FLOWSERVE

USER INSTRUCTIONS

Installation
Operation
Maintenance

INNOMAG® TB-MAG™
Sealless Chemical Process Pumps

Horizontal (close-coupled, long coupled
or Dual Drive™), Vertical (close coupled),
ETFE lined casing or metallic casing
in DCI or Stainless Steel Alloys

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

Experience In Motion

Original Instructions

CONTENTS

1 General Information

1.1 Scope of manual

NOTICE

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

- ▷ These instructions must be read prior to installing, operating, using, or maintaining the equipment in any region worldwide.
- ▷ The equipment must not be put into service until all the safe operating conditions noted in the instructions have been met.
- ▷ Failure to comply with the information provided in the User Instructions is misuse. Personal injury, product damage, delay in operation, or product failure caused by misuse are not covered by the Flowserve warranty.

These instructions are intended to familiarize the reader with the product and its permitted use. Operating the product in compliance with this instruction is important to help ensure reliability in service and avoid risks. These instructions may not consider all local regulations; ensure such regulations are observed by all, including those installing the product. Always coordinate repair activities with operations personnel and follow all plant safety requirements and applicable safety and health legislation. Supplementary user instructions determined from the contract requirements for inclusion into User Instructions for buy-out equipment such as driver, instrumentation, controller, sub-driver, seals, mounting component etc., are delivered separately.

1.2 Disclaimer

Information in this User Instruction is believed to be complete and reliable. Despite all Flowserve's efforts to provide comprehensive information and instructions, sound engineering and safety practices shall be used. Please consult with a qualified engineer.

Flowserve manufactures products to applicable 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 product. The failure to properly select, install, or use authorized Flowserve parts and accessories is 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 use.

1.3 Symbol explanation

Symbols	Meaning	Description
	Information	This symbol indicates a recommendation and important information for handling the product.
	Hazard prevention	This symbol indicates hazard prevention measures.
	Prerequisites	This symbol refers to the prerequisite conditions in operating instructions.
	Repetition	This symbol in operating instructions refers to repetition of a sequence of actions.
	Result	This symbol refers to the result of operating instructions or sequence of actions.
	Step	This symbol refers to an individual step.
	Spare	This symbol indicates spares required in a maintenance/service step.
	Special tool	This symbol refers to special tools required in an installation or maintenance/service step.
	Personnel	This symbol refers to a section for specially authorized personnel.
	Consumables	This symbol refers to consumables required in an installation or maintenance/service step.
	Protective equipment	This symbol refers to protective equipment required in an installation or maintenance/service step.
	Documentation	This symbol refers to supplier documentation required in an installation or maintenance/service step.

Table 1: Used symbols

1.4 Certification instruction

It is a legal requirement that machinery and equipment put into service within certain regions of the world shall conform to the Marking Directives applicable to Flowserve products (i.e., Machinery Directive, Low Voltage Directive, Electromagnetic Compatibility (EMC) Directive, Pressure Equipment Directive (PED), Directive 2014/34/EC Equipment for Potentially Explosive Atmospheres (ATEX), Directive 2006/42/EC (CE Marking).

NOTICE

The Certificates defined in the Contract requirements are provided with these instructions where applicable. If required, copies of other certificates sent separately to the Purchaser shall be obtained from the Purchaser for retention with this User Instruction.

1.5 Units

The units of measure used in this document are according to the imperial system (e.g., lb, ft, s, …) followed by metric equivalents in parenthesis.

1.6 Warranty

Flowserve Warranty applies only if the pump is installed and operated in compliance with these instructions and in operating conditions approved by Flowserve.

2 Safety Information

2.1 Intended use

Always consult with an independent, licensed engineer to help design a pump system and to select the appropriate products for that system. Flowserve designs products to operate in a variety of application conditions. An acknowledgement of these conditions has been sent separately to the Purchaser. A copy shall be kept with these instructions. Any use of a Flowserve product outside of these conditions could result in damage to the equipment, serious personal injury, or death.

NOTICE

The product/system must not be operated beyond the parameters specified for the application.

- ▷ If there is any doubt as to the suitability of the product/system for the intended application, contact Flowserve for advice, quoting the serial number or consult a licensed engineer to determine suitability for your application.

⚠ WARNING

Installing, operating, or maintaining the product/system in any way that is not covered in this User Instruction could cause death, serious personnel injury, or damage to the equipment. This includes any modification to the product/system or use of the parts not provided by Flowserve.

- ▷ Only operate the product/system when it has successfully passed all acceptance criteria.
- ▷ Do not operate the product/system in a partially assembled condition.
- ▷ If the conditions of service on the customer's purchase order change (i.e., pumping fluid, temperature, or duty conditions) the user shall seek written agreement from Flowserve before pump start.
- ▷ Observe equipment labels, such as arrows designating the direction of rotation, warning signs, etc., and keep them in a legible condition. Replace damaged and/or illegible labels immediately.

2.2 Safety symbols and description

This User Instruction contains specific safety markings where non-observance of an instruction would cause a hazard. The specific safety markings are:

Symbols	Description
⚠ DANGER	**DANGER** This symbol indicates a hazardous situation which, if not avoided, will result in death or serious injury
⚠ WARNING	**WARNING** This symbol indicates a hazardous situation which, if not avoided, could result in death or serious injury
⚠ CAUTION	**CAUTION** This symbol indicates a hazardous situation which, if not avoided, could result in minor or moderate injury
SAFETY INSTRUCTION	**SAFETY INSTRUCTIONS** This symbol indicates specific safety-related instruction or procedures
NOTICE	**NOTICE** This symbol is used to address practices not related to physical injury

Table 2: Definition of safety symbols and markings

Symbols	Description
	**SAFETY ALERT** This is the safety alert symbol. It is used to alert you to potential physical injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.
	**ELECTRICAL HAZARD** This symbol indicates electrical safety instructions where non-compliance would affect personnel safety and could result in loss of life.
	**TOXIC HAZARD** This symbol indicates “hazardous substances and toxic fluid” safety instructions where non-compliance would affect personnel safety and would damage the equipment or property.
	**ATEX EXPLOSION PROTECTION** This symbol indicates explosive atmosphere marking according to ATEX. It is used in safety instructions where non-compliance in the hazardous area would cause the risk of an explosion.
	**PACEMAKER** This symbol indicates “Pacemaker” safety instructions where non-compliance would affect personal safety and could result in loss of life.
	**CAUSTIC**
	**RISK OF ENTRAPMENT**
	**RISK OF FIRE**
	**HANGING LOAD**
	**IRRITATING**
	**RISK OF SLIPPING**
	**EXCLAMATION SYMBOL** This symbol is used for notice labels.
	**RISK FOR ENVIRONMENTAL DAMAGE**
	**RISK FOR MATERIAL DAMAGE**
	**DO NOT USE DRY CLOTH**
	**DANGER OF EXPLOSION**

Table 3: Additional symbols

2.3 Non-compliance with safety instructions

⚠ WARNING

Non-compliance with the safety instructions may result in risk to personnel as well as to the environment and the pump/pump set and result in the loss of any right to claim damages. For example, non-compliance may result from, or lead to, the following:

- Failure of important functions of the pump/pump set/plant.
- Failure of specified procedures of maintenance and repair.
- Exposure of people to electrical, mechanical, and chemical hazards.
- Danger to the environment due to hazardous substances being released.

2.4 Accident prevention

The customer undertakes to respect the safety instructions shown in this manual, the national accident prevention regulations, as well as the internal regulations relating to the working conditions, the equipment operation and safety.

2.5 Personnel actions in case of incident, critical failure, or accident

NOTICE

If one or more critical failures are detected, it is necessary to decommission the equipment to find out and eliminate the causes of these failures. In case of any incidents and / or accidents, personnel are required to comply, with the relevant local instructions developed and accepted by the end-user operator.

2.6 Critical failures

⚠ CAUTION

The following critical failures may lead to an accident:

- Permanent loss of tightness of joints against the external environment.
- Destruction or loss of the tightness of the pump body or auxiliary elements.
- Leaks of the working or cooling media.
- Failure of equipment controlling the operation parameters.
- Decoupling of magnetic drives during start up and operation can cause excessive heat.
- The pump must only be used to handle liquids for which it has been approved to prevent excessive temperatures and magnet decoupling as result of high viscous or high specific gravity fluid.

2.7 General hazard sources

2.7.1 Mechanical Hazards

Mechanical energy can cause personal injury and material damage. Mechanical hazards during installation and maintenance can be divided up as follows.

a) Lifting limits and guidelines.

⚠ CAUTION

The load values mentioned in this section are Flowserve recommendations only.

- ▷ All lifting must be done in compliance with site safety protocol, local regulations, and related industry standards.Failure of specified procedures of maintenance and repair.

Many precision parts have sharp corners which require appropriate personal protective equipment during handling. Prior to any attempt to lift an item, employees must first determine the approximate weight and stability of the load.

- ▷ Large, unstable, or awkward loads should always be handled with the assistance of additional personnel or appropriate mechanical means.
- ▷ Loads more than 50 lb (23 kg) shall only be lifted by appropriate mechanical means and in accordance with current local legislation or with the assistance of additional personnel.
- ▷ Lifting items less than 50 lb (23 kg) may be prohibited without assistance if the lift is repetitive and/or awkward (i.e., away from the body, above the shoulders or below the knees) thus placing excessive stress on the personnel.
- ▷ Repetitive lifting of any kind shall be evaluated as part of a documented end-user safety program.

b) Rotating and other moving parts

⚠ WARNING

Rotating and other moving parts may cause injury during installation and maintenance work.

- ▷ Guards for moving parts (e.g., couplings) must not be removed from the pump/ pump set while in operation.
- ▷ Coupling guards are safety components only. DO NOT use as a step or other support point.
- ▷ To prevent a potential hazard from mechanical contact, the coupling guard must be non-sparking and anti-static for EPL Gb (category 2) equipment.
- ▷ The coupling must be selected to comply with 2006/42/EC and correct alignment must be maintained.

2.7.2 Electrical Hazards

⚠ DANGER

Electrical power can cause serious injuries and even death. It is often the cause of material damage, in particular fires.

- ▷ Never do maintenance or installation works when the unit is connected to power.
- ▷ Always make sure local regulations are complied with.

SAFETY INSTRUCTIONS

Carry out the following safety measures prior to working on electrical devices:

- ▷ Wear insulated shoes with rubber soles.
- ▷ Disconnect the system from the electrical supply.
- ▷ Safeguard the system against activation.
- ▷ Use a suitable measuring instrument to check that the system has been electrically isolated. Observe a five second discharge time for capacitors.
- ▷ Cover neighboring live parts and attach appropriate warning signs.

⚠ DANGER

Damaged earthing can cause serious personal injury and damage to property.

▷ Repairs or other work, always ensure that all earthing is re-established.

NOTICE

Also refer to the user instructions of all auxiliary devices installed on the pump and in the installation.

2.7.3 Additional hazards

Irritant and toxic substances

⚠ WARNING

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

Hazardous liquids

⚠ WARNING

▷ Pumped media and equipment can cause suffocation.

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

▷ Gland packing or belt drive must not be used when pumping hazardous liquids.

Hot/cold components

⚠ WARNING

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

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

▷ Never apply heat to remove impeller, trapped lubricant or vapor could cause an explosion.

Corners and sharp edges

⚠ WARNING

Corners and sharp edges can be the cause of tripping, falling and entrapment accidents and skin injuries.

Thermal shock

⚠ WARNING

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 shall be avoided.

Magnetic field

⚠ DANGER

TB-MAG pumps contain extremely strong permanent neodymium magnets which could affect the functioning of pacemakers and implanted heart defibrillators. If you wear these devices keep sufficient distance to magnets.

⚠ CAUTION

- Magnets produce a far-reaching, strong magnetic field. They can damage laptops, computer hard drives, credit and ATM cards, data storage media, mechanical watches, hearing aids and speakers. Keep magnets away from devices and objects that could be damaged by strong magnetic fields.
- Magnets can attract metallic foreign objects into the close clearance rotating zones causing leakage or overheating.
- Magnetic drives develop a high attraction force, always use pinch resistant gloves, non-magnetic tools, and proper precautions.

NOTICE

Dual Drive pumps contain two magnetic drives.

2.7.4 Noise hazards

⚠ CAUTION

Attention must be given to the exposure of personnel to the noise. 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 Table 4. 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 several 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 noise levels in the table should be adjusted for the driver level obtained from the supplier. Consult Flowserve or a noise specialist if assistance is required in adjusting the values.

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

The values in Table 4. are in sound pressure level at 3 ft (1 m) from the machine, for “free field conditions over a reflecting plane” and are valid for preferred range of pump operation (80% to 110% of B.E.P.). For estimating sound power level LWA (re 1 pW) then add 14 dBA to the sound pressure values in Table 4.

Motor size and speed hp (kW)	Typical sound pressure level at 3 ft (1 m) reference dBA							
	3550 r/min		2900 r/min		1750 r/min		1450 r/min	
	Pump only	Pump and motor	Pump only	Pump and motor	Pump only	Pump and motor	Pump only	Pump and motor
<0.75 (<0.55)	58	65	50	58	50	52	50	52
1 (0.75)	60	65	52	59	51	54	51	54
1.5 (1.1)	62	67	54	60	55	57	53	56
2 (1.5)	63	66	55	63	56	59	54	58
3 (2.2)	64	69	57	65	58	62	56	60
4 (3)	63	71	58	68	59	64	57	62
5 (4)	64	72	60	69	61	65	59	63
7.5 (5.5)	66	73	62	71	63	67	61	65
10 (7.5)	67	73	63	71	64	69	62	67
15 (11)	69	76	65	73	66	71	64	69
20 (15)	71	77	67	74	68	72	66	70
25 (18.5)	72	78	68	75	69	70	67	70
30 (22)	73	78	69	76	70	71	68	71
40 (30)	75	79	71	77	72	72	70	72
50 (37)	76	80	72	78	73	73	71	73
60 (45)	77	81	73	79	74	74	72	74
75 (55)	78	81	74	79	75	75	73	75
100(75)	80	83	76	81	77	76	75	76
120 (90)	81	84	77	81	78	77	76	77
150 (110)	82	85	78	82	79	78	77	78
3200 (150)	84	87	80	84	81	79	79	79
270 (200)	①	①	①	①	81	81	79	79
400 (300)					83	86	81	82

Table 4: Typical sound pressure level

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

2.8 Responsibility of the operating company

NOTICE

The owner is the person who operates the equipment or commissions a third party with its use and is responsible for the protection of the user, personnel, the environment and or third party.

The following non-exhaustive list of tasks falls under the responsibility of the owner:

- Implementing the valid occupational safety provisions,
- Generating a risk assessment for the conditions at the site of operation,
- Generating work instructions for the operation of the equipment in the installation,
- Updating the work instructions in accordance with the valid provisions,
- Deployment of personnel qualified for the activity,
- Regular training of personnel, Informing of risks at the workplace and
- Providing the necessary personal protective equipment,
- Designing the overall system (that includes the pump) to be suitable and appropriate for the application,
- Ensuring the pump set is only operated within the specific design limits of temperature, pressure, flow and pumped fluid specific gravity of the pump set.
- Ensuring the pump is adequately monitored for the risk level of the pumped fluid. High risk fluids may require vibration, temperature, power, and leakage monitoring. Especially for Dual Drive pumps.

NOTICE

Signs affixed directly on the machine, such as the arrow indicating the direction of rotation or the arrows indicating fluid suction and discharge connections must be observed and kept legible.

