FLOWSERVE

USER INSTRUCTIONS

IDP® WMV and WMVS

Multiline centrifugal pumps

Installation
Operation
Maintenance

PCN= 26999970 02-17 (EE). (Based on C948KH001.)
Original instructions.

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

Experience In Motion

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1 INTRODUCTION AND SAFETY

1.1 General

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

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

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

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

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

1.2 CE marking and approvals

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

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

Where applicable this document incorporates information relevant to these Directives and Approvals. To confirm the Approvals applying and if the product is CE marked, check the serial number plate markings and the Certification. (See section 9, *Certification*.)

1.3 Disclaimer

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

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

1.4 Copyright

1.5 Duty conditions

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

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

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

1.6 Safety

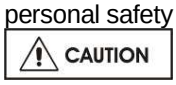
1.6.1 Summary of safety markings

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

 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.

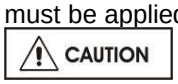
 THERMAL SHOCK
Rapid changes in the temperature of the liquid within the pump can cause thermal shock, which can result in damage or breakage of components and should be avoided.

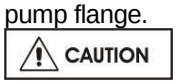
 NEVER APPLY HEAT TO REMOVE IMPELLER
Trapped lubricant or vapour could cause an explosion.

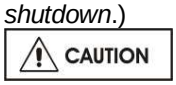
 HOT (and cold) PARTS
If hot or freezing components or auxiliary heating supplies can present a danger to operators and persons entering the immediate area action must be taken to avoid accidental contact. If complete protection is not possible, the machine access must be limited to maintenance staff 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.

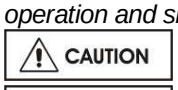
If the temperature is greater than 80 ºC (175 ºF) or below -5 ºC (20 ºF) in a restricted zone, or exceeds local regulations, action as above shall be taken.

 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.

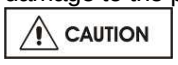
 PREVENT EXCESSIVE EXTERNAL PIPE LOAD
Do not use pump as a support for piping. Do not mount expansion joints, unless allowed by Flowserve in writing, so that their force, due to internal pressure, acts on the pump flange.

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

 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 2014/34/EU (previously 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

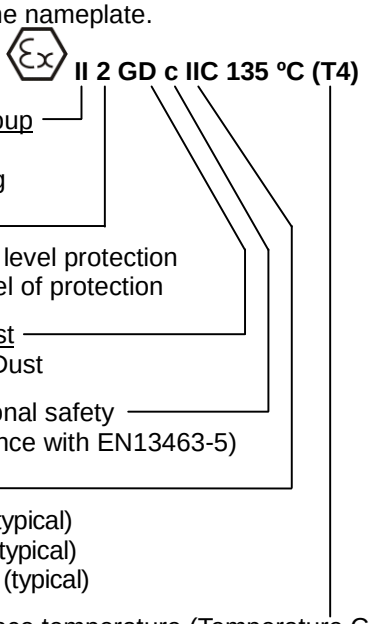
 Use equipment only in the zone for which it is appropriate. Always check that the driver, drive coupling assembly, seal and pump equipment are suitably rated and/or certified for the classification of the specific atmosphere in which they are to be installed.

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:

Maximum permitted liquid temperature for pumps

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

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

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

The operator is responsible to ensure that the specified maximum liquid temperature is not exceeded.

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.

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

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

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

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.

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

1.6.4.6 Additional requirement for metallic pumps on non-metallic baseplates

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

1.6.4.7 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

1.6.4.8 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.*)

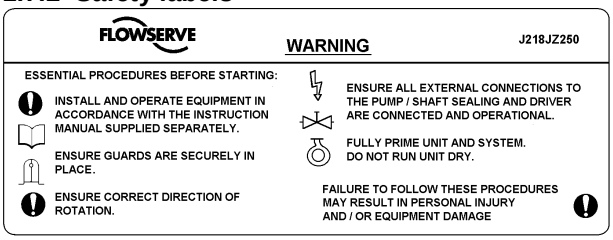
1.7 Nameplate and safety labels

1.7.1 Nameplate

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

EU regulation 547/2012 requires the statement on a product nameplate: MEI ≥ 0.40. (See section 1.8.2, *Ecodesign*.)

1.7.2 Safety labels



1.8 Specific machine performance

1.8.1 General

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

1.8.2 Ecodesign

EU regulation 547/2012 of the Directive 2009/125/EC, for the minimum efficiency of defined classes of water pumps requires that products must show their Minimum Efficiency Index (MEI) value. The EU benchmark MEI ≥ 0.70. Also product information must be available to users.

Performance curves will have been provided with the quotation or order or are available at flowserve.com.

The efficiency of a pump with trimmed impeller is usually lower than that of a pump with the full impeller diameter. Trimming of the impeller will adapt the pump to a fixed duty point, leading to reduced energy consumption. The minimum efficiency index (MEI) is based on the full impeller diameter.

