holes, select flange fasteners with thread engagement at least equal to the fastener diameter but that do not bottom out in the tapped holes before the joint is tight.

4.7.2 Suction piping
To avoid NPSH and suction problems, suction piping must be at least as large as the pump suction connection. Never use pipe or fittings on the suction that are smaller in diameter than the pump suction size.

Figure 4-3 illustrates the ideal piping configuration with a minimum of 10 pipe diameters between the source and the pump suction. In most cases, horizontal reducers should be eccentric and mounted with the flat side up as shown in Figure 4-4 with a maximum of one pipe size reduction.

Never mount eccentric reducers with the flat side down. Horizontally mounted concentric reducers should not be used if there is any possibility of entrained air in the process fluid. Vertically mounted concentric reducers are acceptable. In applications where the fluid is completely deaerated and free of any vapor or suspended solids, concentric reducers are preferable to eccentric reducers

FIGURE 4-3 and FIGURE 4-4



Avoid the use of throttling valves and strainers in the suction line. Start up strainers must be removed shortly before start up. When the pump is installed below the source of supply, a valve should be installed in the suction line to isolate the pump and permit pump inspection and maintenance. Never place a valve directly on the suction nozzle of the pump.

Refer to the Centrifugal Pump Section of the Hydraulic Institute Standards for additional recommendations on suction piping.
Refer to section 3.4 for performance and operating limits.

4.7.3 Net positive suction head

The NPSH required varies with every size of pump and for any given pump is varies with the capacity. The NPSH required by your unit can be obtained from the performance curves available from your Flowserve Pump Division representative.

To determine the NPSH available in your system refer to Figure 4-1 and the following equation.

$$\text{Avaliable NPSH} = ? \; Z + \frac{(P-P_V)2.31}{\text{Sp. Gr.}} \; H_f\text{-}H_e$$

Where Z = Static head in feet
P = Pressure on surface of liquid in psia
P_V = Vapor pressure of liquid at pumping temperature in psia
H_f = Suction line friction losses in feet
H_e = Entrance Loss from tank to pipe in feet

Note: For boiling liquids P equals P_V and this item can be omitted from the equation.

If the available NPSH is not equal to or greater than that required by the pump, it must be increased. This is usually done by increasing the static head, Z.

4.7.4 Discharge piping

Install a valve in the discharge line. This valve is required for regulating flow and/or to isolate the pump for inspection and maintenance.

CAUTION When fluid velocity in the pipe is high, for example, 3 m/s (10 ft/sec) or higher, a rapidly closing discharge valve can cause a damaging pressure surge. A dampening arrangement should be provided in the piping.

4.7.5 Pump and shaft alignment check

After connecting the piping, rotate the pump drive shaft clockwise (view from motor end) by hand several complete revolutions to be sure there is no binding and that all parts are free. Recheck shaft alignment (see section 4.6). If piping caused unit to be out of alignment, correct piping to relieve strain on the pump.

4.7.6 Mechanical seal

It is Flowserve's standard practice to install the mechanical seal in the pump prior to shipment. Specific order requirements may specify that the seal be shipped separately, or none be supplied. It is the pump installer's responsibility to determine if a seal was installed. If a seal was supplied but not installed, the seal and installation instructions will be shipped with the pump.

CAUTION Failure to ensure that a seal is installed may result in serious leakage of the pumped fluid.

Seal and any seal support system (if used) must be installed and operated as specified by the seal manufacturer.

The cover may have ports that have been temporarily plugged at the factory to keep out foreign matter. It is the installer's responsibility to determine if these plugs should be removed and external piping connected.

4.8 Electrical connections

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

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

4.8.3 CAUTION See section 5.2, *Direction of rotation* before connecting the motor to the electrical supply.

4.9 Final shaft alignment check for horizontal pumps

a) Level baseplate if appropriate.
b) Mount and level pump if appropriate. Level the pump by putting a level on the discharge flange. If not level, adjust the pump bracket bearing frame as follows:
c) Check initial alignment. If pump and driver have been remounted or the specifications given below are not met, perform an initial alignment as described in Section 4.6. This ensures there will be sufficient clearance between the motor hold down bolts and motor foot holes to move the motor into final alignment. The pump and driver should be within 0.38 mm (0.015 in.) FIM (Full Indicator Movement) parallel, and 0.0025 mm/mm (0.0025 in./in.) FIM angular.
d) Run piping to the suction and discharge to the pump. There should be no piping loads transmitted to the pump after connection is made. Recheck the alignment to verify that there are no significant changes.
e) Perform final alignment. Check for soft-foot under the driver. An indicator placed on the coupling, reading in the vertical direction, should not indicate more than 0.05 mm (0.002 in.) movement when any driver fastener is loosened. Align the driver first in the vertical direction by shimming underneath its feet. When satisfactory alignment is obtained the number of shims in the pack should be minimized. It is recommended that no more than five shims be used under any foot. Final horizontal alignment is made by moving the driver. Maximum pump reliability is obtained by having near perfect alignment. Flowserve recommends no more than 0.05 mm (0.002 in.) parallel, and 0.0005 mm/mm (0.0005 in./in.) angular misalignment (see Section 6.8.7.2).
f) Operate the pump for at least an hour or until it reaches final operating temperature. Shut the pump down and recheck alignment while the pump is hot. Piping thermal expansion may change the alignment. Realign pump as necessary.

5 COMMISSIONING, STARTUP, OPERATION AND SHUTDOWN

5.1 Pre-commission procedure

Pre start-up checks
Prior to starting the pump preform the following checks. All checks are described in the Maintenance Section of this manual.

- ? Pump and motor properly secured to the baseplate
- ? All fasteners tightened to the correct torque
- ? Coupling guard in place and not rubbing
- ? Rotation check, see section 5.2
  This is absolutely essential
- ? Shaft seal properly installed (if field installed)
- ? Seal support system operational (if used)
- ? Pump instrumentation is operational (if used)
- ? Pump is primed
- ? Pump shaft rotates freely by hand

Preliminary to starting
Read this instruction book thoroughly before starting the unit. Make sure the following items are checked before starting:

- ? Alignment
- ? Lubricate the driver (if required)
- ? Check the direction of rotation of the driver
- ? Lubricate the coupling (if required)
- ? Fill the pump with liquid. If a priming device is used, turn it on before the pump is started

5.2 Direction of rotation

CAUTION

5.2.1 Rotation check
Check the rotation of the motor before connecting the shaft coupling. A direction arrow is cast on the casing. Make sure the motor rotates in the same direction.

CAUTION

5.2.2 Coupling installation
Remove all protective material from the coupling and shaft. Install the coupling as advised by the coupling manufacturer. Pumps are normally shipped without the spacer installed, but with the hubs installed.

CAUTION

5.3 Guarding

Power must never be applied to the driver with the coupling guard removed.

5.4 Priming and auxiliary supplies

The D-800 is a centrifugal pump and is unable to move liquid unless primed. A pump is said to be “primed” when the casing and the suction piping are completely filled with liquid. When a condition exists where the suction pressure may drop below the pump’s capability, a low-pressure control device should be added to shut the pump down when the pressure drops below a predetermined minimum.