2.9 Qualified personnel and targeted group

NOTICE

All personnel involved in the operation, installation and maintenance of the unit must be qualified to carry out the work involved. Qualified personnel for installation, operation and maintenance of the equipment are characterized by:

- Fulfillment of the qualification required for the activity.
- Knowledge of the current operating instructions
- Knowledge of the applicable operational safety regulations
- Knowledge of local rescue facilities.

If the personnel in question does not already possess the necessary knowledge and skill, appropriate training and instruction must be provided. If required, the operator may ask the manufacturer / supplier to provide applicable training.

SAFETY INSTRUCTIONS

Always co-ordinate repair activities with operation and health and safety personnel and follow all plant safety requirements and applicable safety and health laws and regulations.

2.9.1 Specialist for electrical installation

Low-voltage electrician with standard tools for connecting electric motors and determining the rotating electric field.

2.9.2 Machine fitter

Specialist personnel for installation, maintenance, repair and overhaul of machine and plant components in mechanical and plant engineering sector using standard tools.

2.9.3 Transport specialist

Trained in handling hand pallet trucks, forklifts, or cranes, depending on application.

2.9.4 Packaging specialist

Experience in the safe packaging of machines for transport.

2.10 Industrial health and safety measures

Follow industry safety standards including the use of appropriate equipment in required areas.

2.11 Potentially explosive area

All instructions for equipment 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 the European Explosion Protection Directive 2014/34/EU. Always observe the regional legal Ex requirements. e.g., Ex electrical items outside the EU may be required certified to other than ATEX e.g., IECEx, UL.

Measures are required to:

- Avoid excess temperature.
- Prevent collection of explosive mixtures.
- Prevent the generation of sparks.
- Prevent leakages.
- Maintain the pump to avoid hazard.
- Dual Drive pumps require leakage monitoring in the secondary containment field. If leakage is detected, immediately shutdown the pump and within 48 hours drain and service the pump prior to commencing operations. Consult your INNOMAG sales contact for details.

⚠ WARNING

- ▷ Use equipment only in the zone for which it is appropriate.
- ▷ Always check that all equipment is suitably rated and/or certified for the classification of the specific atmosphere in which they are to be installed and used.
- ▷ 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, both electrical and non electrical 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 per Europian Directive 2014/34/EU.per (VFD) can cause additional heating effects in the motor and so, for pumps sets with a VFD, the ATEX Certification for the motor must state that it is covers the situation where electrical supply is from the VFD. This particular requirement still applies even if the VFD is in a safe area.
- ▷ Direct on line starting of the Dual Drive pump with its dual magnetic drives shall only be done with the discharge valve partially open not fully open. Starting with a full open discharge valve can cause decoupling and rapid overheating of the magnetic drive.
- ▷ Make sure a maintenance plan and schedule are adopted in line with these User Instructions.

2.11.1 Electrical systems

NOTICE

For pump sets with electrical devices (e.g., motor, temperature measurement device), the installed devices need to be certified in accordance with the zone they are installed in.

2.11.2 Mechanically generated sparks

⚠ WARNING

Eliminate the risk of sparking and excessive surface temperatures due to mechanical stresses.

- ▷ Always make sure the coupling is aligned correctly, refer also to Chapter 5.
- ▷ For hot applications, make sure to check the alignment with pump at operating temperature.
- ▷ Apply adequate provisions to allow for thermal expansion in hot or cold applications.

Eliminate the risk of sparks during maintenance works.

- ▷ Tools used during maintenance in the installation must be approved for the applicable zone.
- ▷ Always move the equipment to safe area for dismantling.

2.11.3 Sparks produced by external shocks

NOTICE

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

These instructions must be read prior to installing, operating, using, or maintaining the equipment in any region worldwide.

- ▷ The equipment must not be put into service until all the safe operating conditions noted in the instructions have been met.
- ▷ Failure to comply with the information provided in the User Instructions is misuse. Personal injury, product damage, delay in operation, or product failure caused by misuse are not covered by the Flowserve warranty.

⚠ WARNING

During use in explosive atmospheres, the operator shall see to it that external shocks on the pump or pump set components, which could produce sparks, are not likely to occur,

- ▷ Necessary guards shall be installed to prevent this.

2.11.4 Leakage of flammable liquids

⚠ WARNING

In case of flammable liquids, leakage to the atmosphere could create a hazardous situation.

- ▷ Gland packing must not be used when pumping flammable and explosive liquids.
- ▷ Only qualified personnel shall do assembly and installation works, taking in to account the assembly and installation instructions.
- ▷ Prior to first pump start always check pump assembly tightening torques per Table 10.
- ▷ Avoid entrapment of liquid in the pump and associated piping during operation due to closing of valves, which could cause dangerous pressures to occur.
- ▷ The use of brittle materials for pressure containing parts that are directly exposed to the atmosphere is not allowed when handling flammable media. When handling flammable media, make sure that the fluid does not contain any abrasive particles. In case of doubt, contact FLOWSERVE.
- ▷ For applications where there is a risk of (ferro)magnetic particles entering the pump, provisions need to be taken to make sure that no (ferro)magnetic particles reach the area of the inner magnet. (e.g., by external circulation, suction strainer, ...)

  Note, Dual Drive pumps contain two mag drives.
- ▷ Make sure the area of the installation is well ventilated.

2.11.5 Buildup of explosive mixtures

⚠ WARNING

Buildup of explosive mixtures inside the equipment must be avoided!

- ▷ Always ensure the pump is properly filled and vented.
- ▷ Never run the pump dry.
- ▷ Make sure if a suction strainer is installed that it is not clogged and regularly checked.
- ▷ If system operation could allow start-up of pump without completely being filled, a liquid detection device shall be installed in the vertical section of discharge piping to prevent this condition.
- ▷ If system operation could allow the pump running dry a power monitor shall be installed to prevent this condition.
- ▷ Liquid level controls are recommended to avoid the risk of dry running.

2.11.6 Static electricity

⚠ WARNING

Eliminate the risk of sparks generated by static electricity.

- ▷ Make sure metal baseplates are properly earthed. In case a non-metal baseplate is used all components must be earthed individually.
- ▷ Make sure the interface between pump and baseplate is electrically conductive. If this cannot be assured, the pump shall be earthed individually.
- ▷ Make sure all auxiliary equipment installed has equipotential bonding with the earthing provision of the installation.
- ▷ Do not rub non-metallic or coated surfaces with a dry cloth Ensure cloth is damp.
- ▷ The applied painting systems by Flowserve allows the equipment to be used for all gas groups including IIC. If a special paint system or repainting is required, contact Flowserve.

2.11.7 Hot surfaces

2.11.7.1 Pump

⚠ WARNING

Insulation could lead to elevated surface temperatures.

- ▷ Always ensure that the surfaces of areas with elevated temperatures (e.g., bearing supports, lantern) have free contact with the atmosphere to allow convective heat removal!

2.11.7.2 Temperature limits

⚠ WARNING

Pumps have a temperature class as stated in the ATEX Ex rating on the nameplate. These are based on a maximum ambient temperature of 104 ºF (40 ºC); 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.

2.11.7.3 Temperature limits

Temperature class to ISO 80079-36	Maximum surface temperature permitted	Temperature limit of liquid handled
T6	185 °F (85 °C)	149 °F (65 °C)
T5	212 °F (100 °C)	176 °F (80 °C)
T4	275 °F (135 °C)	239 °F (115 °C) *
T3	392 °F (200 °C)	356 °F (180 °C) *
T2	572 °F (300 °C)	527 °F (275 °C) *
T1	842 °F (450 °C)	752 °F (400 °C)

Table 5: ATEX temperature classes

* The table only takes the ATEX temperature class into consideration.

The temperature rises at the seals and bearings and due to the minimum permitted flow rate is considered in the temperatures stated.

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

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

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

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

If a defective cooling system can generate surface temperatures higher than acceptable, a cooling monitoring device must be installed.

2.11.7.4 Preventing the collection 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 always filled with liquid during the pump operation, so that an explosive atmosphere is prevented.

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

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

2.11.7.5 Additional requirement for metallic pumps on non-metallic baseplates

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

2.11.7.6 Preventing leakage

	NOTICE
	▷ The pump must only be used to handle liquids for which it has been approved to have the correct corrosion resistance. ▷ Dual Drive pumps installed in an explosive environment require a leakage detection device to be installed which operates an alarm or automatic switch-off function. If leakage is detected, immediately shutdown the pump and within 48 hours drain and service the pump prior to commencing operations.

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.

2.11.7.7 Maintenance to avoid the hazard

	NOTICE
	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 8, maintenance.)

	NOTICE
	Table 5, 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 operating limits for the installed equipment must be observed. ▷ Grease lubricated bearings are not allowed for temperature class T5. ▷ For pumps with heating jackets the use of Table 5 also applies. In this case, the liquid with the highest temperature shall be used. ▷ The auto ignition temperature of the heating/cooling liquid used must be considered when defining the required temperature class of the equipment. In case auxiliary heating equipment is installed (e.g., jacketing or tracing), the user is responsible for compliance with the Directive 2014/34/EC (ATEX) and resulting surface temperature.

⚠ *WARNING*

Dry run could result in excessive surface temperatures.

- ▷ Always ensure the pump is properly filled and vented and does not run dry.
- ▷ Only check motor direction of rotation with the pump decoupled. For close-coupled pumps where decoupling is not feasible, check the direction of rotation only with the pump primed and vented.
- ▷ Insufficient flow could result in excessive surface temperatures.
- ▷ Never run pump against completely closed discharge valve.
- ▷ Make sure the minimum flow for the equipment is adhered to.
- ▷ For liquids with physical properties strongly deviating from water the minimum flow needs to be checked against the maximum allowable surface temperature. For critical services, a detailed analysis shall be performed. Contact FLOWSERVE.
- ▷ Dynamic contact between rotating and static components could lead to excessive surface temperatures or burning deposits.
- ▷ In dirty or dusty environments, regular checks must be made, and dirt removed from areas around close clearances, bearing housings and motors.
- ▷ Make sure the allowable running clearances are adhered to.

2.11.7.8 Pump set assemblies

In the case pump set assemblies (combination of pump, motor and other auxiliary equipment), the temperature class is determined by the equipment with the lowest class. e.g., for a pumped liquid temperature of 212°F (100°C) the combination with a T3 motor would result in a temperature class T3 for the complete assembly. For combinations of close-coupled pumps and motor the heat transfer between pump and motor can lead to elevated temperatures at the motor flange and shaft. The maximum allowed surface temperatures specified by the motor manufacturer must be observed. If these maximum allowable temperatures are not known, the general stated maximum ambient temperature for which the installed motor has been certified needs to be considered. In general, 104°F (40°C) applies as a minimum. Ensure the equipment temperature class is suitable for the hazard zone.

2.11.8 ATEX Marking

2.11.8.1 Pump

The ATEX Marking examples are specified below. For specific marking refer to the nameplate and declaration of conformity of the supplied pump.

Figure 1: EN ISO 80079-36

1. EX mark
2. Equipment group
3. Equipment category
4. Gas or Dust
5. Type of protection
6. Gas or Dust group
7. Temperature class
8. EPL Equipment protection level defined in EN ISO 80079-36 & 37

NOTICE

Refer to Chapter 2.11.7 for temperature limits.

NOTICE

The pump must comply with the ISO 80079-37 regarding the non-electrical type of protection constructional safety “c”.

The temperature class marked on the pump is the highest ATEX Temperature class the pump can be operated without causing an ignition source. Example: T4 marking means the pump can be operated in T1 through T4 but must be within the operating limits listed in Section 12.4 Performance and operating limits. A T4 marking also means the pump is not safe for temperature classes T5 or T6. A temperature marking of T6 means the pump pump can be operated in T1 through T6 but must be within the operating limits listed in Section 12.4 Performance and operating limits.

2.11.8.2 Complete Pump sets

⚠ *WARNING*

If the pump is combined with other mechanical or electrical components in one set, the category of the complete unit will correspond, based upon the Directive 2014/34/EU, only to that category with which all its components comply.

Note: These comments are of particular importance when pumps, which conform to a given category of Directive 2014/34/EU, are powered by a driver which is not in the same category. Plant management personnel shall always check that all elements of the set comply with the Directive 2014/34/EU.

2.11.9 Monitoring technical parameters

⚠ WARNING

When using pumps in areas with an explosion risk, the operator must check the following parameters regularly:

- Bearing temperature.
- That the pump is always filled with liquid during operation.
- That the pump does not operate against a closed valve for any length of time.
- Vibration, power, and temperature monitoring of bearings are recommended for Dual Drive pumps and any pump operating in a potentially explosive atmosphere.
- The operator must ensure that pumps, which show evidence of abnormal operation, are switched off and not started again until the cause of the abnormal operation has been eliminated.
- Dual Drive pumps installed in an explosive environment a leakage detection device must be installed which operates an alarm or automatic switch-off function. If leakage is detected, immediately shutdown the pump and within 48 hours drain and service the pump prior to commencing operations.
- If the pumped liquid can freeze, polymerize or contains solid particles, a temperature monitoring devise should be installed in the pump casing.

2.12 Protective equipment

SAFETY INSTRUCTIONS

Follow applicable regulations. Wear work clothes such as safety shoes. Use safety equipment specified in the hazard information. Non- limitative list of Personal protective equipment:

- Safety glasses
- Safety gloves
- Protective clothing

2.13 Safety devices

Pump motor electrical source connection shall follow all applicable local, national, and international regulations. Connection shall include circuit breakers for overload protection and disconnect means for maintenance.

2.14 Control of Hazardous Energy

⚠ WARNING

To ensure worker safety, follow safe methods for preventing the release of hazardous energy (electrical, mechanical, hydraulic, pneumatic, chemical, thermal, and other energy sources) while the pump equipment is undergoing maintenance or taken out of service. Procedure shall follow all applicable local, national, and or international regulations. Example: United States of America, Occupational Safety and Health Administration (OSHA) standard for The Control of Hazardous Energy (Lockout/Tagout), Title 29 Code of Federal Regulations (CFR)Parts 1910.147 and 1910.333.

3 Product Description

3.1 General product description

The TB-MAG chemical process pumps are fluoropolymer lined, magnetically coupled, single stage, thrust balanced, centrifugal pumps. Pump options include ASME and ISO horizontal as well as ASME vertical. The horizontal version of the TB-MAG pump line conforms to the dimensional specifications noted in ISO 2858 and ISO 15783 for ISO pump sizes and ASME B73.3 for ASME pump sizes although a few exceptions do exist. Both have centerline discharge.

Figure 2: TB-MAG chemical process pumps

3.2 Dual Drive

The horizontal TB-MAG pumps are available with a Dual Drive option. This option provides a backup secondary containment area if the primary containment shell develops a leak. Leaking process fluid from the primary containment shell will be collected in the secondary containment field at full rated pressure for up to 48 hours. The Dual Drive option incorporates a second Magnetic Drive and non-metallic shell assembly which has no rotating seals. The TB-MAG Dual Drive pump set meets the mounting layout of long coupled pumps. Secondary containment is defined by the following standards: ASME B73.3 Section 5.6, ANSI HI 5.1 thru 5.6 and ISO 15783.

3.3 Metallic Casing

The Metallic Casings for TB-MAG Pumps are available in various Stainless-Steel alloys or Ductile Iron (DCI) without the ETFE lining. Contact Flowserve for more information. These optional materials are considered compatible with the Machinery Directive 2006/42/EC and Explosion Protection 2014/34/EU for use in ATEX environments. INNOMAG pumps must be operated within the limits described in Section12.4 Performance and operating limits. The end user is responsible for determining the chemical compatibility of the process fluid with the material of construction selected.