The operation of this water pump with variable duty points may be more efficient and economic when controlled by, for example, by the use of a variable speed drive that matches the pump duty to the system.

Information on benchmark efficiency is available at; www.europump.org/efficiencycharts

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.

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.

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

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.

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

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

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

CAUTION No specific lifting points are provided for this complete machine (unless so specified). Any lifting points that can be seen are provided only for dismantling parts for servicing. Slings, ropes and other lifting gear should be positioned where they cannot slip and where a balanced lift is obtained. The angle between sling or ropes used for lifting must not exceed 60°.

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

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 or toxic fluids 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
This is a multi-stage centrifugal pump of modular design.

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

8WMV(S)16

Nominal BEP flow rate, m^3/h:

Pump type/materials:
WMV - Iron/Noryl
WMVS - Stainless steel/Noryl

Number of stages:

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

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

3.3 Design of major parts

3.3.1 Pump casing
The casing(s) contain passageways to transfer the liquid between the outside diameter of the preceding impeller and the eye of the subsequent impeller.

3.3.2 Impeller
A shrouded impeller with hub rings is fitted.

3.3.3 Shaft
The shaft carries the impellers and has multiple support bearings plus a hydraulic balancing mechanism.

3.3.4 Bearing housing and lubrication
The pump bearing system is product lubricated.

The pump uses the driver's bearings to give primary support and positioning to the input shaft. See the driver's instruction book for lubrication details.

3.3.5 Seal housing
The seal housing has spigots between the pump casing and bearing housing for optimum concentricity.

3.3.6 Shaft seal
The mechanical seal(s) attached to the pump shaft seals the pumped liquid from the environment.

3.3.7 Driver
The pump is driven by a close coupled electric motor.

The position of the terminal box can be changed by rotating the complete motor. To do this, remove the fasteners from the motor flange, rotate the motor and refit the fasteners.

3.3.8 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.)

These pumps are generally fitted with TEFC motors with an ambient temperature limit of 40 °C. Specific pumps may be fitted with motors to suit client's requirements with other ambient temperature limits - see motor nameplate for details.

3.4.1 Pressure limits
The operating pressure has been selected to meet your specified requirements. See paragraph 1.5, *Duty conditions,* for details.

Pump size	Max. working pressure bar g (psi)
5WMV, 8WMV	24 (348)
16WMV	30 (435)
5WMVS, 8WMVS	29.5 (428)
16WMVS	41 (595)

Note: Maximum suction pressure is dependent on the number of pump stages. Suction pressure plus closed valve head must not exceed the maximum working pressure stated above.

3.4.2 Temperature limits

Pump size	No of stages	Maximum liquid temperature °C (°F) at pump rotational speed			
		3 500 rpm	2 900 rpm	1 750 rpm	1 450 rpm
5 and 8 WMV(S)	30	N/A	35 (95)	35 (95)	35 (95)
	24	N/A	100 (212)	100 (212)	100 (212)
	20	35 (95)	100 (212)	100 (212)	100 (212)
	18	35 (95)	100 (212)	100 (212)	100 (212)
	16	100 (212)	100 (212)	100 (212)	100 (212)
	14	100 (212)	100 (212)	100 (212)	100 (212)
	12	100 (212)	100 (212)	100 (212)	100 (212)
	10	100 (212)	100 (212)	100 (212)	100 (212)
	8	100 (212)	100 (212)	100 (212)	100 (212)
	6	100 (212)	100 (212)	100 (212)	100 (212)
	5	100 (212)	100 (212)	100 (212)	100 (212)
	4	100 (212)	100 (212)	100 (212)	100 (212)
16 WMV(S) and WMV(S)	24	N/A	35 (95)	35 (95)	35 (95)
	20	N/A	35 (95)	35 (95)	35 (95)
	18	N/A	35 (95)	35 (95)	35 (95)
	16	N/A	100 (212)	100 (212)	100 (212)
	14	35 (95)	100 (212)	100 (212)	100 (212)
	12	35 (95)	100 (212)	100 (212)	100 (212)
	10	100 (212)	100 (212)	100 (212)	100 (212)
	8	100 (212)	100 (212)	100 (212)	100 (212)
	6	100 (212)	100 (212)	100 (212)	100 (212)
	5	100 (212)	100 (212)	100 (212)	100 (212)
	4	100 (212)	100 (212)	100 (212)	100 (212)

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
These pumps are not normally supplied in part assemblies but special accessories such as loose orifice plates are supplied loose. Ensure these are incorporated in the final installation.

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.

Pumps should not be mounted with the motor below the pump casing.

Where pumps are to be horizontally mounted, the four mounting brackets (two left hand and two right hand) are supplied in a separate package with the necessary bolts for fitting.