Priming
Before starting any centrifugal pump it is absolutely necessary that both the casing and suction pipe be completely filled with liquid. This priming can be accomplished by any of the following methods.

a) When the liquid supply level is above the center line of the pump, it is primed by opening the suction and discharge valves. The inflowing liquid will displace the air and fill the suction line, pump casing, and discharge line up to the level of supply.
b) Where the pump is operating with suction lift and the suction line is equipped with a foot valve, the system is filled with liquid by filling through the discharge piping.
c) When the pumps operating on a suction lift where foot valves will not operate properly, a priming chamber may be used.
d) Instead of the preceding methods of filling the pump, one of a number of types of air removal apparatus may be used, depending upon the facilities available. This apparatus is required when the pump operates under a suction lift and there is no foot valve in the suction pipe. The connections are made in the top if the pipe at the pump suction opening. To prime, shut the discharge valve and do not start the driver until the pump and piping are full or water.

5.5 Starting the pump

5.5.1 Open the suction valve to full open position. Always leave the suction valve open while the pump is operating. Any throttling or adjusting of flow must be done through the discharge valve. Partially closing the suction valve can create serious NPSH and pump performance problems.

CAUTION Operating a pump with both the suction and discharge valves closed could cause an explosion.

5.5.2 Ensure the pump is primed. (See section 5.4)

5.5.3 Start the driver (typically, an electric motor).

5.5.4 Slowly open the discharge valve until the desired flow is reached.

CAUTION It is important that the discharge valve be opened within a short interval after starting the driver. Failure to do this could cause a dangerous build up of heat, and possibly an explosion.

Starting
The procedure for starting the unit will vary somewhat with each installation but the following steps will generally apply:

a) Make certain that suction and discharge valves are open.
b) Start the driver.
c) Check to see that the pump is delivering liquid.
d) When in service for about one half hour check for quiet operation and temperature of bearings. After the pump reaches operating temperature shut it down. Then check the alignment and check for binding.

5.6 Running or operation

5.6.1 Minimum continuous flow
Minimum continuous stable flow is the lowest flow at which the pump can operate. The size of the pump, the energy absorbed, and the liquid pumped are some of the considerations in determining the minimum continuous flow (MCF).
The minimum continuous flow (capacity) is established as a percentage of the *best efficiency point* (BEP).

5.6.2 Minimum thermal flow
Pumps also have a *minimum thermal flow*. This is defined as the minimum flow that will not cause an excessive temperature rise. Minimum thermal flow is application dependent.

CAUTION Do not operate the pump below minimum thermal flow, as this could cause an excessive temperature rise.

Avoid running a centrifugal pump at drastically reduced capacities or with discharge valve closed for extended periods of time. This can cause severe temperature rise and the liquid in the pump may reach its boiling point. If this occurs, the mechanical seal will be exposed to vapor, with no lubrication, and may score or seize to the stationary parts. Continued running under these conditions when the suction valve is also closed can create an explosive condition due to the confined vapor at high pressure and temperature.

Thermostats may be used to safeguard against over heating by shutting down the pump at a predetermined temperature.

Safeguards should also be taken against possible operation with a closed discharge valve, such as installing a bypass back to the suction source. The size of the bypass line and the required bypass flow rate is a function of the input horsepower and the allowable temperature rise.

5.6.3 Reduced head
Note that when discharge head drops, the pump's flow rate usually increases rapidly. Check motor for temperature rise as this may cause overload. If overloading occurs, throttle the discharge.

5.6.4 Surging condition
A rapidly closing discharge valve can cause a damaging pressure surge. A dampening arrangement should be provided in the piping.

5.6.5 Operation in sub-freezing conditions
When using the pump in sub-freezing conditions where the pump is periodically idle, the pump should be properly drained or protected with thermal devices which will keep the liquid in the pump from freezing.

5.7 Stopping and shutdown

The procedure for stopping may vary with each installation the following steps will generally apply

a) Close the discharge valve.
b) Shut down the driver.
c) Close the suction valve.

5.8 Hydraulic, mechanical and electrical duty

5.8.1 Net positive suction head (NPSH)

Net positive suction head - available ($NPSH_A$) is the measure of the energy in a liquid above the vapor pressure. It is used to determine the likelihood that a fluid will vaporize in the pump. It is critical because a centrifugal pump is designed to pump a liquid. Vaporization in a pump will result in damage to the pump, deterioration of the *Total differential head* (TDH) and possibly a stop of pumping.

Net positive suction head - required ($NPSH_R$) is the decrease of fluid energy between the inlet of the pump and the point of lowest pressure in the pump. The decrease occurs because of friction losses and fluid accelerations in the inlet region of the pump, particularly accelerations as fluid enters the impeller vanes. The value for $NPSH_R$ for the specific pump purchased is given on the pump performance curve.

For a pump to operate properly the $NPSH_A$ must be greater than the $NPSH_R$. Good practice dictates that this margin should be at least 1.5 m (5 ft) or 20%, whichever is greater.

Ensuring that $NPSH_A$ is larger than $NPSH_R$ by the suggested margin will enhance pump performance and reliability. It will also reduce the risk of cavitation, which can severely damage the pump.

5.8.2 Specific gravity (SG)

Pump capacity and total head are constant with SG. However pressure displayed on a pressure gauge is directly proportional to SG. Power absorbed is also directly proportional to SG. Therefore, check that any change in SG will not overload the pump driver or overpressurize the pump.

5.8.3 Viscosity

For a given flow rate the total head reduces with increased viscosity and increases with reduced viscosity. For a given flow rate the power absorbed increases with the increased viscosity, and reduces with reduced viscosity.

5.8.4 Pump speed

Changing the pump speed affects flow, total head, power absorbed, NPSHr, noise and vibration levels. Flow varies in direct proportion to pump speed. Head varies as speed ratio squared. Power varies as speed ratio cubed. If increasing speed ensure the maximum working pressure is not exceeded, driver is not overloaded, NPSHa>NPSHr, noise and vibration are within local requirements and regulations.

6 MAINTENANCE

It is the plant operator's responsibility to ensure that all maintenance, inspection and assembly work is carried out by authorized and qualified personnel who have adequately familiarized themselves with the subject matter by studying this manual in detail. (See also section 1.6.2.)

Any work on the machine must be performed when it is at a standstill. It is imperative that the procedure for shutting down the machine is followed, as described in section 5.7.

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 the pump from being accidentally started. Place a warning sign on the starting device: ***"Machine under repair: do not start"***.

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

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

Refer to the parts list shown in section 8 for item number references used throughout this section.

6.1 Maintenance schedule

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

a) Any auxiliary systems installed must be monitored, if necessary, to ensure they function correctly.
b) Check for any leaks from gaskets and seals. The correct functioning of the shaft seal must be checked regularly.
c) Check that the duty condition is in the safe operating range for the pump.
d) Check vibration, noise level and surface temperature at the bearings to confirm satisfactory operation.
e) Check dirt and dust is removed from areas around close clearances, bearing housings and motors.