3.4 Scope of delivery

The pump is to be used only for the operating conditions stated by the customer and confirmed by the supplier. warranty is assumed within the scope of the Flowserve conditions of sale. Appropriate application and operating conditions are contained in the attached datasheets. The exact scope of the delivery is stated in the order documentation.

3.5 Design of major parts

3.5.1 Pump casing

Ductile iron with bonded ETFE lining.

The horizontal version of the TB-MAG pump casing is designed with a horizontal centerline end inlet and a vertical centerline top outlet that makes it self-venting.

For ease of maintenance, the pump is constructed so that pipe connectors do not have to be disturbed when internal maintenance is required (back pull out).

3.5.2 Impeller

Integrally molded one-piece impeller / inner rotor. The impeller is fully shrouded (closed) with fully open suction.The inner rotor is fitted with Neodymium Iron Boron (NdFeB) magnets.

3.5.3 Wetted Bearings

The standard material for the bearings and shaft is alpha sintered silicon carbide (SiC). The system is comprised of a shaft which is cantilever mounted into the containment shell and rotating bushing(s) mounted in the impeller. Thrust bearings are not required due to thrust balance design.

3.5.4 Containment Ring

This part aligns and supports the containment shell to establish the pressure boundary of the pump. Allows servicing of the motor without opening the liquid end of the pump.

3.5.5 Outer Magnet Assembly

One-piece steel housing fitted with Neodymium Iron Boron (NdFeB) magnets. One common outer rotor for each motor frame and a visual alignment groove allows for ease of axial alignment.

3.5.6 Containment Shell and O-ring

The containment shell is comprised of an aramid fiber composite outer housing and an ETFE liner. The shell includes a fully confined O-ring groove which establishes the gasket interface with the casing.

3.5.7 Adapter

Mates pump to motor in close-coupled arrangements. Design allows the use of multiple motor sizes with one adapter.

3.5.8 Driver

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

3.5.9 Dual Drive

This option utilizes the same component construction as the Horizontal TB-MAG with the addition of a second containment shell and mag drive. The two mag drives are connected via an intermediate shaft mounted in a bearing frame with greased for life bearings.

3.6 Connections

3.6.1 Electrical connections

⚠ DANGER

Electrical connections must be made by a qualified electrician in compliance with all applicable local, national, and international regulations.

⚠ WARNING

It is important to be aware of the EUROPEAN DIRECTIVE on potentially explosive areas where compliance with IEC 60079-14 or EN 60079-14 is an additional requirement for making electrical connections.

⚠ WARNING

It is important to be aware of the EUROPEAN DIRECTIVE on electromagnetic compatibility when wiring 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 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 shall be checked to ensure the power supply is appropriate.

⚠ WARNING

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 6.4, Direction of rotation before connecting the motor to the electrical supply.
- For close-coupled and Dual Drive pumps it is necessary to wire the motor with flexible conduit of sufficient length to allow the motor/power end assembly to be moved back from the casing [1100] for maintenance.

3.6.2 Mechanical connections

NOTICE

For more information regarding maximum nozzle loads, refer to Chapter 12.1.1

3.6.3 Tools, equipment, and fixtures

NOTICE

No special tools are required for the installation and operation of the pump unit. All work can be carried out with standard tools. For more information regarding tool details in Chapter 8.2

4 Packaging, Transportation and Storage

4.1 Consignment receipt and unpacking

NOTICE

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

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

Each pump/wet end has a unique serial number. Check that this number corresponds with that advised. Always use this number in correspondence and when ordering spare parts or further accessories

Review packing symbols to avoid possible damages to the package. Below are some examples of these symbols:


This side up


Keep dry


Centre of gravity


Attachment point


Fragile


Protect from direct sunlight


Do not use hooks

4.2 Lubricants and auxiliary material

	NOTICE
	If the order has not been expressly for an oil-free and grease-free pump, grease and mounting pastes have been used during pump assembly. If residual material of this must not come in contact with the liquid handled, clean the pump using a cold cleaner, before it is installed in the system

4.2.1 Recommended lubricants

- Threads and bare mating surfaces: Copper based anti-seize compound.
- Rubber O-rings at assembly: Castrol Iloform™ Solid Stick Wax. Plastic encapsulated seals do not need assembly lube.
- Long Coupled Bearing lubricant: see Table 11.
- Pipe threads: for stainless steel pipe threads us a non-galling pipe thread sealant.

4.3 Handling

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

4.4 Transportation

4.4.1 Lifting

	NOTICE
	A crane must be used for all pump sets or components more than 55 lb (25 kg). Fully trained personnel must carry out lifting, in accordance with local regulations. For safe lifting refer 2.5.1 Lifting limits and guidelines.

Slings, ropes, and other lifting gear shall 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°.

4.4.1.1 Bare pump

	CAUTION
	To avoid distortion, the bare pump shall be lifted as shown:

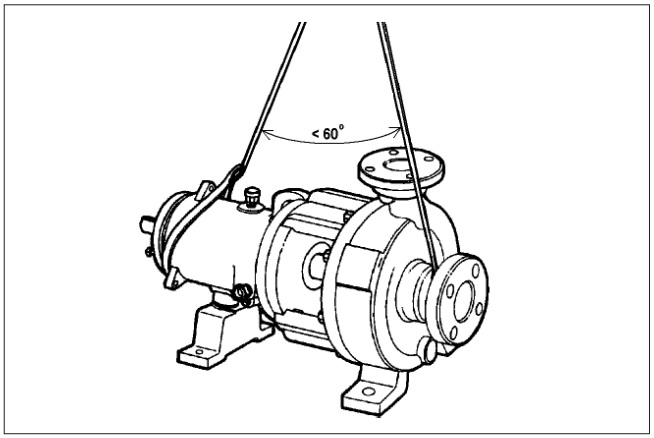


Figure 3: Bare pump lifting

4.4.1.2 Pump and folded steel or polycrete baseplate set

Where the baseplate is folded steel or polycrete there are no specific lifting points provided for the complete machine set. Any lifting points that can be seen are provided only for dismantling parts for servicing.

The pump and folded steel, or polycrete, baseplate set shall be lifted as shown. With a sling around the pump discharge nozzle, and around the outboard end of the motor frame using choker hitches pulled tight. The sling shall 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.

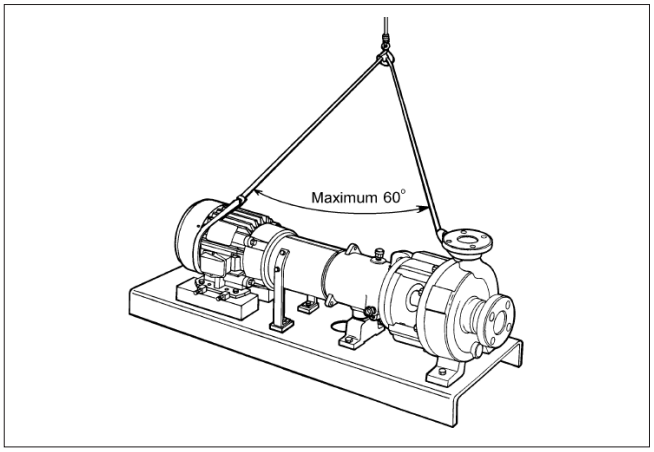


Figure 4: Lifting pump with baseplate

4.4.2 Pump and cast iron or fabricated, baseplate set

The pump and cast iron, or fabricated, baseplate set which has specific lifting points, shall be lifted as shown in Figure 4-3. Before lifting the driver alone, refer to the manufacturer's instructions.

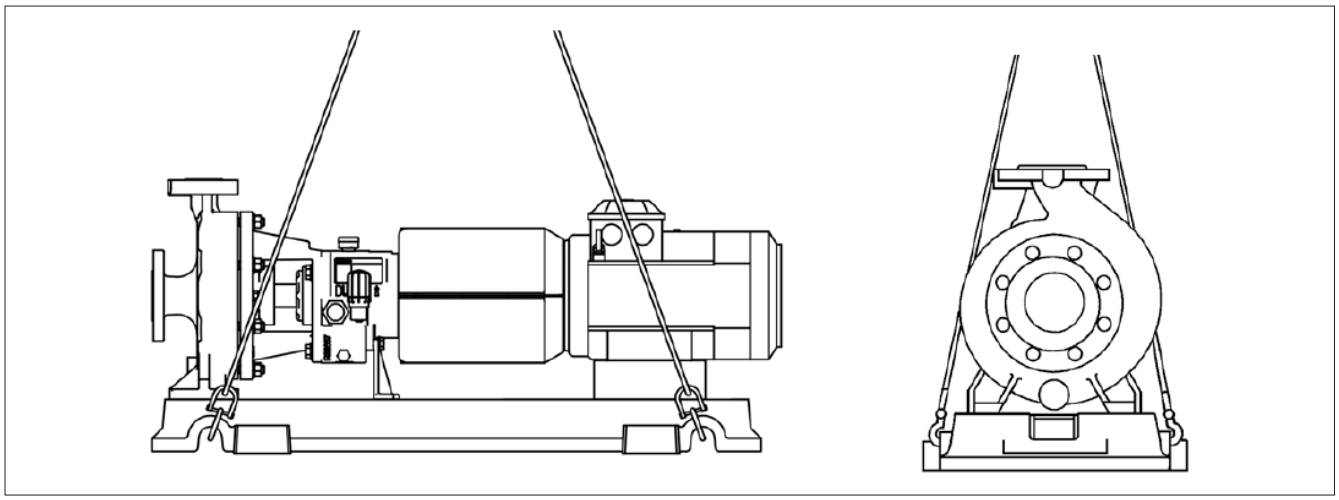


Figure 5: Lifting pump with cast iron or fabricated baseplate

⚠ DANGER

Hanging loads, risk of personnel injury.

- ▷ Only use suitable lifting equipment and wear appropriate protective equipment. Only lift the pump in horizontal position.
- ▷ The installed sleeve bearings are susceptible to shock and vibrations, handle with care.
- ▷ Do not attempt to lift the pump or the pump set using eyebolts on the components.

⚠ DANGER

Figure 4-4 shows an example of incorrect lifting of the pump.

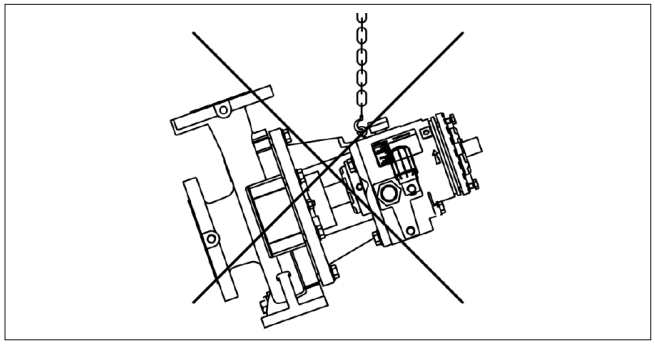


Figure 6: Incorrect lifting

4.5 Storage

4.5.1 Short Term Storage up to 6 months. Store the pump in a clean, dry location with the following conditions.

- Suction and discharge flange covers securely in place and all other ports plugged
- Temperatures within the minimum and maximum ambient temperatures listed in Section 12.4
- Humidity less than 65%
- Prevent condensation from forming or ground water incursion
- Free of ozone generating equipment such as fluorescent light sources, mercury vapor lamps, high voltage electrical equipment
- Free from dust or adequately wrapped to prevent dust infiltration
- Free of chemicals, solvents, fuels, acids, etc.
- Free or protected from exposure to UV light sources such as sunlight or bright artificial light with high ultraviolet content

4.5.2 Long Term Storage 12 months or longer in addition to all of Section 4.5.1

- Rotate the impeller by hand monthly. While rotating, also gently push and pull the impeller to check it is free to move axially.
- Long Coupled and Dual Drive sections, rotate shafts by hand monthly
- Dual Drive interior sections are bare ductile iron with a steel shaft. They have a light coating of rust inhibitor from the factory. Visually inspect the interior for rust formation. A light coating of rust is acceptable but excessive rusting should be addressed immediately and generally indicates the storage is too humid or damp and the parts should be moved to a dryer location or replaced.

4.5.3 Recommissioning after storage see Section 6 Commissioning.

⚠ WARNING

Failure to follow these storage instructions could result in:

- A damaged pump
- Cracked or compromised non-metallic components
- Damaged or corroded bearings, shafts, interior housing
- Leaks or poor operation at start up
- Degradation of components shortening the expected lifespan of the pump
- Mag drive decoupling and overheating
- Void warranty

⚠ WARNING

The storage area must not contain any ozone-generating equipment, e.g., fluorescent light sources, mercury vapor lamps, high voltage electrical equipment. Damp storage areas are unsuitable. Ensure that no condensation occurs. The most favorable atmospheric humidity is below 65%.

4.6 Recycling and end of product life

At the end of the equipment service life, the relevant materials and parts should be recycled or disposed of using local environmental regulation methods. If the product contains substances which are harmful to the environment, then the removal or disposal of the equipment must be in accordance with local/regional regulations.

⚠ DANGER

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. Refer Chapter 11.2 for more details.

5 Installation

NOTICE

Equipment operated in hazardous locations must comply with the relevant explosion protection regulations. See section 2.11 Potentially explosive atmospheres

⚠ WARNING

Dual Drive pumps installed in an explosive environment require a leakage detection device to be installed which operates an alarm or automatic switch-off function. If leakage is detected, immediately shutdown the pump and within 48 hours drain and service the pump prior to commencing operations.

⚠ CAUTION

On long coupled baseplate pump sets, the coupling elements are supplied loose. It is the responsibility of the installer to ensure that the pump set is properly aligned as detailed in section Alignment methods.

5.1 Inspection and preparation

Prior to installing, checks shall be made for:

- ✓ Possible damage to the pump or the pump set that may occur in transit.
- ✓ Ease of running (check that the shaft is free to rotate by hand).
- ✓ The foundation dimensions.

The following preparatory work must be carried out before placing the pump:

- ✓ Roughen and clean foundation surface.
- ✓ Remove shuttering/cores from the anchor holes.
- ✓ Blow the anchor holes clean.
- ✓ Check the position and dimensions of the anchor holes against the arrangement drawing.

⚠ WARNING

Follow the safety measures described below:

- See Section 2.14 Control of Hazardous Energy
- Connect the pipework carefully to prevent the pumped liquid from escaping during operation and endangering operating personnel.
- Ensure that the suction or inflow line and the discharge line are closed by valves.
- Ensure that all electrical connections are “Locked Out”. Otherwise, there is a risk of electric shock.
- Pay attention to relevant internal plant regulations.
- Avoid accidental contacts with hot components.

5.2 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 practicable to the supply of liquid to be pumped.

Refer to the general arrangement drawing for the pump set.

5.3 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 (if necessary) as detailed in section 5.4 and 5.8.
See Section 8.10.2 Drive End Assembly for installation of drive end magnet assembly.

5.4 Foundation

⚠ CAUTION

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

Ensure the following are met:

1. The baseplate shall be mounted onto a firm foundation, either an appropriate thickness of quality concrete or sturdy steel framework. (It shall NOT be distorted or pulled down onto the surface of the foundation but shall be supported to maintain the original alignment.)
2. Install the baseplate onto packing pieces evenly spaced and adjacent to foundation bolts.
3. Level with shims between baseplate and packing pieces.
4. The pump and driver have been aligned before dispatch however the alignment of pump and motor half coupling must be checked. If this is incorrect, it indicates that the baseplate has become twisted and shall be corrected by re-shimming.
5. If not supplied, guarding shall be fitted as necessary to meet the requirements of ISO 12100 and EN953.