The pump should be mounted with the air release valve uppermost and the drain plugs in suction/ discharge casing on the underside.

a) To assemble, remove the two bolts from the motor flange on the side opposite to the air release valve and loosely bolt on two feet with the bolts and washers provided.
b) Loosely bolt on the two remaining feet to the holes in the suction/discharge casing.
c) Set the feet to the correct distance from the pump axis given on the outline arrangement drawing.
d) Final positioning and locking of the feet should be done with the pump in its installation position.
e) Where horizontally mounted pumps are handling hot liquid we recommend that the brackets at one end only are bolted down. The brackets at the other end should be allowed to move freely on the foundation.

4.4 Grouting

Where applicable, grout in the foundation bolts.

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

4.5 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.

4.5.1 Suction and discharge pipework

CAUTION Never use pump as a support for piping.

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.

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.

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

4.5.2 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 pipe straight is ten 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.
g) Fit a foot valve to the end of the suction pipe when the open tank liquid level is below pump level.

4.5.3 Discharge piping

a) 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.
b) Fitting an isolation valve will allow easier maintenance.
c) On boiler feed service, a pump discharge valve should always be fitted in addition to the boiler non return valve.

d) With modulating control a continuous bypass, controlled by an orifice, should be incorporated. The bypass should preferably be connected to the top of the pump (remove and discard the air relief valve) and piped back to the suction source. The recommended orifice size is given below.
e) Do not operate the pump on closed valve for more than 1 to 2 minutes. Where there is a risk of prolonged operation at closed valve a continuous by-pass should be incorporated:
   - For 5 and 8WMV 2 900 rpm pumps: 2.5 mm (0.1 in.) diameter orifice, 12 mm (0.5 in.) minimum bore pipe.
   - For 16WMV 2 900 rpm pumps: 4 mm (0.16 in.) diameter orifice, 20 mm (0.75 in.) minimum bore pipe.

4.5.4 Flange loads

The permissible flange loading is dependent on a number of factors such as dimensions, flange rating, pressure, temperature, material, pump configuration etc. The recommendations contained in the section on pipework connections should be followed to eliminate these loads.

When requested the permissible flange loading will have been supplied separately to the purchaser and should be obtained and retained with this manual. If in doubt contact Flowserve for information.

4.5.5 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.

Pumps fitted with mechanical seals - the conical design of the single internal seal housing provides excellent liquid circulation around the seal and will not normally require a separate flush.

4.5.6 Final checks

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

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

4.6 Electrical connections

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

Ex 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 5.2, *Direction of rotation,* before connecting the motor to the electrical supply.

4.7 Protection systems

Ex The following protection systems are recommended particularly if the pump is installed in a potentially explosive area or is handling a hazardous liquid. If in 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, install a protection device 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, fit a power monitor 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 install an appropriate leakage detection system.

To prevent excessive surface temperatures at bearings carry out temperature or vibration monitoring.

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

The pump is lubricated by the liquid pumped Electric motors are supplied pre-greased and are normally sealed for life. If in doubt, refer to motor instruction manual.

5.2 Direction of rotation

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

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.

5.3 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.

5.4 Priming and auxiliary supplies

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

5.4.1 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.

5.5 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 1 to 2 minutes.
h) If NO pressure, or LOW pressure, STOP the pump. Refer to section 7, *Faults; causes and remedies,* for fault diagnosis.

5.6 Running the pump

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

5.6.1 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.

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

5.6.2 Bearings

Ex If the pumps are working in a potentially explosive atmosphere monitor temperature and/or vibration at the bearings.

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 105 ºC (220 ºF).

It is important, 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.

5.6.3 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		Pumps ≤ 15 kW mm/sec (in./sec) r.m.s.	Pumps > 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)

5.6.4 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

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

5.7 Stopping and shutdown

a) CAUTION Close the outlet valve, but ensure that the pump runs in this condition for no more than a few seconds.

b) Stop the pump.

c) CAUTION For prolonged shut-downs and especially when ambient temperatures are likely to drop below freezing point, the pump and any cooling and flushing arrangements must be drained or otherwise protected.

5.8 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.

5.8.1 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.

5.8.2 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.

5.8.3 Pump speed

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

5.8.4 Net positive suction head ($NPSH_A$)

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

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

If any change in $NPSH_A$ is proposed, ensure these margins are not significantly eroded. Refer to the pump performance curve to determine exact requirements particularly if flow has changed.

If in doubt please consult your nearest Flowserve office for advice and details of the minimum allowable margin for your application.

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

6 MAINTENANCE

6.1 General

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

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

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) 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.

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

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

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

6.2.1 Routine inspection (daily/weekly)

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

a) Check operating behaviour. Ensure noise, vibration and bearing temperatures are normal.
b) Check that there are no abnormal fluid leaks (static and dynamic seals).
c) Check that shaft seal leaks are within acceptable limits.
d) Check running hours since last recharge of grease or complete grease change. (Certain motors only.)

6.2.2 Periodic inspection (six monthly)

a) CAUTION Check foundation bolts for security of attachment and corrosion.
b) Refer to the manuals of any associated equipment for periodic checks needed.