Check coupling alignment and re-align if necessary

6.1.1 Preventive maintenance

The following sections of this manual give instructions on how to perform a complete maintenance overhaul. However, it is also important to periodically repeat the *Pre start-up checks* listed in section 5.1. These checks will help extend pump life as well as the length of time between major overhauls.

6.1.2 Need for maintenance records

A procedure for keeping accurate maintenance records is a critical part of any program to improve pump reliability. There are many variables that can contribute to pump failures. Often long term and repetitive problems can only be solved by analyzing these variables through pump maintenance records.

6.1.3 Cleanliness

One of the major causes of pump failure is the presence of contaminants in the bearing housing. This contamination can be in the form of moisture, dust, dirt and other solid particles such as metal chips. Contamination can also be harmful to the mechanical seal (especially the seal faces) as well as other parts of the pump.

6.1.4 Mechanical seal
A pump equipped with a mechanical seal must not be run until the pump casing is full of liquid. Running a pump dry will damage the mechanical seal.
For further information on assembly of the mechanical seal refer to the following subsections.

6.1.5 Bearing lubrication
Motors may have grease lubricated bearings which may require periodic replacement of grease. Refer to the instructions on/or supplied with motor.

The D-814 pump bearing frame is equipped with sealed for life bearings which do not require additional lubrication.

6.2 Spare parts
The decision on what spare parts to stock varies greatly depending on many factors such as the criticality of the application, the time required to buy and receive new spares, the erosive/corrosive nature of the application, and the cost of the spare part. Section 8 identifies all of the components that make up each pump addressed in this manual.

6.2.1 Order of spare parts
Flowserve keeps records of all pumps that have been supplied. Spare parts can be ordered from your local Flowserve Distributor or Representative. When ordering spare parts the following information should be supplied:
Model D-814 or D-824
a) Serial number
b) Size type
c) Part name – see section 8
d) Part item number – see section 8
e) Material of construction (if known)
f) Number of parts required
g) Impeller diameter

The pump size and serial number can be found on the name plate. See section 3.2.

6.2.2 Returning parts
All materials returned to the factory must have a Return Material Authorization. Consult the nearest Flowserve Pump Division representative for shipping instructions and a Return Material Order Number.

Unnecessary delays are avoided when parts or equipment are returned to the factory using the correct procedure.

a) Contact your nearest Flowserve Pump Division represtative, listing the material to be returned and the reasons for returning it. Make sure you give the description of the part and it's item number from section 8.
b) On receipt of the Return Material Order Number, mark or tag the material to be returned with this order number. In cases where more than one part or box is returned, print or stencil your name and the Return Material Order Number on each part or box. This will facilitate quick identification.
c) Articles being returned should be carefully packed to prevent damage from handeling or from the exposure to weather. Give the method and date of shipment. This will notify the factory that the material is enroute.

6.3 Recommended spares and consumable items

Mechanical seal, bearings, shaft, impeller, and gaskets. See section 8 for part lists and drawings.

6.4 Fastener torques

Item	Description	Frame size 143-215	Frame size 254 and up	15 in. Pumps
2913	Impeller screw	15 lbf·ft	20 lbf·ft	30 lbf·ft

Item	Description	4, 5, 6 in. Pumps	8-13 in. Pumps	15 in. Pumps
6820	Casing bolts	15 lbf·ft	30 lbf·ft	60 lbf·ft

6.5 Disassembly procedure

a) Remove bolts which hold casing to cover.
b) Separate casing from cover (a pry bar or large screw driver can be used if needed).
c) Remove old casing gasket.
d) Remove the impeller fastening hardware.
e) Remove the impeller and key from the shaft.
f) The sleeve and mechanical seal rotating assembly can be removed from the shaft as a unit.
g) Remove the bolts which hold the cover to the motor or frame.
h) Remove the cover from the motor or frame.
i) Working from the backside of the cover, push the seal seat out using a plastic drift or other suitable device.
j) Remove the rotating assembly portion of the mechanical seal assembly from the sleeve.
k) Casing wear ring, if equipped, can be removed through the suction opening by the same method as for the cover ring, using a specially sharpened drift pin or by drilling holes in the ring to split it.

CAUTION Do not strike the shaft, impeller or sleeve with a hammer. This will damage the ball bearings and shaft.

6.5.1 Disassembly of frame

a) If there is any reason to suspect a bent shaft or a misalignment problem, the shaft should be checked for runout with a dial indicator before disassembling the bearing frame. Maximum runout at mechanical seal is 0.002 in.
b) To disassemble the bearing frame, remove the 4 cap screws that hold the bearing cover [3260] to the bearing housing [3200].
c) Remove the shaft [2100] and bearings [3041 and 3043] by pressing on the impeller end of the shaft. Protect the threaded end of the shaft during this operation. In this process the deflector [2540] will be pushed off the shaft.
d) The bearings may be removed from the shaft by conventional pressing or pulling methods once the retaining ring [2530] is removed.

6.6 Examination and repair of parts

With pump liquid end dissembled, clean all parts and check for worn and damaged areas. It is seldom economical on the D-800 pumps to repair damaged or worn parts. Therefore, when a part is unusable, it should be replaced.

6.6.1 Casing

Clean and inspect gasket surfaces for damaged areas that would cause leaks. Check casing wear ring surfaces for excessive wear. Figure 6-2 gives standard casing wear ring clearances for cover and casing sides of the impeller.

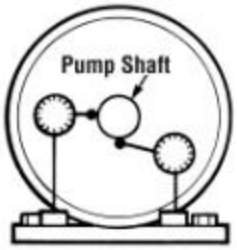
6.6.2 Impeller

Check casing wear ring surfaces for excess wear, impeller vanes, and gasket surfaces of impeller hub for damage. If excessively worn or eroded, the impeller must be replaced.

6.6.2.1 Impeller balancing

Shaft whip is deflection where the centerline of the impeller is moving around the true axis of the pump. It is not caused by hydraulic force but rather by an imbalance with the rotating element. Shaft whip is very hard on the mechanical seal because the faces must flex with each revolution in order to maintain contact. To minimize shaft whip it is imperative that the impeller is balanced. All impellers manufactured by Flowserve are balanced after they are trimmed. If for any reason, a customer trims an impeller, it must be re-balanced.

Pipe Strain Movement



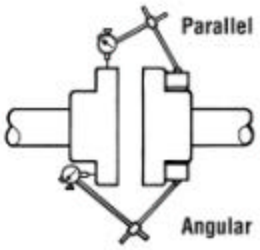
6.6.3 Alignment

Misalignment of the pump and motor shafts can cause the following problems:

? Failure of the mechanical seal
? Failure of the motor and/or pump bearings
? Failure of the coupling
? Excessive vibration/noise

The schematics below show the technique for a typical rim and face alignment using a dial indicator. It is important that this alignment be done after the flanges are loaded, and at typical operating temperatures.

Alignment



Many companies today are using laser alignment which is a more sophisticated and accurate technique. With this method a laser and sensor measure misalignment. This is fed to a graphic display that shows the required adjustment for each of the motor feet.

6.6.3.2 Vibration analysis

Vibration analysis is a type of condition monitoring where a pump's vibration "signature" is monitored on a regular, periodic basis. A problem can be noticed before it becomes serious by using this tool. This can also help find the root cause of the problem and possible solutions.