5.4.1 Protection of openings and threads

When the pump is shipped, all openings are covered. This protection/covering should not be removed until installation. If, for any reason, the pump is removed from service, this protection should be reinstalled.

5.4.2 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 may be generally classified into two types:

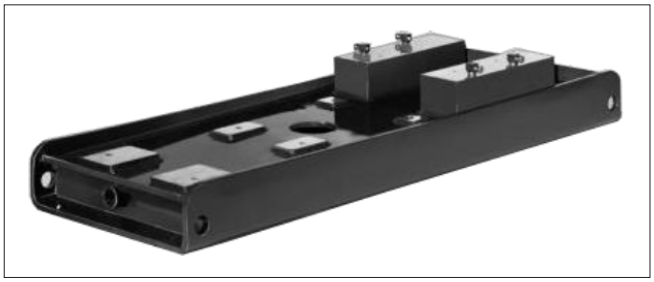


Figure 7: Foundation-mounted, grouted design

Figure 8: Stilt mounted, or free standing

- Baseplates intended for grouted installation are designed to use the grout as a stiffening member.
- Stilt mounted baseplates are designed to provide their own rigidity. Therefore, the designs of the two baseplates are usually different.

Regardless of the type of baseplate used, it must provide certain functions that ensure a reliable installation. Three of these requirements are:

- 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.
- 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 for long couple pumps. Experience indicates that a baseplate with a top surface flatness of 0.015 in./ft (1.25 mm/m) across the diagonal corners of the baseplate provides such a mounting surface. Therefore, this is the tolerance to which we supply our standard baseplate. Some users may desire an even flatter surface, which can facilitate installation and alignment. Flowserve will supply flatter baseplates upon request at extra cost. For example, mounting surface flatness of 0.002 in./ft (0.17 mm/m) is offered on the Flowserve Type E "Ten Point" baseplate
- The baseplate must be designed to allow the user to final field align the pump and driver to within their own 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 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 precision final alignment when the installer puts the baseplate assembly into its original, top levelled, unstressed condition.

5.4.3 Stilt and spring mounted baseplates

Flowserve offers stilt and spring mounted baseplates. (See Figure 8 for stilt mounted option.) The low vibration levels of TB-MAG pumps allow the use of these baseplates provided they are of a rigid design. The baseplate is set on a flat surface with no tie down bolts or other means of anchoring it to the floor.

General instructions for assembling these baseplates are given below. For dimensional information, please refer to the appropriate Flowserve "Sales Drawing."

5.4.3.1 Stilt mounted baseplate assembly instructions

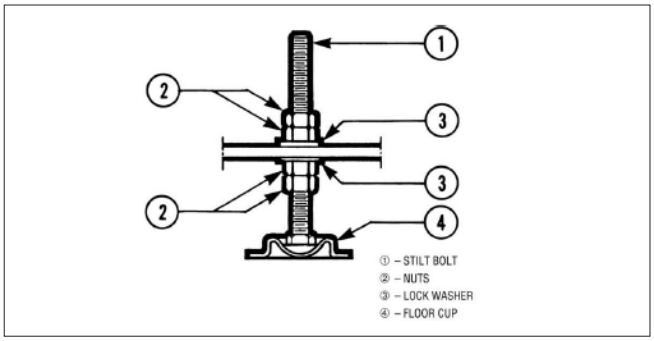


Figure 9: Stilt mounted baseplate

Refer To Figure 9

1. Raise or block baseplate/pump above the floor to allow for the assembly of the stilts.
2. Predetermine or measure the approximate desired height for the baseplate above the floor.
3. Set the bottom nuts [2] above the stilt bolt head [1] to the desired height.
4. Assemble lock washer [3] down over the stilt bolt.
5. Assemble the stilt bolt up through hole in the bottom plate and hold in place.
6. Assemble the lock washer [3] and nut [2] on the stilt bolt. Tighten the nut down on the lock washer.
7. After all four stilts have been assembled, position the baseplate in place over the floor cups [4] under each stilt location and lower the baseplate to the floor.
8. Level and make final height adjustments to the suction and discharge pipe by first loosening the top nuts and turning the bottom nuts to raise or lower the baseplate.
9. Tighten the top and bottom nuts at the lock washer [3] first then tighten the other nuts.
10. It should be noted that the connecting pipelines must be individually supported, and that the stilt mounted baseplate is not intended to support total static pipe load.

5.4.3.2 Stilt/spring mounted baseplate assembly instructions

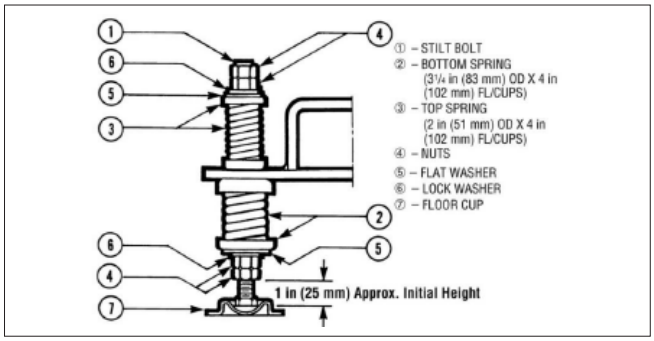


Figure 10: Stilt/spring mounted baseplate

Refer to Figure 10

1. Raise or block up baseplate/pump above the floor to allow for the assembly of the stilts.
2. Set the bottom nuts [4] at approximately1in. (25mm) above the stilt bolt head [1]. This allows for 2 in. (51 mm) upward movement for the final height adjustment of the suction/discharge flange.
3. Assemble the lock washer [6] flat washer [5] and bottom spring/cup assembly [2] down over the stilt bolt [1].
4. Assemble the stilt bolt/bottom spring up through hole in the bottom plate and hold in place.
5. Assemble top spring/cup assembly [3] down over stilt bolt.
6. Assemble flat washer [5], lock washer [6] and nuts [4] on the stilt bolt.
7. Tighten down top nuts, compressing the top spring approximately 0.5 in.(13 mm). Additional compression may be required to stabilize the baseplate.
8. After all four stilts have been assembled, position the baseplate in place over the floor cups [7] under each stilt location and lower the baseplate to the floor.
9. Level and make final height adjustments to the suction and discharge pipe by first loosening the top nuts and turning the bottom nuts to raise or lower the baseplate.
10. Recompress the top spring to the compression established in step 7, and lock the nuts in place.
11. It should be noted that the connecting pipelines must be individually supported, and that the spring mounted baseplate is not intended to support total static pipe loads.

5.4.3.3 Stilt/spring mounted baseplates - motor alignment (Long Coupled pumps only)

The procedure for motor alignment on stilt or spring mounted baseplates are similar to grouted baseplates. The difference is primarily in the way the baseplate is levelled.

1. Level the baseplate by using the stilt adjusters.
2. After the base is level, it is locked in place by locking the stilt adjusters.
3. Next the initial pump alignment must be checked. The vertical height adjustment provided by the stilts allows the possibility of slightly twisting the baseplate. If there has been no transit damage or twisting of the baseplate during stilt height adjustment, the pump and driver should be within 0.015 in. (0.38 mm) parallel, and 0.0025 in./in. (0.0025 mm/mm) angular alignment. If this is not the case, check to see if the driver mounting fasteners are centered in the driver feet holes.
4. If the fasteners are not centered there was likely shipping damage. 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 pump for horizontal alignment.
5. If the fasteners are centered, then the baseplate may be twisted. Slightly adjust (one turn of the adjusting nut) the stilts at the driver end of the baseplate and check for alignment to the above tolerances. Repeat as necessary while maintaining a level condition as measured from the pump discharge flange.
6. Lock the stilt adjusters.

!	***NOTICE***
	The remaining steps are as listed for new grouted baseplates.

5.5 Grouting

Where applicable, grout in the foundation bolts. Foundation bolts should only be fully tightened when the grout has cured.

After adding pipework connections and rechecking the coupling alignment, the baseplate should then be grouted in accordance with good engineering practice. Fabricated steel, folded steel and cast-iron baseplates can be filled with grout. If in doubt, please contact your nearest service center for advice.

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

5.5.1 Baseplate Inspection

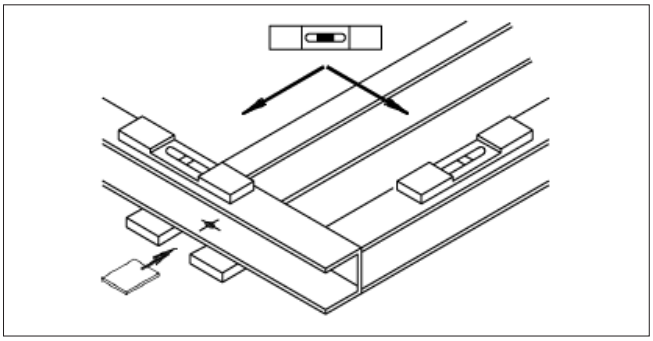


Figure 11: Baseplate Inspection

1. Completely clean the underside of baseplate.
2. Inspect for any damage that would impede proper installation or future use of the baseplate.
3. Confirm baseplate hole pattern for proper mounting bolt installation.
4. Lower the baseplate carefully onto mounting bolts.

	⚠ ***CAUTION***
	Must adhere to proper transport and lifting procedures.

5. Level the baseplate using shims and/or wedges. Use machinist's levels to maintain a flat and level surface.
6. Max difference across length 0.125 in. (3.2 mm)
7. Max difference across width 0.059 in. (1.5 mm)
8. Secure baseplate using mounting bolts to prevent unwanted movement during operation.
9. Perform final inspection to verify that baseplate is securely mounted, level, and ready to be used.

5.6 Initial alignment (long Coupled only)

5.6.1 Thermal expansion

	⚠ ***WARNING***
	The pump and motor will normally have to be aligned at ambient temperature with an allowance for thermal expansion at operating temperature. In pump installations involving high liquid temperatures, typically above 212 ºF (100 ºC), the unit should be run at the actual operating temperature, shut down and the alignment checked immediately.

5.6.2 Alignment methods

	⚠ ***DANGER***
	▷ Pump and driver must be isolated electrically, and the half couplings disconnected. ▷ The alignment must be checked.

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

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

For couplings with narrow flanges use a dial indicator as shown. The alignment values are maximums for continuous service.

5.7 Connecting 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.

5.7.1 Suction and discharge piping

⚠ CAUTION

- Never use the pump as a support for piping.
- Flange gaskets for ETFE Lined pump casing shall be Non-metallic to prevent damage to the ETFE raised face, raised face standard size and compatible with the process fluid.
- Flange gaskets for metallic casings shall match the mating flange for size and compatible with the process fluid.
- Non-metallic gaskets incur creep relaxation. Before commissioning the pump, check and retighten fasteners and set screws to tightening torque values specified in Table 10 for the pump assembly and flange joint fasteners per industry standards.
- Re-tighten all fasteners after 24 hours or after the first thermal cycle.
- Check all fasteners annually.

All piping must be independently supported, accurately aligned, and preferably connected to the pump by a short length of flexible piping. The pump shall not have to support the weight of the pipe or compensate for misalignment. It shall 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 can 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. Check the surface of both flanges (pump/pipe) to ensure they are clean, flat, and without defects or obstructions.

5.7.2 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 12 (1) illustrates the ideal piping configuration with a minimum of 10 pipe diameters between the source and the pump suction. In most cases, horizontal reducers shall be eccentric and mounted with the flat side up as shown in Figure 12 (2) with a maximum of one pipe size reduction.

SAFETY INSTRUCTIONS

Never mount eccentric reducers with the flat side down. Horizontally mounted concentric reducers shall 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 de-aerated and free of any vapor or suspended solids, concentric reducers are preferable to eccentric reducers.

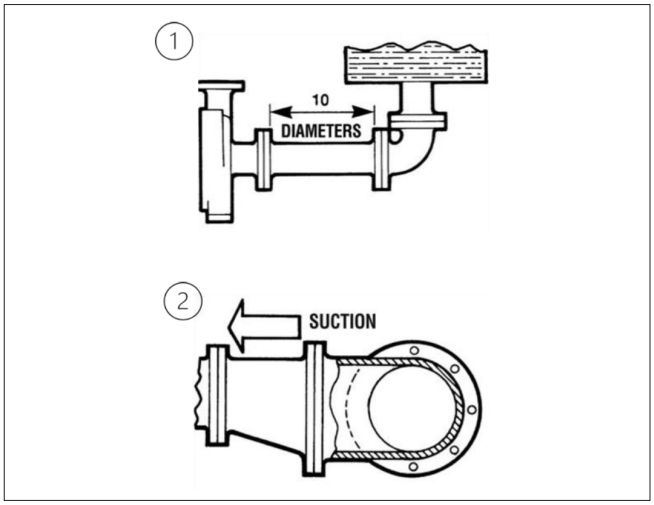


Figure 12: Suction piping

Avoid the use of throttling valves and strainers in the suction line. Pump start strainers must be removed shortly before pump start. 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.

However, never place a valve directly on the suction nozzle of the pump.

Refer to Section 12.4 for performance and operating limits. Refer to the Centrifugal Pump IOM Section of the H.I. Standards for additional recommendations on suction piping.

5.7.3 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, 10 ft/sec (3 m/s) or higher, a rapidly closing discharge valve can cause a damaging pressure surge. A dampening arrangement should be provided in the piping.

5.7.4 Auxiliary piping

⚠ CAUTION
▷ Auxiliary connections are fitted with protective metal or plastic plugs which will need to be removed.

5.7.4.1 Pumps fitted with heating/cooling jackets

Connect the heating/cooling pipes from the site supply. The top connection shall be used as the outlet to ensure complete filling/venting of the annulus with heating/cooling liquids. Inlet for steam is usually at the top, outlet at the bottom.

⚠ WARNING
Casing heating or cooling jackets shall be designed to prevent damage to the pump, ETFE components, seals and permanent magnets. Failure to comply can lead to leakage, decoupling and overheating. • Pump casing exterior temperatures shall not exceed the pumped fluid temperature limits listed in Section 12.4 • Steam jackets shall be designed to prevent localized high temperature steam impingement onto the pump casing • Limit steam saturation pressure to prevent excessive temperatures • Temperature monitoring of the casing external surface with alarms is recommended

5.8 Final Shaft alignment check

5.8.1 Close-coupled and Dual Drive pumps

After connecting piping to the pump, rotate motor shaft several times by hand to ensure there is no binding and all parts are free. Recheck the coupling alignment, as previously described, to ensure no pipe strain. If pipe strain exists, correct piping.

5.8.2 Long coupled pumps

⚠ CAUTION
The pump and motor will normally have to be aligned at ambient temperature with an allowance for thermal expansion at operating temperature. In pump installations involving high liquid temperatures, typically above 100 °C (212 °F), the unit should be run at the actual operating temperature, shut down and the alignment checked immediately.

1. Level baseplate if appropriate.
2. Mount and level pump if appropriate. Level the pump by putting a level on the discharge flange. If not level, adjust the foot piece by adding or removing shims between the foot piece [3134] and the bearing housing.
3. 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 5.5. 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 0.015 in. (0.38 mm) FIM (full indicator movement) parallel, and 0.0025 in./in. (0.0025 mm/mm) FIM angular.
4. Stilt mounted baseplates If initial alignment cannot be achieved with the motor fasteners centered, the baseplate may be twisted. Slightly adjust (one turn of the adjusting nut) the stilts at the driver end of the baseplate and check for alignment to the above tolerances. Repeat as necessary while maintaining a level condition as measured from the pump discharge flange.
5. 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.
6. 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 0.002 in. (0.05 mm) movement when any driver fastener is loosened. Align the driver first in the vertical direction by shimming underneath its feet.
7. 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 0.002 in. (0.05 mm) parallel, and 0.0005 in./in. (0.0127 mm/mm) angular misalignment.
8. 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.