6.2.3 Re-lubrication

For general guidelines refer to section 5.1, *Lubrication.*

6.2.4 Mechanical seals

When leakage becomes unacceptable the seal will need replacement.

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

Recommended spares are defined on the following basis:

- Class 1 – Start-up and commissioning spares.
- Class 2 – Two year spares requirements covering maintenance for this period.
- Class 3 – Capital spares requirements.

Recommended spares are based on repair kits and full replacement rotating assemblies as listed in the following part numbers.

6.4.1 Repair kits - Class 1 and Class 2

Parts list supplied	Part no.	Part no.
Mechanical seal	KIT5&8WMV	KIT5&8WMVS
Shim x 2		
Retaining ring		
Screw, retaining ring		
Balance drum		
Balance drum bearing		
O-ring x 2		

Parts list supplied	Part no.	Part no.
Mechanical seal	KIT16WMV	KIT16WMVS
Shim x 2		
Retaining ring		
Screw, retaining ring		
Balance drum		
Balance drum bearing		
O-ring x 2		

6.4.2 Rotating assembly (fully assembled) – Class 3

The rotating assembly below comprises:

- Mechanical seal
- Retaining ring
- Retaining ring screw
- Balance drum
- Set of impeller assemblies
- Set of casing stage pieces
- Coupling locating pin
- Set of spacer shims
- Set of O-rings
- Balance drum bearing

(NB - pre-load cone is not included.)

6.4.2.1 WMV rotating assembly

Stages	5WMV	8WMV	16WMV
4	RASSY-5WMV4-STD	RASSY-8WMV4	RASSY-16WMV4
5	RASSY-5WMV5	RASSY-8WMV5	RASSY-16WMV5
6	RASSY-5WMV6	RASSY-8WMV6	RASSY-16WMV6
8	RASSY-5WMV8-STD	RASSY-8WMV8	RASSY-16WMV8
10	RASSY-5WMV10-STD	RASSY-8WMV10	RASSY-16WMV10
12	RASSY-5WM12	RASSY-8WMV12-STD	RASSY-16WMV12
14	RASSY-5WMV14	RASSY-8WM14	RASSY-16WMV14-STD
16	RASSY-5WMV16	RASSY-8WMV16	RASSY-16WMV16
18	RASSY-5WMV18	RASSY-8WMV18	N/A
20	RASSY-5WMV20-STD	RASSY-8WMV20	N/A
24	RASSY-5WMV24	RASSY-8WMV24-STD	N/A
30	N/A	N/A	N/A

6.4.2.2 WMVS rotating assembly

Stages	5WMVS	8WMVS	16WMVS
4	RASSY-5WMVS4	RASSY-8WMVS4	RASSY-16WMVS4
5	RASSY-5WMVS5	RASSY-8WMVS5	RASSY-16WMVS5
6	RASSY-5WMVS6	RASSY-8WMVS6	RASSY-16WMVS6
8	RASSY-5WMVS8	RASSY-8WMVS8	RASSY-16WMVS8
10	RASSY-5WMVS10	RASSY-8WMVS10	RASSY-16WMVS10
12	RASSY-5WMVS12	RASSY-8WMVS12	RASSY-16WMVS12
14	RASSY-5WMVS14	RASSY-8WMVS14	RASSY-16WMVS14
16	RASSY-5WMVS16	RASSY-8WMVS16	RASSY-16WMVS16
18	RASSY-5WMVS18	RASSY-8WMVS18	RASSY-16WMVS18
20	RASSY-5WMVS20	RASSY-8WMVS20-STD	RASSY-16WMVS20
24	RASSY-5WMVS24	RASSY-8WMVS24	RASSY-16WMVS24
30	RASSY-5WMVS20-STD	RASSY-8WMVS30	N/A

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 20 screws/nuts
- Socket spanners (wrenches), up to M 20 screws
- Allen keys, up to 10 mm (A/F)
- Range of screwdrivers
- Thickness feeler gauges
- Shims of 1 mm thickness

6.6 Fastener torques

Pump size	Fastener	Torque Nm (lbf•ft)
5 and 8WMV(S)	Impeller nut Tie rod nut Coupling screw	13.5 (10) 35-40 (25-30) 27 (20)
16WMV(S)	Impeller nut Tie rod nut Coupling screw	20 (15) 55 (40) 27 (20)

6.7 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.*)

a) Isolate the power supply and disconnect motor cables.
b) Close suction and discharge valves and drain the pump casing - remove drain plugs (22) and (23).
c) Pumps mounted horizontally must be removed from the pipework and lifted to the vertical position for dismantling purposes.
d) Spring out the coupling guards (5). Remove the four socket head screws from the coupling and separate the coupling halves.
e) Push out the location pin (4) from the pump shaft.
f) Remove the four bolts securing the motor to the motor stool and lift off the motor. (Tapped holes for lifting eyes are incorporated in the larger motors.)
g) Remove the four tie rod nuts and lift off the motor stool, withdraw the pre-load cone (9) and any shims (10).