On a centrifugal pump causes can include the following: unbalance, misalignment, defective bearings, resonance, hydraulic forces, cavitation and recirculation.

Flowserve urges customers to work with an equipment supplier or consultant to establish an on-going vibration analysis program.

6.6.4 Cover

Clean and inspect gasket surfaces. Clean the mechanical seal cavity. Check cover ring for wear and excess clearance. See Figure 6-2. Cover rings may be driven out by use of a hammer and drift pin. Removing cast iron casing rings requires special procedures beyond the scope of this instruction book.

6.6.5 Sleeve

Check for any damage to gasket surface on impeller end, O-ring groove on driver end, or outside diameter where rubber bellows of mechanical seal contacts.

6.6.6 Mechanical seal

It is normal pratice to replace the mechanical seeal when rebuilding a pump.

6.6.7 Motor shaft

Check the shaft for any bent condition by installing the sleeve, clamping a dial indicator to the motor frame face and reading a runout at the center of the sleeve while turning the shaft by hand. Maximum allowable runout is 0.002 inches for proper performance of mechanical seal. A runout reading greater than this maximum indicates the motor requires repairs beyond the scope of this instruction book.

6.7 Assembly of pump and seal

The D-814 and D-824 pumps are easy to put together. Tasks requiring the most care are the installation of the mechanical seal and bearings.

a) Study section 8, Parts List and Drawings, and become familiar with the name of each part of the assembled pump.
b) Make sure all the parts are clean and ready for assembly. This means no dirt or pieces of old gaskets in the joints between the motor, cover and casing. Make sure the parts around the mechanical seal are clean. Dirt and misalignment will ruin the mechanical seal.
c) Install the sleeve O-ring in place against the shaft shoulder. Sharp edges of the keyway can cut the O-ring.
d) Press in the cover ring, beveled edge first, using a pressure tool that will hold the ring square with the cover bore. A little lubricant will ease pressing. Be careful not to gouge or distort the ring.
e) Push the stationary element squarely into the cover. The stationary element O-ring can be lubricated to ease installation into the cover. Don't install the cover on the motor or bearing frame yet. Clean the face of the stationary element.
f) Check the sleeve fit on the motor shaft. It should slide easily into place. If it doesn't, find out why. Do not try to drive the sleeve on to the shaft with a hammer. Check to make sure there are no score marks or scratches on the sleeve.
g) Install the cover and tighten the bolts that hold it to the motor or bearing frame. Make sure the nameplate is properly positioned.
h) Slide the sleeve on the shaft so that it covers the sleeve O-ring and butts against the shoulder.
i) Lubricate the inside of the rotating element bellows and install on the sleeve by hand. A twisting motion may be needed to make it ride smoothly over the shoulders on the sleeve. Push it by hand until it contacts the stationary element. Install the spring and spring holder.

j) Install the retaining ring using one hand to hold the retaining ring pliers and the other hand to compress the spring. When the spring pressure is released, the spring will push the sleeve outward, temporarily exposing the sleeve O-ring.
k) Install the key, first twisting the sleeve on the shaft untill both keyways line up.
l) Install the sleeve gasket.
m) Place the impeller on the shaft, engaging the key.
n) Put the impeller screw gasket, impeller washer and impeller washer gasket together on the impeller screw as a subassembly.
o) Install the impeller screw subassembly. With one hand, push the impeller back against the mechanical seal spring and with the other hand turn the impeller screw in hand tight.
p) Tighten the impeller screw 15 lbf˙ft torque for 3/8 in. thread (motor frame sizes 143-215), 20 lbf˙ft torque for 1/2 in. thread (frame 254 up), and 30 lbf˙ft torque for 5/8 in. thread (15 in. pumps).
q) Install the casing gasket in the casing.
r) Install the casing and tighten all bolts. Tighten the bolts 15 lbf˙ft torque on 4, 5 and 6 in. pumps, 30 lbf˙ft torque on 8, 9, 10, 11, 12 and 13 in. pumps and 60 lbf˙ft torque on 15 in. pumps.
s) Turn the motor shaft and check for and binding or rubs caused by such things as damaged or misaligned parts. Any such conditions must be corrected before the pump is run.

The pump is now ready for installation.

6.7.1 Assembly of frame

Use the following procedure to assemble the bearing frame.

a) Press bearings on shaft. Note that the inboard bearing [4041] can face either way. However, the outboard bearing [4043] must face in the proper direction, as illustrated in section 8.5.
b) Install the shaft and bearing subassembly in the bearing housing [3200] by inserting from coupling end and pushing through until the retaining ring contacts the back face of the housing.
c) Install bearing cover [3260] and bolts.
d) Install deflector [2540].
e) Install the pump bracket on the frame using its hardware.

Figure 6-2

Pump Size	Casing Ring Diameter Clearances Inches	Cover Ring Diameter Clearances Inches
1 1/2x1x6T	0.01-0.015	0.010-0.015
2x1x8T	0.010-0.015	0.010-0.015
2x1x6T	0.010-0.015	0.010-0.015
2 1/2x1 1/2x9F	0.010-0.017	0.010-0.017
3x2x9F	0.010-0.017	0.010-0.017
4x3x9F	0.010-0.017	0.010-0.017
5x4x12F	0.010-0.017	0.010-0.017
6x5x12F	0.010-0.017	0.010-0.017
5x4x15F	0.010-0.017	0.010-0.017
6x5x15F	0.010-0.017	0.010-0.017
2x1x10F	0.012-0.017	0.012-0.017
3x1 1/2x10F	0.012-0.017	0.012-0.017
2 1/2x1 1/2x8T	0.012-0.017	0.012-0.017
2 1/2x1 1/2x6T	0.012-0.017	0.012-0.017
2 1/2x1 1/2x5T	0.012-0.017	0.012-0.017
3x2x10F	0.012-0.017	0.012-0.017
3x2x8T	0.012-0.017	0.012-0.017
3x2x6T	0.012-0.017	0.012-0.017
3x2x5F	0.012-0.017	0.012-0.017
3x2x5T	0.012-0.017	0.012-0.017
2 1/2x2 1/2x4T	0.012-0.017	0.012-0.017
3x3x4F	0.018-0.022	0.012-0.017
1 1/2x1x6F	0.018-0.024	0.010-0.015
1 1/2x1x8F	0.018-0.024	0.010-0.015
3x1 1/2x5F	0.018-0.024	0.012-0.017
3x1 1/2x6F	0.018-0.024	0.012-0.017
3x1 1/2x8F	0.018-0.024	0.012-0.017
3x2x8F	0.018-0.024	0.012-0.017
3x2x6F	0.018-0.024	0.012-0.017
4x3x10F	0.021-0.027	0.021-0.027
4x3x8F	0.021-0.027	0.021-0.027
4x3x6F	0.021-0.027	0.021-0.027
4x3x5F	0.021-0.027	0.012-0.017
6x4x8F	0.021-0.027	0.021-0.027
6x4x6F	0.021-0.027	0.021-0.027
6x4x10F	0.021-0.027	0.021-0.027
6x4x11F	0.021-0.027	0.021-0.027
3x1 1/2x13F	0.018-0.024	0.018-0.024
3x2x13F	0.018-0.024	0.018-0.024
4x3x13F	0.021-0.027	0.021-0.027
6x4x13F	0.028-0.034	0.028-0.032

7 FAULTS; CAUSES AND REMEDIES

Troubleshooting

The following is a guide to troubleshooting problems with Flowserve D-800 pumps. Common problems are analyzed and solutions offered. Obviously, it is impossible to cover every possible scenario. If a problem exists that is not covered by one of the examples, then refer to one of the books listed in the Sources of additional information section or contact a Flowserve Sales Engineer or Distributor/Representative for assistance.