5.8.3 Coupling

NOTICE

The remaining steps are as listed for new grouted baseplates.

NOTICE

- The couplings are to be assembled on the shafts taking care to avoid any impact.
- They can be heated to facilitate assembly.
- The shaft ends must be perfectly aligned, and the distance between the two Flowserve half-couplings must be 0.079 to 0.118 in. (2 to 3 mm).
- The coupling shall always be in accordance with maximum torque required and should be verified by an experienced person.

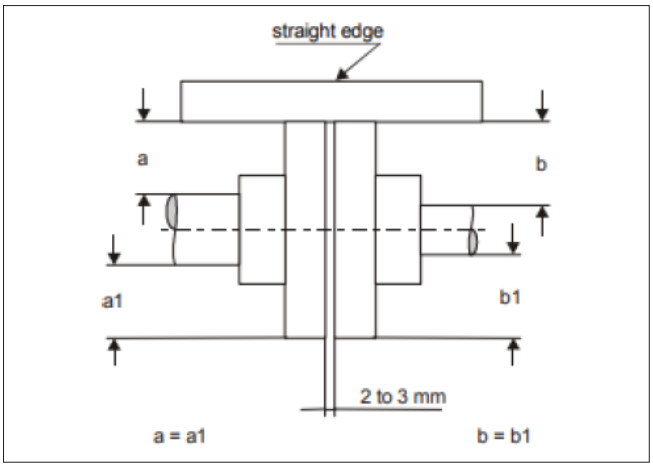


Figure 13: Coupling inspection.

⚠ DANGER

It is essential that the coupling is equipped with a guard in accordance with current regulations on the prevention of accidents and the protection of persons.

5.9 Protection Systems

NOTICE

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

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

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

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

To prevent excessive surface temperatures at bearings it is recommended that temperature or vibration monitoring is carried out.

Dual Drive pumps installed in an explosive environment require a leakage detection device to be installed which operates an alarm or automatic switch-off function. If leakage is detected, immediately shutdown the pump and within 48 hours drain and service the pump prior to commencing operations.

5.9.1 Auxiliary equipment – instrumentation

Contact your local Flowserve Sales office, Distributor, or Representative for more details.

5.9.1.1 Leak detection

An optical leak detection system is available for TB-MAG pumps. An ultrasonic leak detection device and adapter are available for Dual Drive pumps.

5.9.1.2 Temperature probe

An optional temperature probe can be installed on the casing drain to monitor the internal fluid in the casing [1100].

5.9.1.3 Temperature Probe Installation

The temperature probe thermowell will be packaged separately for protection during shipping and must be assembled before use. For wiring refer to the thermocouple sensor manufacturer's instructions

- Verify that rubber gasket / O-ring is secured to temperature sensor tip.
- Insert temperature sensor tip into the thermowell and hand tighten.
- Use a wrench to fully secure the sensor to the thermowell.
- Adjust direction of sensor sheathing before tightening compression fitting.
- Ensure sensor tip is fully pressed into thermowell.

- Hand-tighten the compression fitting.
- Use a wrench to fully tighten the compression fitting and secure sensor sheathing.
- Affix the PTFE drain gasket to thermal well.
- Insert the completed temperature probe assembly into the casing drain and insert bolts (1/2 in.-13 ASME, M12x1.75 ISO) with lock washers.
- Tighten bolts evenly to maintain alignment and torque per Table 10 Drain cover.
- Install wire leads to appropriate temperature monitor per manufacturer instructions and guidelines.

	⚠ CAUTION
	Do not over tighten the fitting.

	NOTICE
	The sensor must be fully inserted to get an accurate reading.

5.9.2 Additional plumbing

If additional plumbing is added to the secondary containment ports of a Dual Drive pump, these connections, systems and the secondary containment portion of the pump shall be leak tested prior to commissioning. See ANSI HI 5.1-5.6, Section 5.6.3 Liquid-tight integrity test (standard test) or ISO 15783 Section 6.3.2 Hermetic integrity test (optional).

	⚠ WARNING
	Dual Drive pumps. While leak testing, the Wet End must be pressurized prior to the secondary containment field and at the same or higher pressure. Pressurizing the secondary containment field without pressurizing the wet end will damage the primary containment shell, shaft and bearings.

5.9.3 RedRaven™

RedRaven is Flowserve's end-to-end Internet of Things (IoT) solution that helps the user to monitor and optimize flow control equipment performance and proactively identify and address issues before they cause downtime and disruptions. The major benefit of using RedRaven is that it will help to improve plant productivity, profitability, energy efficiency, and safety. Consult your INNOMAG sales contact for details.

Contact Flowserve for more Information or visit https://www.flowserve.com/en/innovation/iot/

REDRAVEN™

Figure 14: RedRaven Logo

6 Commissioning

6.1 Pre-start checks

	⚠ CAUTION
	▷ Never use the pump as a support for piping.
	▷ Non-metallic gaskets incur creep relaxation. Before commissioning the pump, check and retighten fasteners and set screws to tightening torque values specified in Table 10 for the pump assembly and flange joint fasteners per industry standards.
	▷ Re-tighten all fasteners after 24 hours or after the first thermal cycle.
	▷ Check all fasteners annually.

Prior to starting the pump, it is essential that the following checks be made.

- ✓ Pump unit is undamaged.
- ✓ Pump is primed.
- ✓ Pump and motor properly secured to the baseplate.
- ✓ Pump instrumentation is operational.
- ✓ Shaft seal is properly installed.

- ✓ Impeller rotates freely.
- ✓ Bearing lubrication.
- ✓ Heating/cooling for jacketed casing/cover are turned on operational.
- ✓ Cooling or any auxiliary supply system is turned on and bleed.
- ✓ Remove temporary supports installed for shipping.
- ✓ Direction of rotation only after filling the pump.
- ✓ Coupling alignments.
- ✓ Suction Valve is fully open.
- ✓ Discharge Valve is only partially open.
- ✓ All fasteners are properly tightened per Table 10.

6.2 Pre-start checks

TB-MAG pumps are product lubricated at the wet end. See paragraph 8.12.2 for long coupled bearing lubrication. Dual Drive bearings are sealed greased for life see Section 8.

⚠ WARNING

For oil lubricated pumps, fill the bearing housing [3200] with correct grade of oil to the correct level, i.e., by use of the sight glass [3856] or constant level oiler bottle [3855].

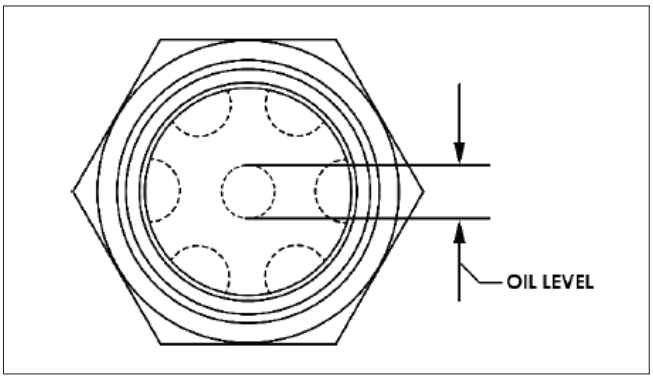


Figure 15: Sight Glass

When fitted with a constant level oiler [3855], the bearing housing [3200] shall be filled by unscrewing or hinging back the transparent bottle and filling it with oil. The standard Adams oilers and the Trico Watchdog oilers are self-setting and internally vent balanced.

Where an adjustable body oiler is fitted this shall be set to the height shown in the following diagram.

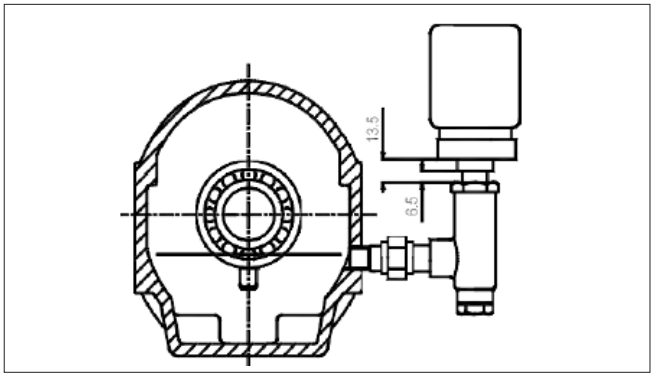


Figure 16: Constant level oiler

NOTICE

The oil filled bottle shall then be refitted to return it to the upright position. Filling shall be repeated until oil remains visible within the bottle.

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

NOTICE

Dual Drive pumps utilize sealed, greased for life bearings, and require no supplementary lubrication.

6.3 Filling and priming

⚠ CAUTION

Ensure inlet pipe and pump casing [1100] 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.

6.4 Direction of rotation

⚠ CAUTION

- Correct rotation is indicated by the arrow on the casing [1100]. Improper rotation will not damage the pump however, performance is greatly reduced. Rotation may be determined by viewing the motor's fan.
- Do not bump the motor to test rotation or run the pump without the suction completely flooded. Dry running can damage the pump in a matter of seconds if the pump is not equipped with dry- run bearings.
- If maintenance work has been carried out to the site's electrical supply, the direction of rotation shall be re-checked in case the supply phasing has been altered.

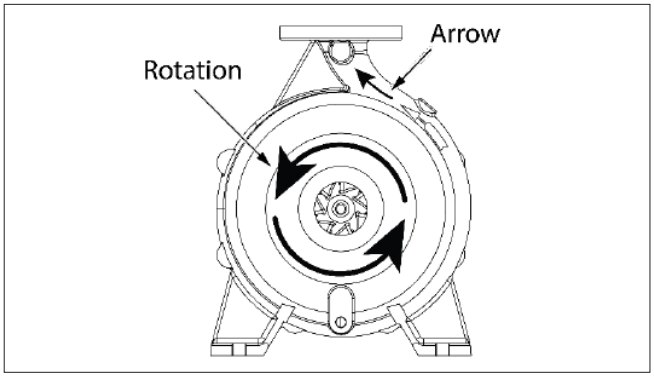


Figure 17: Direction of rotation

6.5 Guarding

⚠ CAUTION

If the pump configuration requires guarding it will be supplied fitted to the pump set. Some Configurations are enclosed and require no additional guarding.

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.

6.6 Initial pump start

NOTICE

Abnormal noises, vibrations, temperatures, or leaks will lead to product damage. When detected:

- Switch off the product immediately.
- Do not put the product back into operation until the causes have been identified and solved.

1. Completely open the shut-off valve in the supply/ suction line.
2. Slightly open the control valve in the discharge line.
3. If the pumping pressure does not constantly rise with increasing speed, stop the motor again and bleed the pump carefully again.
4. After reaching the speed, slowly open the control valve in the discharge line and adjust to the operating point.

⚠ WARNING

- Operating with the valve closed at the discharge end, even for short durations, is possible only if the installation is equipped with a by-pass providing for circulation of the minimum flow necessary for the correct operation of the pump. If not, operating with the valve closed at the discharge end quickly causes the destruction of the sealing and seizing of the moving parts.
- Running the pump with valve closed for a prolonged period may cause temperature rise and result in explosion. The risk is higher when pumping high-temperature liquid.
- Dual Drive pumps with two mag drives shall never be Direct on line started with a wide open discharge valve. This could cause decoupling of the mag drives and immediate overheating. During start up, listen for signs of decoupling, loud, high amplitude vibration and low discharge pressure. Immediately shutdown if signs of decoupling are experienced.
- Inlet valves shall be fully open when pump is running.

6.6.1 Check of normal operation

Personnel: Machine fitter

1. Check the liquid level in the tank at the suction end (if applicable).
2. Check for correct operation. Watch out for abnormal noises, vibrations, temperatures, and leaks.
3. Check that the operating conditions are reached.
4. For sealed long coupled pumps, check the temperature of the shaft seal.

⚠ WARNING

- In the event of significant leakage, stop the pump as soon as possible, and check all seals.

7 Operation

7.1 Starting the pump

NOTICE

1. Close the discharge valve. Fully open the suction valve. Pump requires a flooded suction.
2. Fully open discharge valve to complete priming. Turn back the discharge valve until it is 1/4 to 1/2 open. TB-MAG pumps operate safely with discharge valve partially open.
3. Continuous operation against a closed discharge valve may cause pump to overheat.
4. If the pressure is satisfactory, slowly open the discharge valve.
5. Do not run the pump with the discharge valve closed for a period longer than 10 seconds.
6. If NO pressure, or low pressure, stop the pump. Refer to section 9,Troubleshooting guide.

NOTICE

1. Do not operate pump with suction valve closed. Operating pump more than a few minutes after suction valve closed may cause bearing failure.
2. Start motor and check the discharge pressure.

7.2 Normal Operation

⚠ CAUTION

Care must be taken when operating pump. Safety gloves are essential. Loose clothing must not be worn.

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

Figure 17: Direction of rotation

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

7.2.2 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.

7.2.3 Surging condition

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

7.3 Monitoring

If the installation and/or application creates a risk for exceeding the allowable use of the pump, additional monitoring equipment shall be used.

7.3.1 Power monitor

A motor load monitor monitors the electric power consumption of the driver. Boundary conditions can be set and an error message or an emergency stop can be generated when reaching the set values.

7.3.1.1 Minimum and maximum flow rate

A power monitor can be used to indirectly monitor minimum and maximum flow rates by using the pump hydraulic curve and power curve to set the minimum and maximum power set points of the power monitor to the corresponding flow rates at a given speed.

7.3.1.2 Minimum continuous flow

Minimum continuous stable flow is the lowest flow at which the pump can operate and still meet the bearing life, shaft deflection and bearing housing vibration limits documented in the latest version of ISO 5199.

Pumps may be operated at lower flows, but it must be recognized that the pump may exceed one or more of these limits. For example, vibration may exceed the limit set by the ISO standard. The size of the pump, the energy absorbed, and the liquid pumped are some of the considerations in determining the minimum continuous flow (MCF).

7.3.1.3 Minimum thermal flow

INNOMAG TB-MAG ASME and ISO 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.

	NOTICE
!	Do not operate the pump below minimum thermal flow, as this could cause an excessive temperature rise. Contact a Flowserve sales engineer for determination of minimum thermal flow.

Avoid running a centrifugal pump at drastically reduced capacities or with discharge valve closed for extended periods of time. This can cause severe temperature to 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.

7.3.1.4 Dry run

In most cases, the absorbed power during dry run will be lower than the absorbed power at minimum operating flow. A power monitor can be used to indirectly monitor dry run conditions by using the pump hydraulic curve and power curve to set the minimum power set points of the power monitor.

7.3.1.5 Magnetic drive decoupling

Exceeding the maximum torque of the magnetic drive can be caused by several failure modes (eg. blocked rotor, exceeding maximum flow rate, etc). The motor power consumption will decrease considerably to the level required only for rotating the outer rotor. Magnetic drive decoupling can be detected by setting a minimum value for the motor power monitor.