6.7.1 Mechanical seal

a) Without further dismantling this provides access to the mechanical seal. Pumps are fitted with either a Crane Type 502 seal (8) or Flowserve PAC P250 seal (8). Pull off the mechanical seal by hand or use light leverage if necessary. Cleaning the shaft and lubrication by soap solution or light oil is beneficial in this operation. The seal seat is removed from the motor stool by pressing out from the motor side.
b) If replacing the seal is the only maintenance required, clean the pump shaft, replace the O-ring in the motor stool, if damaged and re-assemble the pump as described in the assembly section.
c) To continue dismantling, lift off the outer casing (18), remove the tie rods (17), and release the seal retaining ring (12) by slackening the grub screw (11). (In the case of the older type Angus seal, the sleeve is removed by slackening the grub screw.)

d) At this point, although it is possible to lift off the complete shaft assembly, it should be left in place to enable the correct dismantling procedure to be followed.
e) The top stage piece can be lifted off revealing the final stage impeller. If there is any difficulty with this operation light leverage can be applied between the external lugs on the adjoining stage pieces.
f) Now slacken off the impeller nut (13), (right-hand thread) until it stands proud of the split bush (14) by approximately half a thread. The shaft can be prevented from rotation by means of a 5 mm bar through the drilled hole in the top of the shaft.
g) To release the lock of the split bush (14) insert shims between the next two stage pieces. These should be 2-3 mm thick and arranged either side. Take care that the lug and slot inside the stage pieces are still engaged.
h) Now slide a weight with a 17 mm diameter hole (23 mm for size 16WMV) down the shaft and strike the impeller nut. The two coupling halves loosely screwed together are convenient for this. The impact will free the impeller which can then be lifted off complete with split bush and nut. Proceed with the remaining stages in the same manner.
i) The final impeller does not require shimming to release the split bush. It is usually unnecessary to remove the stage piece adaptor (19) but it can be separated from the suction/discharge casing (24) with extraction tools.
j) Should it be necessary to remove the balance drum bearing this can also be done with extraction equipment or, for the shell type bearing, by collapsing it along its split line to relieve the interference fit.

6.7.2 Replacement parts

a) The shaft and balance drum are normally supplied as a combined unit - bonded with a high strength Loctite with primer. If wishing to replace the balance drum only, apply gentle heat and pull from the shaft with extraction tools.
b) Before fitting the new balance drum, thoroughly clean and de-grease the mating surfaces. Bond with Loctite as above.
c) If the balance drum bearing is to be replaced, press squarely into its housing until flush with the top face of the boss (shell type bearing), or far enough into the housing to fit the retaining ring (27) for the polymer bush bearing.
d) It is usual to replace mechanical seals in their entirety, as otherwise initial leakage can be a problem.

6.8 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.

6.8.1 Casing, seal housing and impeller

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

6.8.2 Shaft and sleeve (if fitted)

Replace if grooved, pitted or worn.

Note: If fitted with the older type Angus balanced seal, the replacement does not require a sleeve.

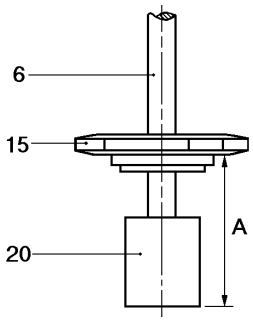
6.8.3 Gaskets and O-rings

After dismantling, discard and replace.

6.9 Assembly

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

a) Ensure threads, gasket and O-ring mating faces are clean. Apply thread sealant to non-face sealing pipe thread fittings.
b) Position the first impeller on the shaft to dimension 'A' as shown.



5WMV and 8WMV: 'A' = 77 mm (3.03 in.)
16WMV: 'A' = 91 mm (3.58 in.)

c) This dimension applies when the impeller nut is tightened using a box spanner gripped in the palm of the hand. Do not use a tommy bar or other form of leverage at this stage. Check the dimension and then tighten the impeller nut to the recommended torque listed.

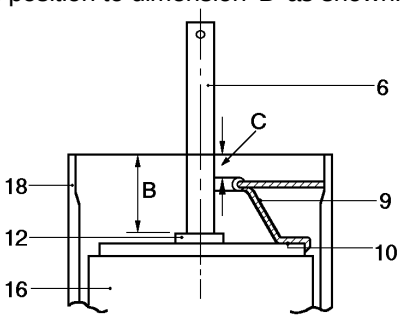
Note: The final tightening will move the impeller slightly.

d) If it has been removed, fit the stage piece adaptor into the suction/discharge casing with three spots of low strength Loctite, first ensuring that the mating surfaces are clean.