FAULT SYMPTOM

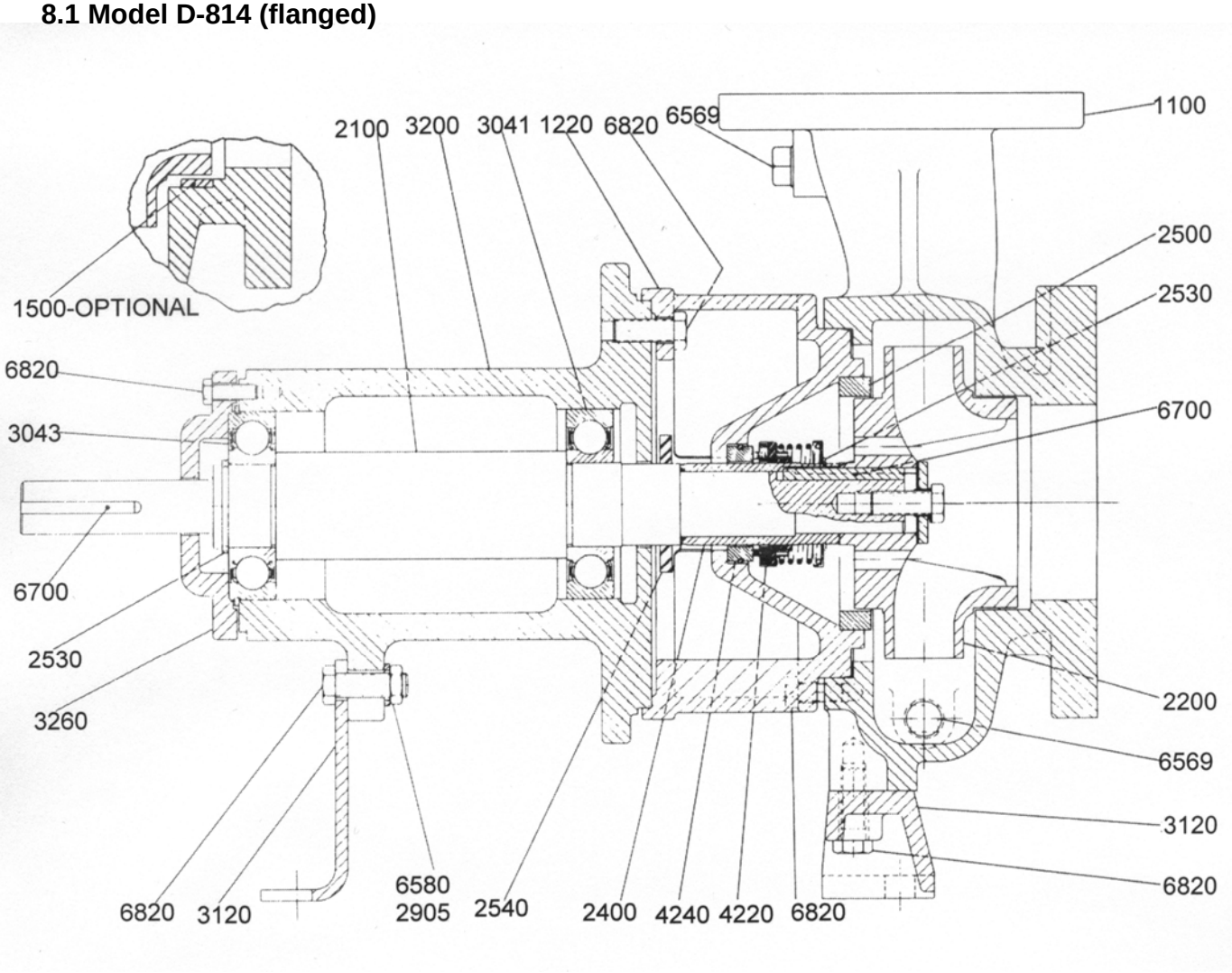
Pump not reaching design flow rate	Pump not reaching design head (TDH)	No discharge or flow with pump running	Pump operates for short period, then loses prime	Excessive noise from wet end	Excessive noise from power end					PROBABLE CAUSES	POSSIBLE REMEDIES
✍	✍		✍	✍						Insufficient NPSH. (Noise may not be present.)	Recalculate NPSH available. It must be greater than the NPSH required by pump at desired flow. If not, redesign suction piping, holding number of elbows and number of planes to a minimum to avoid adverse flow rotation as it approaches the impeller.
✍	✍	✍								System head greater than anticipated.	Reduce system head by increasing pipe size and/or reducing number of fittings. Increase impeller diameter. (NOTE: Increasing impeller diameter may require use of a larger motor.)
✍	✍		✍							Entrained air. Air leak from atmosphere on suction side.	1. Check suction line gaskets and threads for tightness. 2. If vortex formation is observed in suction tank, install vortex breaker. 3. Check for minimum submergence
✍	✍									Entrained gas from process.	Process generated gases may require larger pumps.
✍	✍									Speed too low.	Check motor speed against design speed.
✍	✍	✍								Direction of rotation wrong.	After confirming wrong rotation, reverse any two of three leads on a three phase motor. The pump should be disassembled and inspected before it is restarted.
✍	✍									Impeller too small.	Replace with proper diameter impeller. (NOTE: Increasing impeller diameter may require use of a larger motor.)
✍	✍									Wet end parts (casing cover, impeller) worn, corroded or missing.	Replace part or parts.
	✍	✍								Not properly primed.	Repeat priming operation, recheck instructions. If pump has run dry, disassemble and inspect the pump before operation.
				✍						Impeller rubbing.	1. Check and reset impeller clearance. 2. Check outboard bearing assembly for axial end play.
	✍	✍								Damaged pump shaft, impeller.	Replace damaged parts.
				✍						Abnormal fluid rotation due to complex suction piping.	Redesign suction piping, holding the number of elbows and planes to a minimum to avoid adverse fluid rotation as it approaches the impeller.