7.3.2 Bearings

	NOTICE
Ex	If the pumps are working in a potentially explosive atmosphere temperature or vibration monitoring at the bearings is recommended. If bearing temperatures are to be monitored, it is essential that a benchmark temperature is recorded at the commissioning stage and after the bearing temperature has stabilized. • Record the bearing temperature (t) and the ambient temperature (ta) • Estimate the likely maximum ambient temperature (tb) • Set the alarm at (t+tb-ta+10) ºF (t+tb-ta+5) ºC and the trip at 212 ºF (100 ºC) for oil lubrication and 220 ºF (105 ºC) for grease lubrication

It is important, particularly with grease lubrication, to monitor bearing temperatures. After start up the temperature rise should be gradual, reaching a maximum after approximately 2 hours. This temperature should then remain constant or marginally reduce with time.

7.3.2.1 Bearing temperature monitoring Dual Drive

The bearings in the Dual Drive bearing frame are sealed, greased for life and are not serviceable. When monitoring of bearing temperatures is required, utilize a surface mount RTD or thermocouple on the flat surface adjacent to the top pipe plug port of the bearing frame. Remove the paint to bare metal, use adhesive or mechanical screw. If using a mechanical screw, the screw size is #10-32 [M4]. This location provides the best indication of bearing temperatures. During normal running conditions the bearing temperatures will be approximately 34°F [19°C] above the bearing frame surface temperature and approximately 65°F [36°C] above ambient.

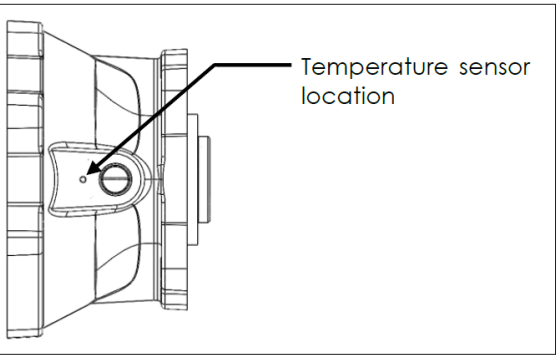


Figure 18: Bearing Sensor location

7.3.3 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	Horizontal pumps ≤ 20 hp (15 kW)	Horizontal pumps > 20 hp (15 kW)	Vertical configurations.
Normal N	≤ 0.12 (3.0)	≤ 0.18 (4.5)	≤ 0.28 (7.1)
Alarm N X 1.2	≤ 0.15 (3.8)	≤ 0.22 (5.6)	≤ 0.35 (9.0)
Shutdown trip N X 2.0	≤ 0.24 (6.0)	≤ 0.36(9.0)	≤ 0.56 (14.2)

7.3.4 Vibration measurements / condition monitoring

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 measurements can be used to detect more than only bearing failure, if processed and analyzed correctly. Flowserve has a range of condition monitoring devices which can be used to monitor pumps and detect different failure modes (e.g., closed discharge valve, cavitation, …). Contact your local Flowserve representative.

7.3.5 Leak monitoring

Dual Drive pumps installed in an explosive environment require a leakage detection device to be installed which operates an alarm and automatic switch-off function. If leakage is detected, immediately shutdown the pump and within 48 hours drain and service the pump prior to commencing operations.

7.3.5.1

The standard method of leak detection for ATEX applications utilizes Echotel® Model 961 Ultrasonic liquid level detection sensor installed in the Dual Drive Adapter sump sensor port. The sensor shall be electrically wired to automatically shut off power to the pump driver and signal an alarm condition upon sensing liquid. This indicates a leak of process fluid from the containment shell to the Dual Drive secondary containment field. For best liquid detection, the arrows on the Model 961 sensor shall be within 45° of vertical when installed. See Figure 19 for mounting location. Torque per Table 10.

7.3.5.2

Alternate method of leak detection by pressure rise for ATEX applications. This method utilizes an Ashcroft® L-Series pressure switch with a single set point of 5 psi (.35 Bar) and electrically wired to automatically shut off power to the pump driver and signal an alarm condition. This method monitors the pressure within the Dual Drive secondary containment field. The secondary containment field will be at or near zero gauge pressure under normal conditions. If the pressure rises above 5 psi (.35 Bar) (normal pressure change for wide ambient temperature swings) then a leak in the pump containment shell is assumed. The pump shall be automatically shut down and an alarm condition signaled. See Figure 19 for mounting location. Torque per Table 10.

7.3.5.3

Alternate method of leak detection by pressure change for ATEX applications. This method utilizes Ashcroft® L-Series pressure switch with dual set points of 5 and 25 psi (0.34 and 1.72 bar) and electrically wired to automatically shut off power to the pump driver and signal an alarm condition. This method monitors the pressure within the Dual Drive secondary containment field. The secondary containment field must be charged with inert gas to 15 ±2 psi (1.03 ±0.14 bar). If the pressure drops below 5 psi (0.34 bar) a leak from the Dual Drive secondary containment field to atmosphere is assumed and it is no longer able to contain process fluid in the event of a containment shell leak. This condition shall activate a warning alarm indicating pump maintenance is required. A rise in monitoring pressure above 25 psi (1.72 bar) indicates a leak of process fluid into the Dual Drive secondary containment field. The pump shall be automatically shutdown and an alarm condition signaled. See Figure 19 for mounting location. Torque per Table 10.

7.3.5.4

RedRaven pressure monitoring equipment can also be used for both ATEX and non-ATEX applications. This offers remote wireless monitoring of the pressure in the secondary containment field with automatic shutdown and alarm capabilities. Contact Flowserve for more details. See Figure 19 for mounting location. Torque per Table 10.

7.3.5.4

Non ATEX applications use similar methods and less costly sensors as described above. Non ATEX applications can also use analog pressure gauges or a visual sight glass located in the Dual Drive Adapter sump. Manual methods require visual inspections twice per shift to identify a potential leak and manual notification of the condition to operations safety personnel. See Figure 19 for mounting location. Torque per Table 10.

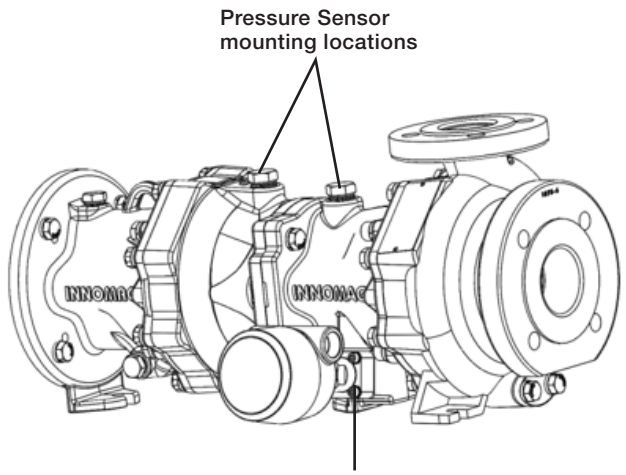


Figure 19

7.4 Stopping and Shut Down

⚠ CAUTION

- ▷ Close the discharge valve but ensure that the pump runs in this condition for no more than a few seconds.
- ▷ Stop the pump.
- ▷ Switch off flushing and/or cooling/heating liquid supplies at a time appropriate to the process.

⚠ CAUTION

- ▷ For prolonged shut down 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.

7.4.1 Longer periods of pumps not running

For longer periods without operation of the pump, a monthly operation of the pump unit is required to avoid deposits in the pump and suction inlet and prevent blockages.

✓ Sufficient pumped medium is available for a functional run of the pump.

1. Start the pump unit.
2. Operate the pump unit for 5 minutes within the allowable operating range.
3. Check noise and vibration levels.
4. Power down the pump unit.

⚠ CAUTION

Non-metallic gaskets incur creep relaxation - before commissioning the pump check and retighten fasteners to tightening torques specified in Table 10.

7.5 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.

7.5.1 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.

7.5.2 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.

7.5.3 Pump speed

Changing pump speed effects flow, total head, power absorbed, NPSHR, 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,

NPSHA > NPSHR, and that noise and vibration are within local requirements and regulations.

7.5.4 Net positive suction head (NPSHA)

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

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

If any change in NPSHA 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.

7.5.5 Pumped flow

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

7.6 Cleaning

NOTICE

Aggressive cleaning and flushing media may damage the pump.

- ▷ Adjust the type and duration of cleaning operations to the housing and sealing materials used.

8 Maintenance

Personnel: Machine fitter

8.1 Schedule

⚠ WARNING

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

- ▷ Any auxiliary systems installed must be monitored, if necessary, to ensure they function correctly.
- ▷ Check for any leaks from gaskets and seals. The correct functioning of the shaft seal must be checked regularly.
- ▷ For long coupled only, check bearing lubricant level, and condition. Change every 4000 hours or at least every six months. Lubricant level shall be at the center of the site glass while the pump is stopped.
- ▷ Check that the duty condition is in the safe operating range for the pump. It is the user's responsibility to ensure the pump is operated within the allowable operation range.
- ▷ Check vibration, noise level and surface temperature at the bearings to confirm satisfactory operation.
- ▷ Check dirt and dust is removed from areas around close clearances, bearing housings and motors.
- ▷ Check coupling alignment and re-align if necessary.
- ▷ To prevent excessive surface temperatures at bearings it is recommended that temperature or vibration monitoring are carried out.
- ▷ Avoid electrostatic charge: do not rub non-metallic surfaces with a dry cloth: ensure cloth is damp.

No.	Service / Parts	Schedule / Cycles	Criteria	Action	
				Good	Inadequate
1	Routine inspection	Daily/weekly	Check operating behavior. Ensure noise, vibration and bearing temperatures are normal	No action	Refer to Chapter 9 Troubleshooting Guide
			Check that there are no abnormal fluid leaks (static and dynamic seals)	No action	Replace every 24 months or if leaks are visible
			Check any auxiliary supplies e.g., heating/ cooling (if fitted) are functioning correctly	No action	Refer to user instructions for auxiliary equipment
2	Periodic inspection	Every six months	Check foundation bolts for security of attachment and corrosion	No action	Retorque per Table 10 or Replace parts if corroded or damaged
			Long Coupled, Check coupling for correct alignment and worn driving elements	No action	Refer to coupling user instructions and Chapter 5
3	Bearings Long Coupled	Daily/Weekly	Check level and condition of bearing lubricant	No action	Refill or replace
		4000 hours or every 6 months	Bearing lubricant oil change interval	Replace lubricant	Replace lubricant
		8,000 hours or 2 years	Check ball bearing for wear and damage	No action	Replace part
4	Sealed Bearings (Dual Drive)	Monthly	If maximum operating temperatures have been exceeded, or the bearing housing is flooded	No action	Replace part
		26,000 hours or 3 years (see 8.1.1)	Maximum runtime limit	Replace part	Replace part
5	Shaft sealing for pumps with mechanical seals	8,000 hours or 2 years	Check for leakage on seal faces	No action	Replace part

Table 8: Recommended maintenance checklist

8.1.1 Dual Drive Bearing replacement

Dual Drive Bearing replacement interval can be extended per the table below. Temperature monitoring per paragraph 7.3.2.1 is required to extend the bearing life beyond 26,000 hours or 3 years. If maximum operating temperatures have been exceeded, or the bearing housing is flooded the bearings shall be replaced immediately. Utilization of RedRaven continuous vibration monitoring is an alternate method of monitoring bearing health.

Min. Bearing Frame Surface Temp °F (°C)		Max. Bearing Frame Surface Temp °F (°C)		Series A/E	Series B/C/F/G
93	(34)	122	(50)	8	8
70	(21)	140	(60)	5	4
57	(11)	158	(70)	4	3

Table 9: Dual Drive Extended Bearing life (yrs)

Notes:

1. Values shown are for the Standard bearing.
2. The life shown in the table can be doubled if using the optional hybrid bearing, up to a max of 10 years.
3. Bearings can run at temperature limits shown in Section 12.4. Typically, after several hours of run time the bearing temperatures will increase to those shown in the table. The Table 9 temperatures only apply to extended bearing life.
4. Temperature monitoring is required to allow extending the bearing life beyond 3 years. See Section 7.3.2.1 for temperature monitoring.
5. Bearing life at these temperatures is based on ISO 281 bearing life calculations and Bearing supplier recommendations for grease life at operating temperatures shown.
6. Cannot exceed the performance and operating limits stated in Section 12.4 and 2.11.7.3.
7. During normal running conditions the bearing temperatures for B/C/F/G sizes will be approximately 34°F [19°C] above the bearing frame surface temperature and approximately 65°F [36°C] above ambient.
8. During normal running conditions the bearing temperatures for A/E sizes will be approximately 39°F [22°C] above the bearing frame surface temperature and approximately 80°F [44°C] above ambient.

8.2 Tools Required

A typical range of tools that will be required to maintain these pumps is listed below.

8.2.1 Readily available Hand Tools

- Imperial and metric size wrenches, sockets, spanners
- Imperial and metric Hex wrenches
- Screwdrivers
- Soft mallet
- Needle Nose Pliers
- Measuring tools
- Knife
- Dial indicator

8.2.2 Shop Equipment

- Arbor Press
- Lathe

8.2.3 Jackscrew Bolts per Pump Size

- A Series containment ring [1240]:
  (2) 1/2 in. -13 x 5 in.
- E Series containment ring [1240]:
  (2) M12 - 1.75 x 11 cm
- B/C Series containment ring [1240]:
  (2) 5/8 in.-11 x 5 in.
- F/G Series containment ring [1240]:
  (2) M16 - 2 x 11 cm
- A/E Series ASME Adapter [1340]:
  (2) 1/2 in. -13 x 5 in.
- A/E Series IEC Adapter [1340]:
  (2) M12 - 1.75 x 11 cm
- B/C/F/G Series ASME Adapter [1340]:
  (2) 5/8 in.-11 x 5 in.
- B/C/F/G Series IEC Adapter [1340]:
  (2) M16 - 2 x 11 cm
- ASME Outer Magnet and Dual Drive inboard outer magnet [7124]:
  1/2 in. - 13 x 4.5 in. jackscrew, (2) 5/16-18 x .75, and jackscrew plate (TLG-2042-FM)
- IEC Outer Magnet [7124] and Dual Drive inboard outer magnet:
  (2) M8 -1.25 x 30 mm, M12 - 1.75 x 100+mm jackscrew and jackscrew plate (TLG-2042-SI)

8.2.4 Flowserve INNOMAG Specialized Equipment

- ▶ Shaft Removal Tool
- A/V/E Series Part # TLG-2017-AA
- B/C/W/F/G Series Part # TLG -2018-AA
- ▶ Shaft Centering Tool
- A/V/E Series Part # TLG-2013-SI
- B/C/W/F/G Series Part # TLG-2015-SI
- C Series (‘H’ Models) Part # TLG-2014-SI
- ▶ Bushing Installation / Removal Kit
- Part # TLG-2016-AA
- ▶ Impeller Trimming Sleeve
- A/V/E Series Part # TLG-2033-AA
- B/C/W/F/G Series Part # TLG-2023-AA

8.3 Tools Required

Fastener	Nominal Screw Size	Torque Lbft (Nm)
All fasteners and set screws except those listed below	5/16in. (M8)	12 (16)
	3/8in. (M10)	18 (25)
	1/2in. (M12)	26 (35)
	5/8in. (M16)	59 (80)
	3/4in. (M20)	96 (130)
Drain flange bolts	1/2in. (M12)	10 (14)
Dual Drive leak sensor adapter, bearing Retaining Cap	1/4in. (M6)	3 (4)
Dual Drive Taper Bushing	1/4in. (M6)	9 (12)
Fastener	Nominal Screw Size	Torque
NPT Fittings	All	Hand tight plus 2-3 full turns
BSPP Fittings	ISO 7-1 Rp ¾	120 (180)

Table 10: Fastener torques

⚠ CAUTION

- ▷ Never use the pump as a support for piping.
- ▷ Non-metallic gaskets incur creep relaxation. Before starting the pump after maintenance, check and retighten fasteners and set screws to tightening torque values specified in Table 10 for the pump assembly and flange joint fasteners per industry standards.
- ▷ Re-tighten all fasteners after 24 hours or after the first thermal cycle.
- ▷ Check all fasteners annually.