e) Lower the shaft and balance drum assembly, with one impeller, into the suction/discharge casing and stage piece adaptor. Ensure that the impeller is sitting squarely on the top face of the stage piece adaptor and fit the first stage piece ensuring that the lug locates with the slot in the stage piece adaptor.
f) Now place shims, 1 mm (0.04 in.) thick, underneath the first stage piece and then slide the next impeller down the shaft into contact with the stage piece.
g) Keeping the shaft firmly pressed down, hand tighten the impeller nut with a box spanner as described above.
h) Now remove the 1 mm (0.04 in.) shims and tighten the impeller nut to the torque listed.
i) Holding down the stage piece with one hand check that there is a minimum of 4 mm (0.16 in.) axial movement (5 mm [0.2 in.] on size 16WMV) in the shaft and impellers.
j) Check the shaft for ease of rotation.
k) Fit each succeeding stage piece and impeller in the same manner, ensuring that the lug inside each stage piece engages in the slot in the previous stage piece. The external lugs on the stage pieces will be in alignment in this condition.
l) Make sure that the shaft is in its bottom position before the impellers are locked and that there is a minimum of 4 mm (0.16 in.) axial movement (5 mm [0.2 in.] on size 16WMV) of the shaft after each stage piece has been fitted. Also check freedom of rotation.
m) Fit the O-rings into the grooves in the suction/ discharge casing and motor stool.
n) Fit the tie rods into the tapped holes in the suction/discharge casing ensuring that they are screwed firmly to the bottom of the thread.
o) Note: On larger units, when working single handed, it may be easier to fit the tie rods after the motor stool has been positioned on top of the outer casing. This can be done by passing the top end of the tie rod up through the hole in the motor stool and then screwing the bottom end into the suction/discharge casing.
p) Apply soap solution or light oil on the O-ring in the suction/discharge casing and fit the outer casing, ensuring that it passes over the O-ring and butts up firmly to the shoulder on the suction/discharge casing. (Any clearance will subsequently give a faulty setting to the seal and pre-load cone.)

6.9.1 Mechanical seal

a) Slide the seal retaining ring (12) onto the shaft and set in position to dimension 'B' as shown.



Dimension	Seal type	5 and 8WMV	16WMV
B	Crane type 2 (discontinued)	41 mm (1.614 in.)	40 mm (1.574 in.)
B	Angus balanced (discontinued)	41 mm (1.614 in.)	42 mm (0.1654 in.)
B	Crane type 502	39.5 mm (1.555 in.)	39 mm (1.535 in.)
B	Flowserve PAC type P250	39.5 mm (1.555 in.)	39 mm (1.535 in.)
C	Any	13.6 - 14.1 mm (0.535 - 0.555 in.)	12.6 - 13.1 mm (0.496 - 0.516 in.)

NB: tolerance on B setting is +1.0 mm - 0.0 mm

b) Lock in position with socket screw.
c) Note: Set seal retaining ring with shaft in bottom position. (For the superseded Angus balanced seal the same dimension applies down to the shoulder on the shaft sleeve.)
d) Fit the pre-load cone (9) and such shims (10) as are necessary to maintain dimension 'C' as shown. The pre-load cone must be kept firmly pressed down whilst checking the dimension. Use shims 1 mm (0.04 in.) and 0.5 mm (0.02 in.) thick as required.
e) Lift off the pre-load cone and shims, apply soap or light oil to the shaft and slide on the seal unit, up to the retaining ring for the crane seal (or to the shoulder on the sleeve for the Angus seal).
f) Re-fit the preload cone and shims. Fit the seal seat in the motor stool.
g) Lower the motor stool over the shaft and tie rods and into the end of the outer casing, aligning the filling/vent connection as shown on the outline arrangement drawing or as required.
h) Take care not to damage the seal seat on the end of the shaft when fitting the motor stool. The shoulder on the motor stool will not fit all the way down to the end of the outer casing until the tie rod nuts are tightened because of the spring pressure from the pre-load cone.
i) Tighten the tie rod nuts to the torque listed.

j) Push the location pin into the drilled hole in the pump shaft, place the two coupling halves around the shaft locating on the pin and loosely bolt together with the four socket head screws.
k) Carefully lower the motor into place onto the spigot on the motor stool.
l) Position the terminal box to the outline arrangement drawing, or as required, and securely tighten the four motor retaining bolts.

6.9.2 Positioning the pump shaft

a) Position pump shaft 1.5 mm (0.06 in.) above bottom position (2 mm [0.08 in.] on size 16WMV) using shims or taper gauges between the bottom face of the coupling and the top face of the motor stool.
b) Tighten the socket head screws in coupling to torque listed. During tightening ensure that the two faces of the coupling halves remain parallel with an equal gap each side.
c) Spring the coupling guards into the grooves in the motor stool.