FAULT SYMPTOM

Pump not reaching design flow rate ? Pump not reaching design head (TDH) ? No discharge or flow with pump running ? Pump operates for short period, then loses prime ? Excessive noise from wet end ? Excessive noise from power end ? ? ? ? ?	PROBABLE CAUSES	POSSIBLE REMEDIES
✍	Bearing contamination appearing on the raceways as scoring, pitting, scratching or rusting caused by adverse environment and entrance of abrasive contaminants from atmosphere.	1. Work with clean tools in clean surroundings. 2. Remove all outside dirt from housing before exposing bearings. 3. Handle with clean dry hands. 4. Treat a used bearing as carefully as a new one. 5. Use clean solvent and flushing oil. 6. Protect disassembled bearing from dirt and moisture. 7. Keep bearings wrapped in paper or clean cloth while not in use. 8. Clean inside of housing before replacing bearings. 9. Check oil seals and replace as required. 10. Check all plugs and tapped openings to make sure that they are tight.
✍	Brinelling of bearing identified by indentation on the ball races, usually caused by incorrectly applied forces in assembling the bearing or by shock loading such as hitting the bearing or drive shaft with a hammer.	When mounting the bearing on the drive shaft use a proper size ring and apply the pressure against the inner ring only. Be sure when mounting a bearing to apply the mounting pressure slowly and evenly.
✍	False brinelling of bearing identified again by either axial or circumferential indentations usually caused by vibration of the balls between the races in a stationary bearing.	1. Correct the source of vibration. 2. Where bearings are oil lubricated and employed in units that may be out of service for extended periods, the drive shaft should be turned over periodically to relubricate all bearing surfaces at intervals of one to three months.
✍	Thrust overload on bearing identified by flaking ball path on one side of the outer race or in the case of maximum capacity bearings, may appear as a spalling of the races in the vicinity of the loading slot. These thrust failures are caused by improper mounting of the bearing or excessive thrust loads.	Follow correct mounting procedures for bearings.
✍	Misalignment identified by fracture of ball retainer or a wide ball path on the inner race and a narrower cocked ball path on the outer race. Misalignment is caused by poor mounting practices or defective drive shaft. For example, bearing not square with the centerline or possibly a bent shaft due to improper handling.	Handle parts carefully and follow recommended mounting procedures. Check all parts for proper fit and alignment.
✍	Bearing damaged by electric arcing identified as electro- etching of both inner and outer ring as a pitting or cratering. Electrical arcing is caused by a static electrical charge emanating from belt drives, electrical leakage or short circuiting.	1. Where current shunting through the bearing cannot be corrected, a shunt in the form of a slip ring assembly should be incorporated. 2. Check all wiring, insulation and rotor windings to be sure that they are sound and all connections are properly made. 3. Where pumps are belt driven, consider the elimination of static charges by proper grounding or consider belt material that is less generative.

8 PARTS LIST AND DRAWINGS

8.1 Model D-814 (flanged)

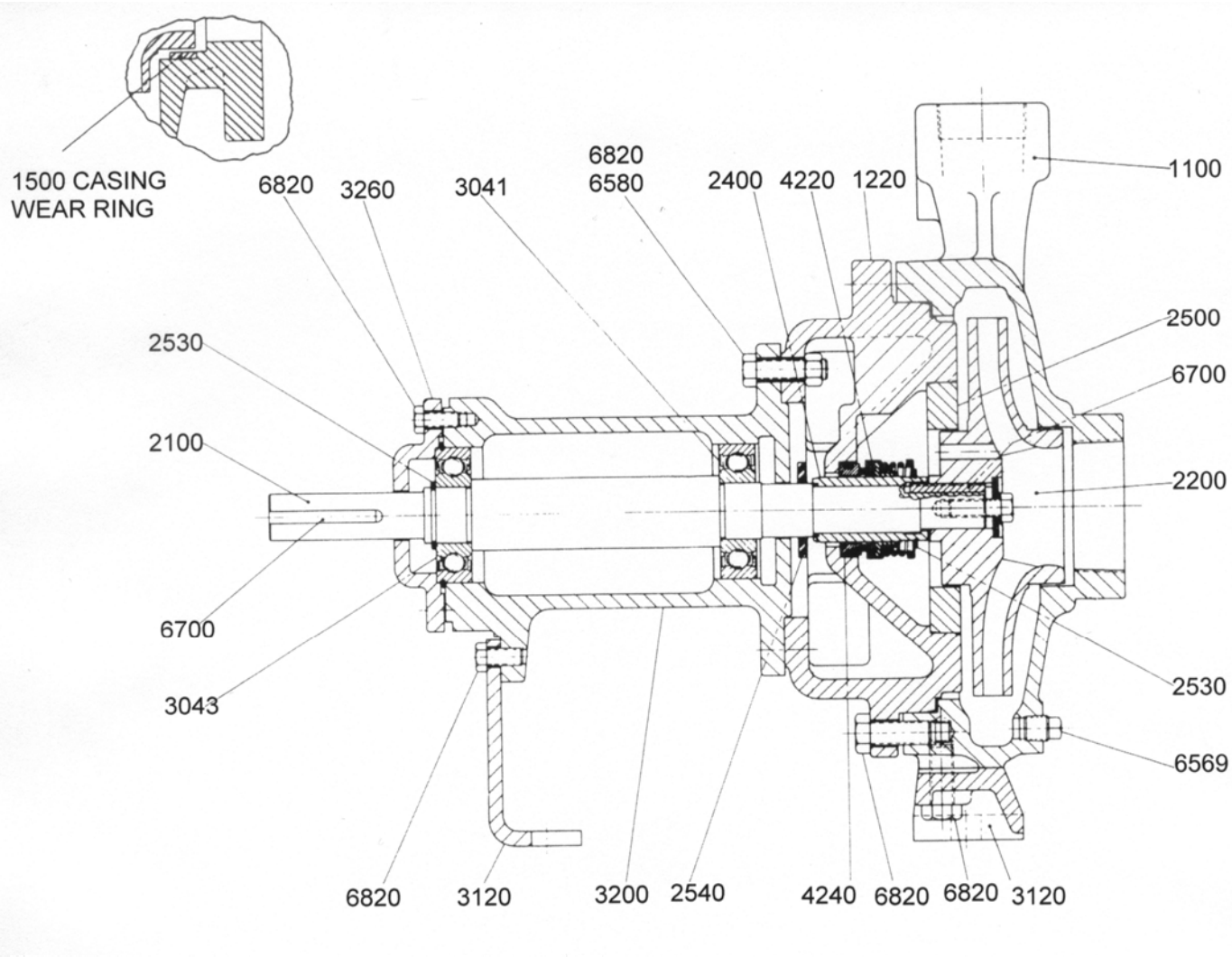


Parts list

Item	Description
1100	Casing
6820	Bolt
2200	Impeller
2100	Shaft
2400	Sleeve
3041	Bearing, Inboard
3043	Bearing, Outboard
2500	Ring
6700	Key
3260	Bearing Cover
2540	Deflector

Item	Description
3120	Pump Bracket
4240	Stationary Element
3134	Support Foot
4220	Rotating Element
6569	Plug
3200	Bearing Housing
2530	Retaining Ring
6580	Nut
1500	Casing Wear Ring (Optional)
2905	Washer
2913	Impeller Screw
1220	Cover