8.4 Sectional drawing TB-MAG

8.4.1 Sectional drawing and parts list

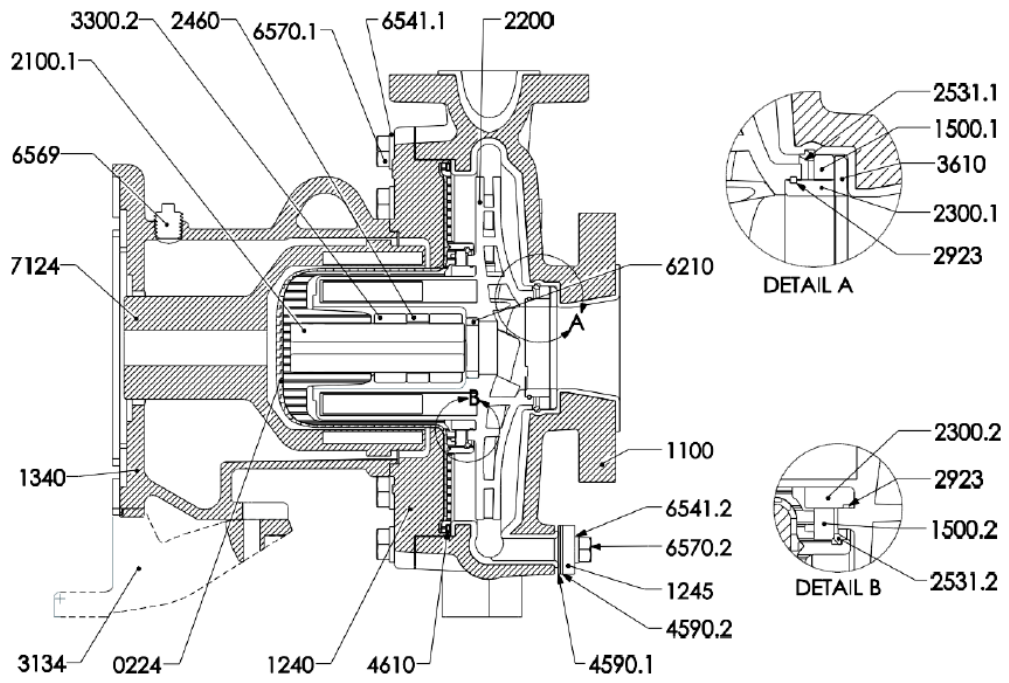


Figure 20: TB-MAG sectional drawing

FIN	Description	HI Reference
0224	Containment Shell	231
1100	Casing	1
1240	Clamping Ring	239
1245	Flange	370
1340	Adapter	19
1500.1	Casing Wear Ring	7
1500.2	Casing Wear Ring	27
2100.1	Shaft	6
2200	Impeller	2
2300.1	Impeller Wear Ring	8A
2300.2	Impeller Wear Ring	8B
2460	Spacer Sleeve	236
2531.1	Split Retaining Ring	9A
2531.2	Split Retaining Ring	9B
2923	Pin	9C
3134	Support Foot	20
3300.2	Bushing, Bearing	235
3610	Thrust Collar	72
4590.1	Gasket, PTFE	371
4590.2	Gasket, Neoprene	372

FIN	Description	HI Reference
4610	O-ring	73
6210	Balance Disc	14
6541.1	Lock Washer	301
6541.2	Lock Washer	301
6569	Plug	302
6570.1	Screw	300
6570.2	Screw	300
7124	Outer Magnet Rotor	232

Note: Vertical models have different casing configuration but are otherwise identical.

8.4.2 Long Coupled Sectional Drawing (optional secondary control seal shown)

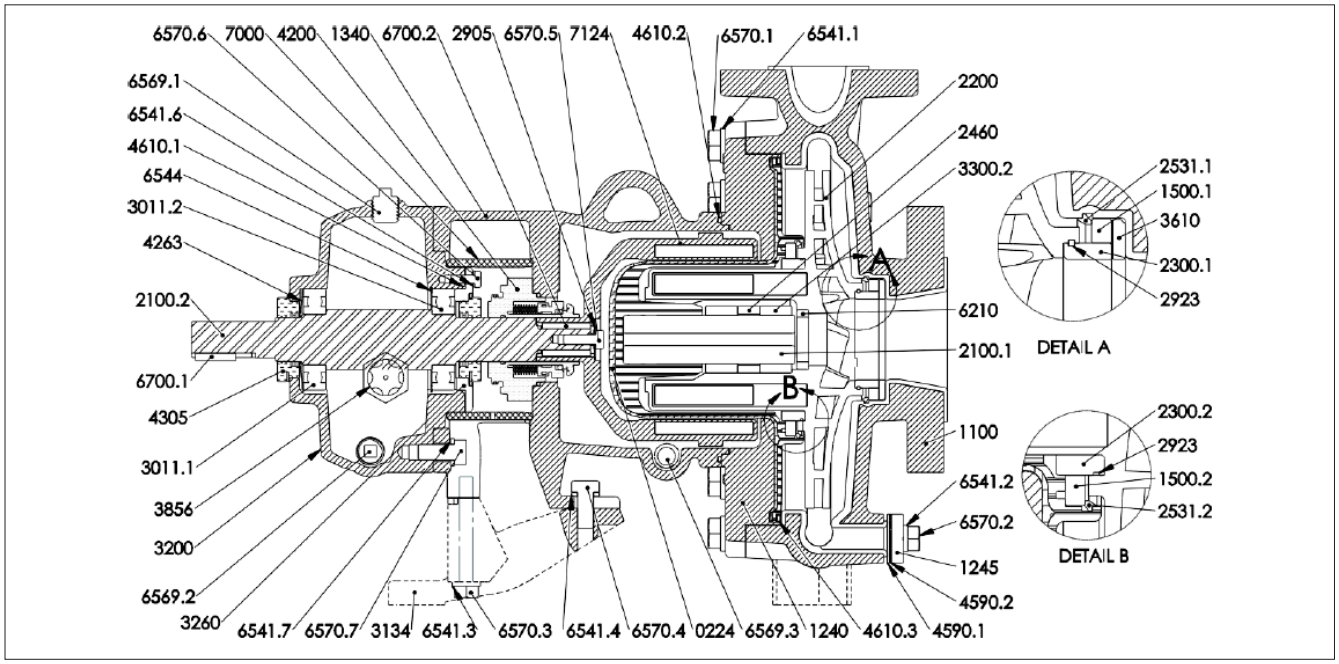


Figure 21: Sectional Drawing (optional secondary control seal shown)

FIN	Description	HI Reference
0224	Containment Shell	231
1100	Casing	1
1240	Clamping Ring	239
1245	Flange	370
1340	Adaptor	71
1500.1	Casing Wear Ring	7
1500.2	Casing Wear Ring	27
2100.1	Shaft	6
2100.2	Shaft	12
2200	Impeller	2
2300.1	Impeller Wear Ring	8A
2300.2	Impeller Wear Ring	8B
2460	Spacer Sleeve	236
2531.1	Split Retaining Ring	9A
2531.2	Split Retaining Ring	9B
2905	Washer	
2923	Pin	9C
3011.1	Radial Ball Bearing	18
3011.2	Radial Ball Bearing	16
3134	Support Foot	20
3200	Bearing Housing	19
3260	Bearing Cover	
3610	Thrust Collar	72
3856	Oil Sight Gauge	
4200	Mechanical Seal (Optional)	89
4263	Spring Plate	
4305	Shaft Seal Ring	47

FIN	Description	HI Reference
4590.1	Gasket, PTFE	371
4590.2	Gasket, Neoprene	372
4610.1	O-ring	
4610.2	O-ring (Sealed Units Only)	
4610.3	O-ring	73
6210	Balance Disc	14
6541.1	Lock Washer	301
6541.2	Lock Washer	301
6541.3	Lock Washer	
6541.4	Lock Washer	
6541.5	Lock Washer	
6541.6	Lock Washer	
6541.7	Lock Washer	
6544	Circlip	
6569.1	Plug	
6569.2	Plug	
6569.3	Plug	
3300.2	Bushing, Bearing	235
6570.2	Screw	300
6570.3	Screw	
6570.4	Screw	
6570.5	Screw	
6570.6	Screw	
6570.1	Screw	300
6571	Screw	
6700	Key	46
6700	Key	
7000	Guard Assembly	
7124	Outer Magnet Rotor	232

8.4.3 Sectional Drawing Dual Drive

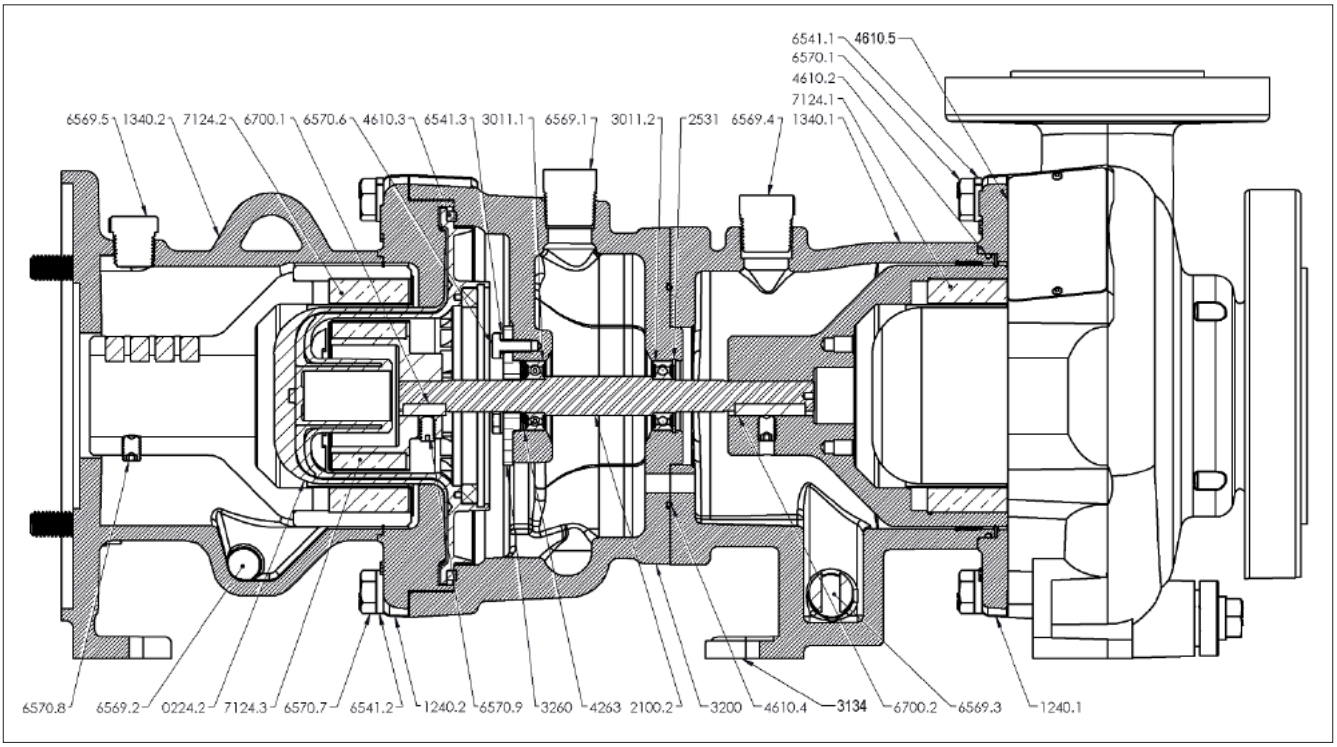


Figure 22: Sectional Drawing Dual Drive A/E sizes.

FIN	Description	HI Reference
0224.1	Containment Shell	231
0224.2	Containment Shell	231
1240.1	Clamping Ring	239
1240.2	Clamping Ring	239
1340.1	Adapter	71
1340.2	Adaptor	71
2100.2	Shaft	12
2531	Split Retaining Ring	9
3011.1	Radial Ball Bearing	18
3011.2	Radial Ball Bearing	16
3134	Support Foot (not shown)	20
3200	Bearing Housing	19
3260	Bearing Cover	
6541.1	Lock Washer	301
6541.2	Lock Washer	301
6541.3	Lock Washer	301
6569.1	Plug	302
6569.2	Plug	302
6569.4	Plug	302
6569.5	Plug	302
6570.1	Screw	300
6570.6	Screw	
6570.7	Screw	
6570.8	Screw	
6570.9	Screw	

FIN	Description	HI Reference
6700	Key	46
4263	Spring Plate	
4610.2	O-ring	
4610.3	O-ring	
4610.4	O-ring	
4610.5	O-ring (not visible)	
6700	Key	
7124.1	Outer Magnet Rotor	232
7124.2	Outer Magnet Rotor	232
7124.3	Inner Magnet Rotor	232
9032	Liquid Level Indicator	248

Reference to figure 20 for wet end

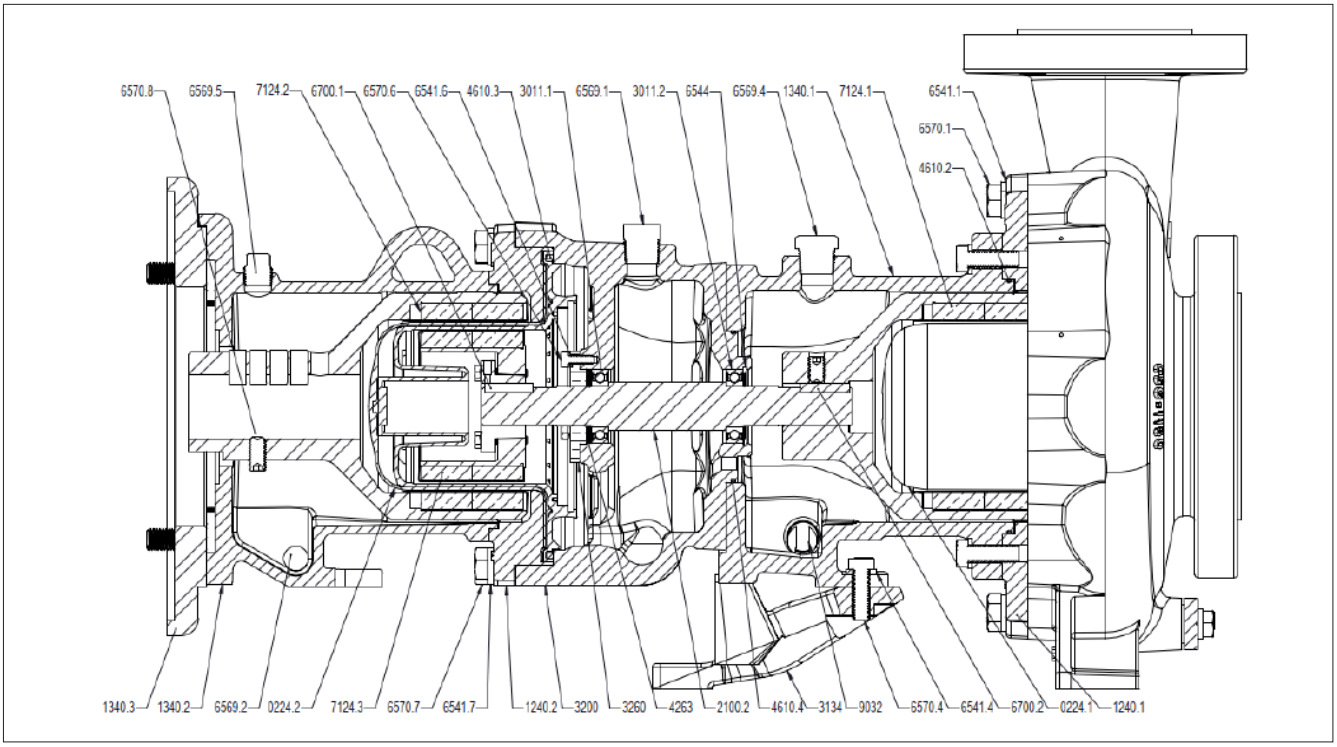


Figure 23: Sectional Drawing Dual Drive B/C/F/G sizes.