7 FAULTS; CAUSES AND REMEDIES

FAULT SYMPTOM

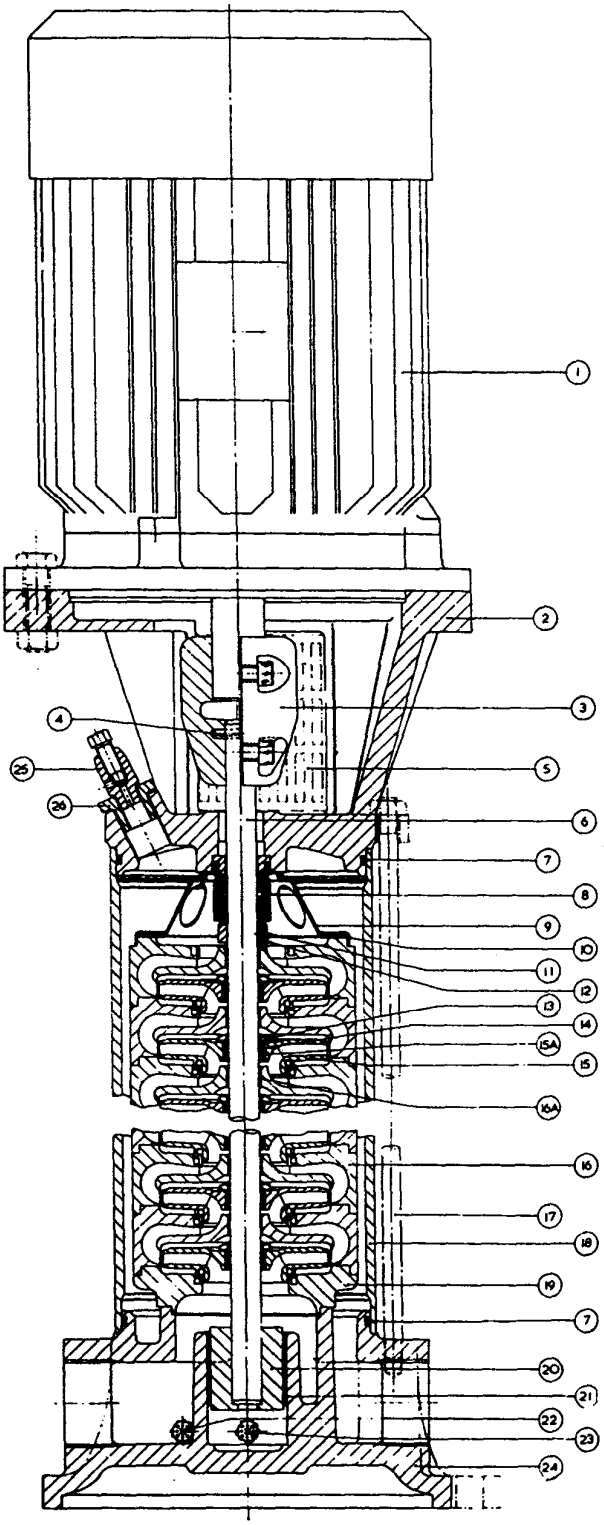
Pump overheats and seizes	Bearings have short life	Pump vibrates or is noisy	Mechanical seal has short life	Mechanical seal leaks excessively	Pump requires excessive power	Pump loses prime after starting	Insufficient pressure developed	Insufficient capacity delivered	Pump does not deliver liquid	POSSIBLE 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.
●	●	●			●					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.

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	POSSIBLE CAUSES	POSSIBLE REMEDIES
		●					●	●		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 SECTIONAL ARRANGEMENT DRAWINGS AND PARTS LISTS