8.2 Model D-814 (threaded)



Parts list

Item	Description
1100	Casing
6820	Bolt
2200	Impeller
2100	Shaft
2400	Sleeve
3041	Bearing, Inboard
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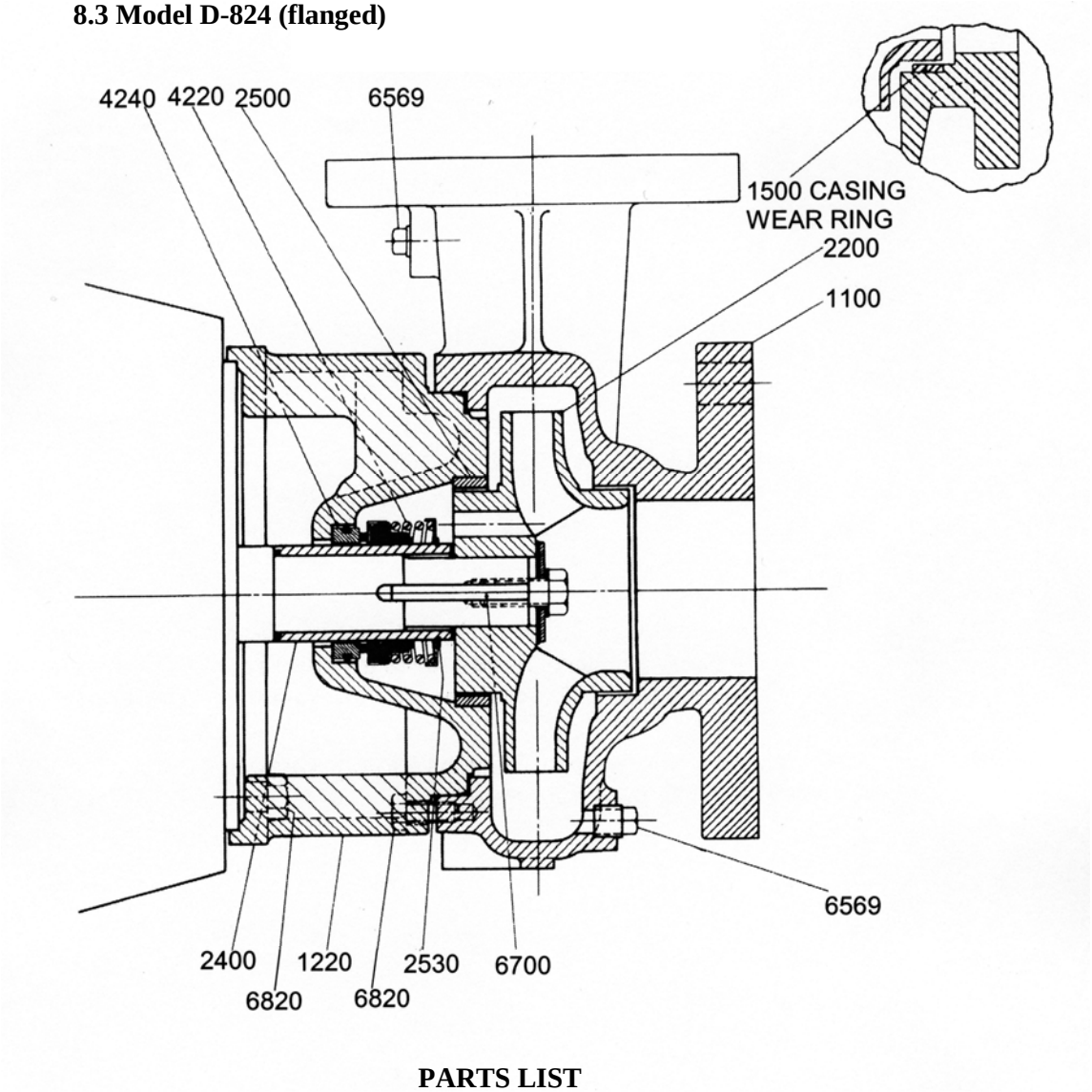
2500	Ring
6700	Key
3260	Bearing Cover
2540	Deflector

Item	Description
3120	Pump Bracket
4240	Stationary Element
3134	Support Foot
4220	Rotating Element
6569	Plug
3200	Bearing Housing
2530	Retaining Ring
6580	Nut
1500	Casing Wear Ring (Optional)
2905	Washer
2913	Impeller Screw
1220	Cover

8.3 Model D-824 (flanged)

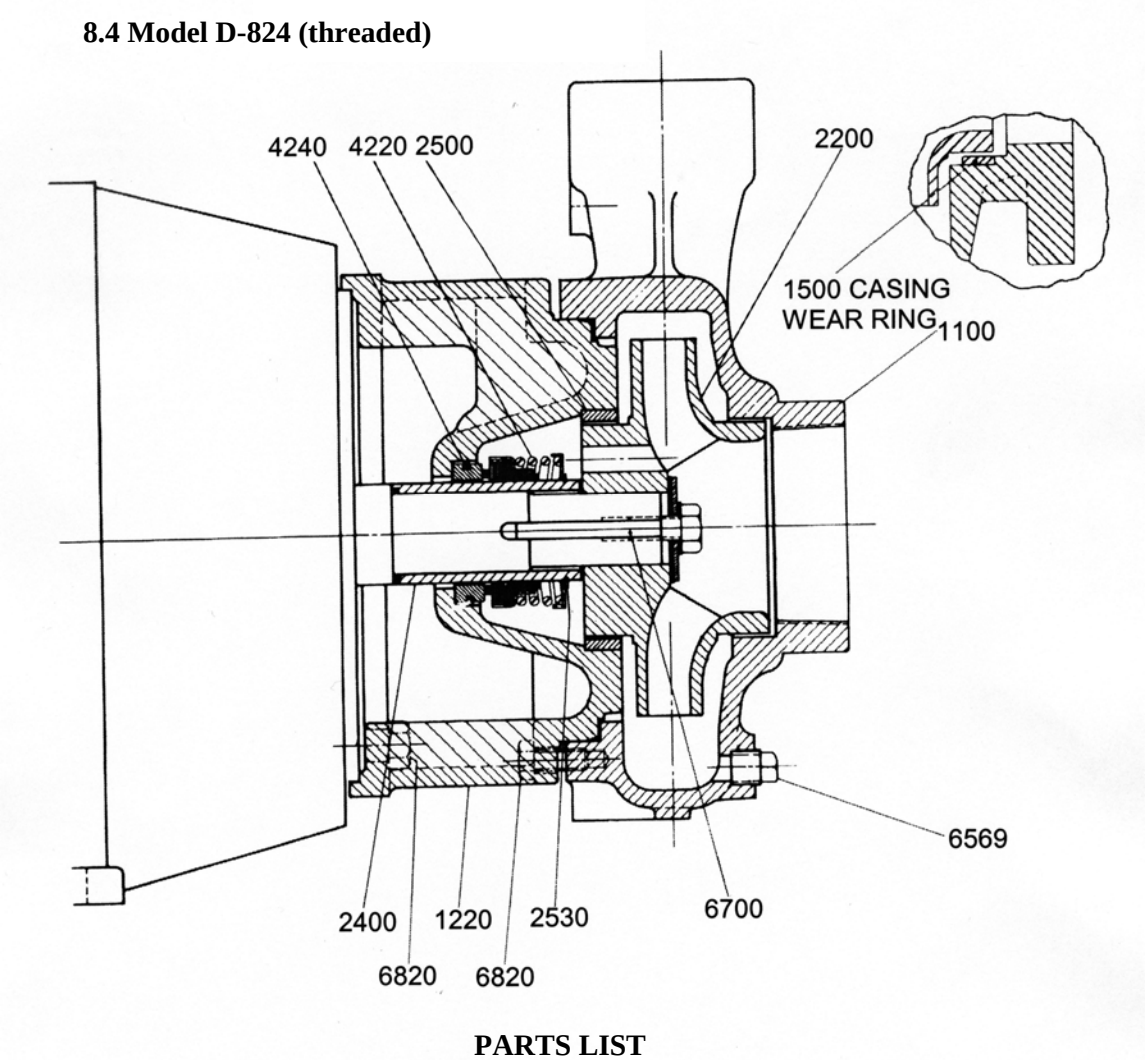


PARTS LIST

Item	Description
1100	Casing
2200	Impeller
1220	Cover
2500	Ring
2400	Sleeve
1500	Casing Wear Ring (Optional)

Item	Description
6700	Key
4240	Stationary Element
4220	Rotating Element
2530	Retaining Ring
6820	Bolt
6569	Plug

8.4 Model D-824 (threaded)

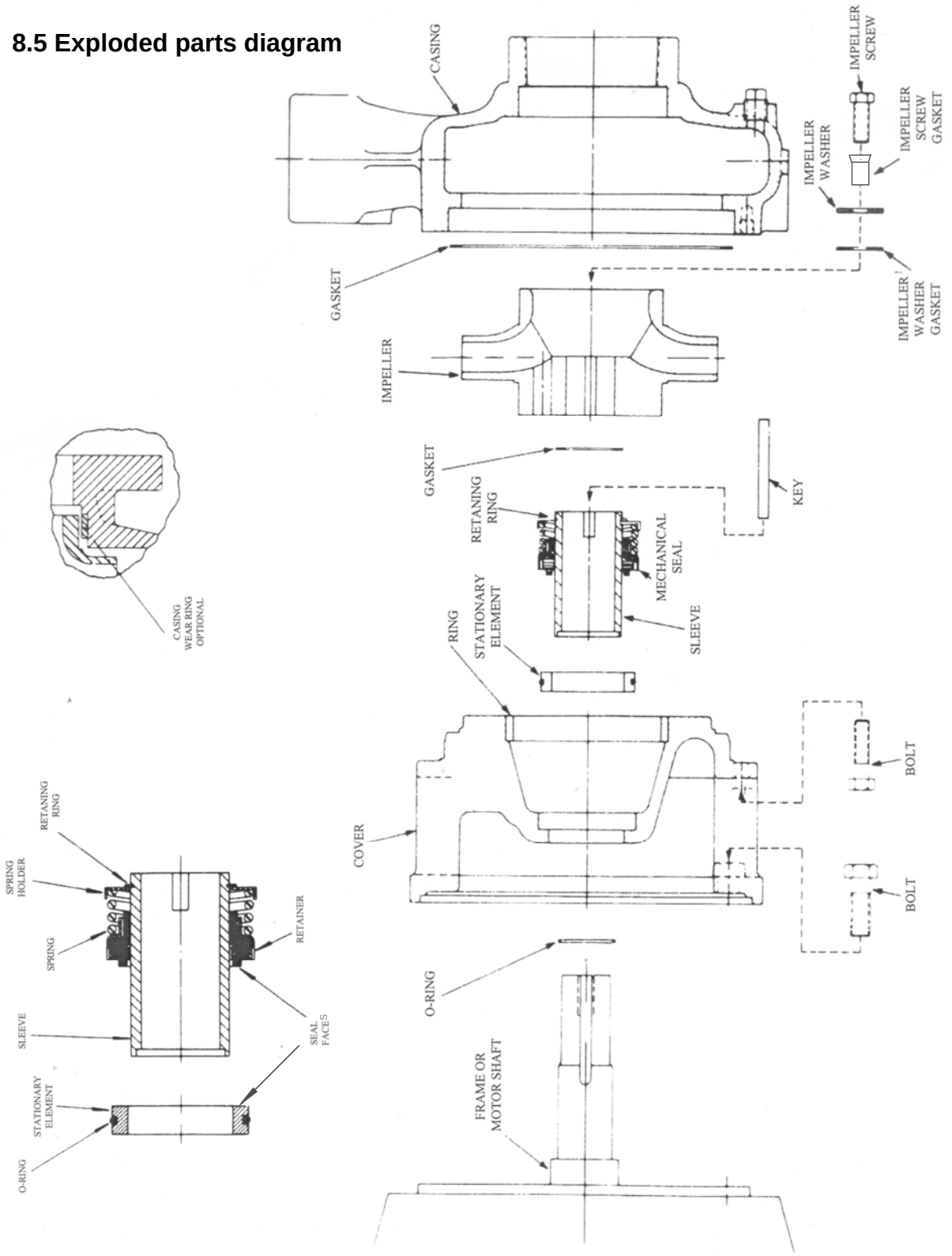


PARTS LIST

Item	Description
1100	Casing
2200	Impeller
1220	Cover
2500	Ring
2400	Sleeve
1500	Casing Wear Ring (Optional)

Item	Description
6700	Key
4240	Stationary Element
4220	Rotating Element
2530	Retaining Ring
6820	Bolt
6569	Plug

8.5 Exploded parts diagram



9 CERTIFICATION

Certificates are provided where applicable. Examples are certificates of compliance, certified hydrostatic test reports, certified performance test reports, etc. Copies of any certificates sent separately to the Purchaser should be obtained from Purchaser for retention with these User Instructions.

10 OTHER RELEVANT DOCUMENTATION AND MANUALS

10.1 Supplementary user instructions

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

10.2 Change notes

Any changes made to the product after original manufacture should be agreed to by Flowserve Pump Division. A record of these changes should be maintained with these User Instructions.

10.3 Additional sources of information

The following are excellent sources for additional information.

Pump Handbook
2nd edition, Igor J. Karassik et al, McGraw-Hill, Inc., New York, NY, 1986.

Centrifugal Pump Sourcebook
John W. Dufour and William E. Nelson, McGraw-Hill, Inc., New York, NY, 1993.

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

USA and Canada
Flowserve Corporation
Pump Division
Millennium Center
222 Las Colinas Blvd., 15th Floor
Irving, TX 75039-5421 USA
Telephone: 1 972 443 6500
Toll Free: 1 800 728 PUMP (7867)
Fax: 1 972 443 6800

Latin America
Flowserve S.A. de C.V.
Avenida Paseo de la Reforma #30
2nd Floor, Colonia Juarez Centro
Mexico, D.F.Z.C. 06040

Telephone: +52 5705 5526
Fax: +52 5705 1125

Europe, Middle East & Africa
Flowserve Limited
Pump Division
Harley House, 94 Hare Lane
Claygate, Esher, Surrey KT10 0RB
United Kingdom
Telephone: +44 (0)1372 463 700
Fax: +44 (0)1372 460 190

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

Telephone: +65 775 3003
Fax: +65 779 4607

Visit our web site at: www.flowserve.com

Your Flowserve contact:

Your local Flowserve representative:

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