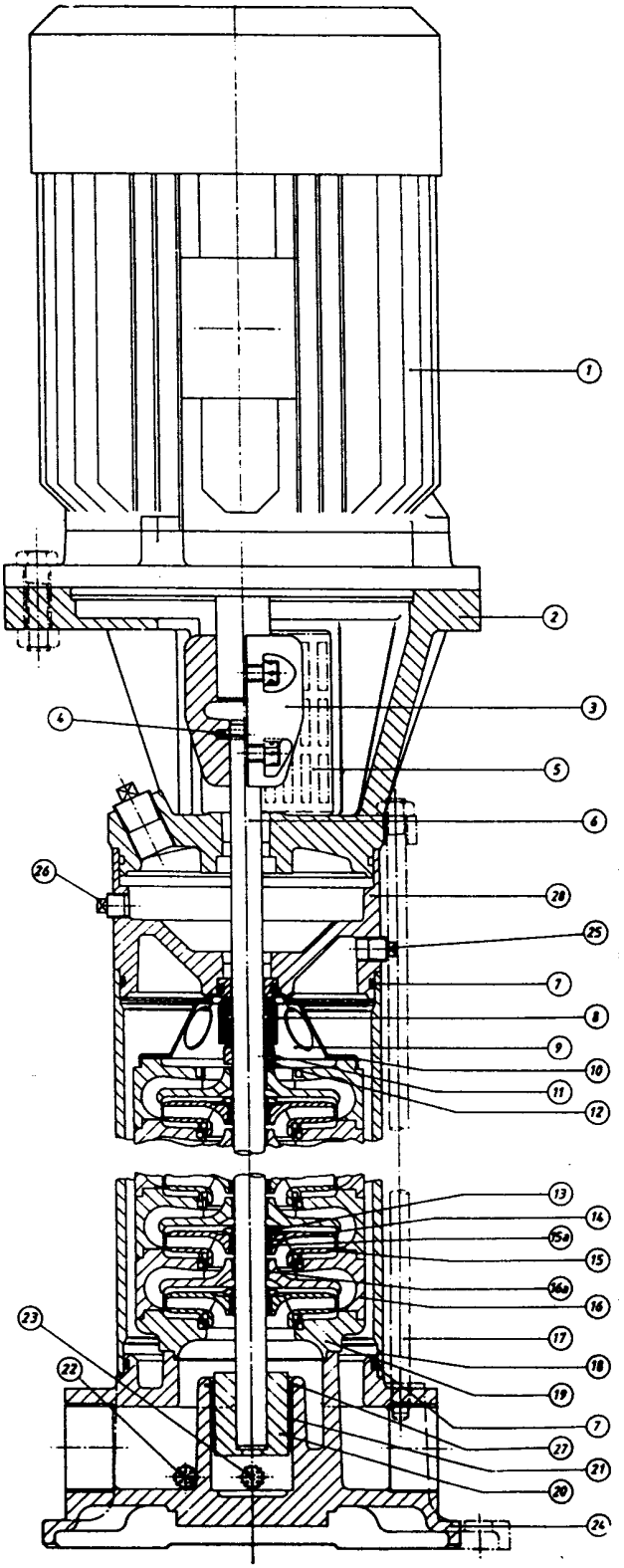
8.1 Type WMV



Item	Part no.	Description	Material
1	8100	Motor	-
2	3160	Motor pedestal	Cast iron
3	7120	Coupling half	Cast iron
-	6570.1	Screw for coupling	-
4	2923	Pin	Zinc plated steel
5	7450	Coupling guard	Sheet steel
6	2100	Shaft	431S29 stainless steel
7	4510	O-ring	Synthetic rubber
8	4200	Mechanical seal	-
9	-	Pre-load cone	Stainless steel
10	3126	Shims	Polypropylene
11	6570.2	Grub screw	Stainless steel
12	2530	Retaining ring	Stainless steel
13	2912	Impeller nut	Stainless steel
14	-	Split bush	Stainless steel
15	2200	Impeller	Noryl® thermoplastic resin
15A	-	Impeller insert	Stainless steel
16	-	Stage piece	Noryl® thermoplastic resin
16A	-	Stage bearing	PTFE/lead/bronze
17	6571	Tie bolt	High tensile steel
18	-	Outer casing	Steel
19	-	Stage piece adaptor	Cast iron
20	6230	Balance drum	Stainless steel
21	6231	Balance drum bearing	PTFE/lead/bronze
22	6569.1	Drain/gauge plug	-
23	6569.2	Drain/gauge plug	-
24	1100	Casing	Cast iron
25	6523	Air release valve	-
26	-	Reducing bush	-

Ref. 15A and 16A are not separate components.
Noryl® is a registered trademark of General Electric Plastics BV.

8.2 Type WMVS



Item	Part no.	Description	Material
1	8100	Motor	-
2	3160	Motor pedestal	Cast iron
3	7120	Coupling half	Cast iron
-	6570.1	Screw for coupling	-
4	2923	Pin	Zinc plated steel
5	7450	Coupling guard	Sheet steel
6	2100	Shaft	431S29 stainless steel
7	4610	O-ring	Synthetic rubber
8	4200	Mechanical seal	-
9	-	Pre-load cone	Stainless steel
10	3126	Shims	Polypropylene
11	6570.2	Grub screw	Stainless steel
12	2530	Retaining ring	Stainless steel
13	2912	Impeller nut	Stainless steel
14	-	Split bush	Stainless steel
15	2200	Impeller	Noryl® thermoplastic resin
15A	-	Impeller insert	Stainless steel
16	-	Stage piece	Noryl® thermoplastic resin
16A	-	Stage bearing	Filled polymer
17	6571	Tie bolt	High tensile steel
18	-	Outer casing	Stainless steel
19	-	Stage piece adaptor	Stainless steel
20	6230	Balance drum	Stainless steel
21	6231	Balance drum bearing	Filled polymer
22	6569.1	Drain/gauge plug	Stainless steel
23	6569.2	Drain/gauge plug	Stainless steel
24	1100	Casing	Stainless steel
25	6523	Filling/vent air release plug	-
26	-	Seal chamber plug	-
27	-	Retaining ring	Stainless steel
28	-	Seal adaptor	Stainless steel

Ref. 15A and 16A are not separate components.
Noryl ® is a registered trademark of General Electric Plastics BV.

8.3 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 Solution Group, 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:

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