FIN	Description	HI Reference
0224.1	Containment Shell	231
0224.2	Containment Shell	231
1240.1	Clamping Ring	239
1240.2	Clamping Ring	239
1340.1	Adapter	71
1340.2	Adaptor	71
2100.2	Shaft	12
2531	Split Retaining Ring	9
3011.1	Radial Ball Bearing	18
3011.2	Radial Ball Bearing	16
3134	Support Foot (not shown)	20
3200	Bearing Housing	19
3260	Bearing Cover	
6541.1	Lock Washer	301
6541.2	Lock Washer	301
6541.3	Lock Washer	301
6569.1	Plug	302
6569.2	Plug	302
6569.4	Plug	302
6569.5	Plug	302
6570.1	Screw	300
6570.6	Screw	
6570.7	Screw	
6570.8	Screw	
6570.9	Screw	

FIN	Description	HI Reference
6700	Key	46
4263	Spring Plate	
4610.2	O-ring	
4610.3	O-ring	
4610.4	O-ring	
4610.5	O-ring (not visible)	
6700	Key	
7124.1	Outer Magnet Rotor	232
7124.2	Outer Magnet Rotor	232
7124.3	Inner Magnet Rotor	232
9032	Liquid Level Indicator	248

Reference to figure 20 for wet end

8.4.4 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 shall be obtained from the Purchaser and retained with these User Instructions.

8.5 Spare parts

8.5.1 The following assemblies are the recommended spare parts:

- Due to the fragility of Silicon Carbide shafts, wear rings, bushings and the experience needed to replace these small components without damage, a complete spare wet end assembly is recommended
- An outer mag drive assembly, a long coupled bearing frame assembly or a Dual Drive assembly are the preferred spare parts
- A selection of gaskets, set screws and plugs if the pump is opened for inspection

8.5.2 Ordering of spares

When ordering spare part, the following information shall be provided to Flowserve:

1. Product serial number.
2. Product size.
3. Part name – taken from the parts list/sectional drawing.
4. Part number – taken from the parts list/sectional drawing.
5. Number of the parts required.

The product size and serial number are provided on the nameplate.

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

	NOTICE
	For the tightening sequence also refer to good industry practice.

8.6 Disassembly

	⚠ WARNING
	To ensure worker safety, follow safe methods for preventing the release of hazardous energy (electrical, mechanical, hydraulic, pneumatic, chemical, thermal, and other energy sources) while the pump equipment is undergoing maintenance or taken out of service. Procedure should follow all applicable local, national, and or international regulations. Example: United States of America, Occupational Safety and Health Administration (OSHA) standard for The Control of Hazardous Energy (Lockout/Tagout), Title 29 Code of Federal Regulations (CFR)Parts 1910.147 and 1910.333.

	SAFETY INSTRUCTIONS
	Any work on the pump assembly must be performed only after it has been safely shut down and hazardous energy has been secured. It is imperative that the procedure for shutting down the machine is followed, as described in Chapter 7.4. Before working on the pump assembly, take measures to prevent an uncontrolled start. See Section 2.14 Control of Hazardous Energy.

8.6.1 Preparation for disassembly

⚠ CAUTION

Proceed as follows:

- ▷ Disconnect power to the motor.
- ▷ Lock out power to driver to prevent personal injury.
- ▷ Drain the plant, at least within the pump area, i.e., between the valves on the suction- and discharge side.
- ▷ If necessary, disconnect any measuring probes or control devices and remove them
- ▷ Drain liquid from the pump by means of the drain plug.
- ▷ For Long Coupled pumps, drain the oil from the bearing housing.
- ▷ The pump casing must not be detached from the pipe union.
- ▷ Remove motor mounting bolts from the baseplate and move the motor so that there is sufficient space 6 in (153 mm). When using a spacer coupling repositioning of the motor is not necessary.
- ▷ Dismantle guard coupling, pump feet and coupling.

⚠ WARNING

If Flowserve INNOMAG TB-MAG ASME ISO pumps contain dangerous chemicals, it is important to follow plant safety guidelines to avoid personal injury or death

8.6.2 Drive/Wet end Separation

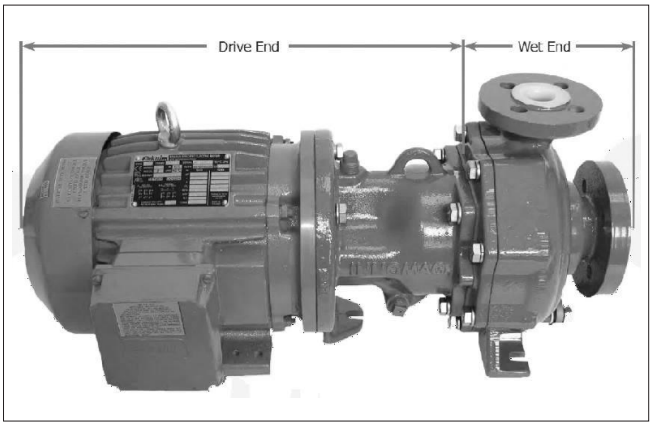


Figure 24: Wet End Separation

⚠ CAUTION

- ▷ Flowserve INNOMAG pumps contain extremely strong magnets. The use of non-magnetic tools and work surface is highly recommended. The work area must be clean and free of any ferrous particles.
- ▷ Wet end and drive end separation requires significant care. The magnetic coupling between the impeller [2200] and outer drive [7124] magnets is very strong. This process requires the magnetic field between the outer drive and impeller to be broken.

8.6.2.1 Close-Coupled and Vertical Pumps

1. Remove the bolt(s) connecting the adapter foot [3134] to the base and any bolts connecting the motor to the base.
2. Remove the (4) hex caps screws on the adapter [1340].
3. Separate the drive end (which includes the adapter [1340], outer magnet assembly [7124] and the motor) from the wet end by evenly tightening the (2) jack bolts (see Section 8.2.1) through the jack bolt holes in the adaptor [1340].

⚠ CAUTION

Removing the close-coupled motor requires significant care. The magnetic coupling between the impeller and outer drive magnets is very strong. The next step requires the magnetic field to be broken.

4. Firmly hold the drive end and with smooth, continuous force, pull it away from the wet end. Pull the drive end back at least 6 in. (150 mm).
5. Turn the drive end off to the side to allow space for disassembly of the wet end.

8.6.2.2 Long Coupled Pumps

⚠ CAUTION

If the long coupled bearing frame [3200] will not be opened, steps 1 and 2 can be skipped. The unit must remain horizontal to prevent oil leakage through the bearing isolators.

1. Remove the metal drain plug [6569.2] below the sight glass [3856] on the bearing frame [3200] to drain the oil.
2. Drain the oil into an oil pan and replace the oil plug [6569.2].
3. Remove the coupling guard and coupling from the motor and bearing frame shafts.
4. Remove the bolts connecting the motor to the baseplate.
5. Move the motor aside to allow space for wet end/ adaptor [1340] separation, approximately 6 in 153 mm).
6. Remove the bolts (2) connecting the support foot [3134] to the base.
7. Remove the (4) hex caps screws on the adapter [1340].
8. Separate the drive end (which includes the adapter [1340], outer magnet assembly [7124]) from the wet end by evenly tightening the (2) jack bolts (see Section 8.2.1) through the jack bolt holes in the containment ring [1240].
9. Firmly hold the bearing frame [3200/1340] and with smooth, continuous force, pull it away from the wet end.
10. Place the bearing frame [3200/1340] aside for disassembly of the wet end.

8.6.2.3 Dual Drive Drive End/secondary containment section

1. Remove the bolt(s) connecting the outboard adapter foot [3134] to the base and any bolts connecting the motor to the base.
2. Remove the (4) hex caps screws on the outboard adapter [1340] that connect it to the outboard containment ring.
3. Separate the drive end (which includes the outboard adapter [1340], outer magnet assembly [7124] and motor) from the secondary containment section by evenly tightening the (2) jack bolts (see Section 8.2.1) through the jack bolt holes in the outboard adapter [1340].

	⚠ CAUTION
⚠	Removing the close-coupled motor requires significant care. The magnetic coupling between the secondary containment section and outer drive magnets is very strong. The next step requires the magnetic field to be broken.

4. Firmly hold the drive end and with smooth, continuous force, pull it away from the secondary containment section. Pull the drive end back at least 6 in. (150 mm).
5. Turn the drive end off to the side to allow space for disassembly of the secondary containment section.

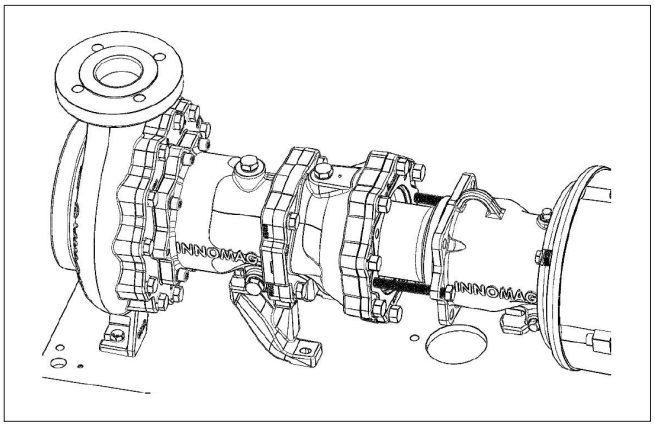


Figure 25: Dual Drive Drive End Separation

8.6.2.4 Dual Drive Secondary containment section/Wet End Separation

1. Remove the bolt(s) connecting the inboard adapter foot [3134] to the base.
2. Remove the (4 or 6) hex caps screws on the inboard adapter [1340] that connect it to the inboard containment ring.
3. Separate the secondary containment section (which includes the inboard adapter [1340], inboard outer magnet assembly rotor [7124], bearing frame, and outboard inner mag drive) from the wet end containment ring by evenly tightening the (2) jack bolts (see Section 8.2.1) through the jack bolt holes in the inboard adapter [1340].

	⚠ CAUTION
⚠	Removing the close-coupled motor requires significant care. The magnetic coupling between the Secondary containment section and pump impeller magnets is very strong. The next step requires the magnetic field to be broken.

4. Firmly hold the Secondary containment section and with smooth, continuous force, pull it away from the wet end. Pull the secondary containment section back at least 6 in. (150 mm).

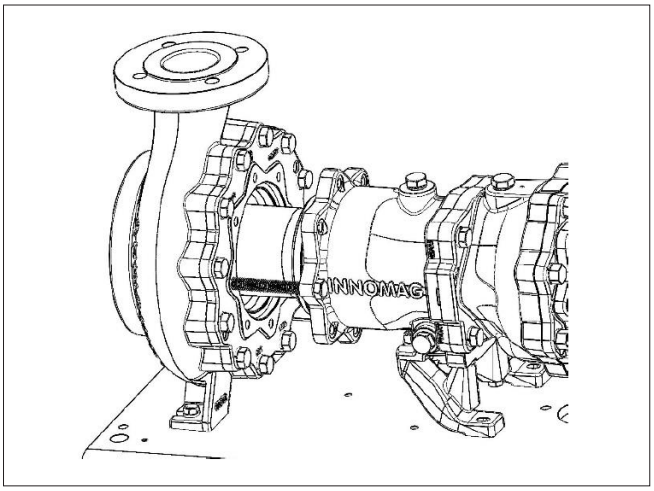


Figure 26: Dual Drive Wet End Separation

8.6.3 Wet End Disassembly

8.6.3.1 Wet End Disassembly – Piping connected

	⚠ *WARNING*
	When handling hazardous and/or toxic fluids, proper personal protection equipment is required. If pump is being drained, precautions must be taken to prevent injury or environmental contamination.

	⚠ *CAUTION*
	▷ Ensure suction and discharge valves are completely closed. ▷ Drain the pump and individually decontaminate each component in accordance with all federal, state, local and company environmental regulations. ▷ For larger pumps (TB-MAG B/C/W/F/G-Series) we recommend having two people perform the following procedures to decrease the chance of damaging or breaking the SiC components.

	NOTICE
	The Dual Drive pump requires a specific containment ring mounted to the pump casing. Standard TB-MAG containment rings are not compatible with the Dual Drive pump at the pump casing. The outboard containment ring for the Dual Drive pump is the standard TB-MAG containment ring. Take note of which type of containment ring is removed from the pump casing and the outboard end for re-assembly.

1. Loosen all hex caps screws [6570.1] on the containment ring [1240] and remove every other bolt. Leave at least 4 bolts loose but still attached to the casing [1100].
2. Visually inspect the containment ring [1240]. If it appears loose then you can remove all the bolts and skip the following step. However, if the pump has been in service for a long period of time, it is very common for the containment ring [1240] to be stuck to the casing [1100]. In this case, use the following procedure:
3. Insert (2) of the bolts you just removed into the jack bolt holes on the containment ring [1240] and evenly tighten them until the ring breaks free. Remove all the remaining hex caps screws [6570.1].
4. Firmly hold the containment shell [0224] and use your index fingers and thumbs to support the containment ring [1240].
5. Pull the assembly back in a straight line until it is clear of the casing [1100].
6. Remove the containment shell [0224] and impeller [2200] from the containment ring [1240].
   Note: optional, may be very difficult on pumps in service for long periods of time.
7. Lift and remove the impeller [2200] from the containment shell [0224].

8.6.3.2 Wet End Disassembly – In Shop (Recommended method)

1. Remove all flange and casing [1100] feet hex caps screws.
2. Place a piece of cardboard or a shop towel on the workspace to protect the plastic on the flange.
3. Lay the wet end face down on the suction flange in the work area.
4. Loosen and remove the hex caps screws [6570.1] on the containment ring [1240] with a wrench.

5. Visually inspect the containment ring [1240]. If it appears loose then you can remove all the hex cap screws [6570.1] and skip the following step.

   However, if the pump has been in service for a long period of time, it is very common for the containment ring [1240] to be stuck to the casing [1100]. In this case, use the following procedure:

6. Insert (2) of the bolts you just removed into the jack bolt holes on the containment ring [1240] and evenly tighten them until the ring breaks free. Remove all the remaining hex cap screws [6570.1].
7. Slightly rotate the containment ring [1240] to make it easier to grab.
8. Lift the containment ring [1240] with your fingers while holding down the containment shell [0224] with your thumbs.
9. Lift the containment ring [1240] straight up off of the containment shell [0224] and set aside.
10. Carefully lift and remove the containment shell [0224] straight up from the impeller [2200].
11. Carefully lift and remove the impeller [2200] straight up from the casing [1100].

8.6.3.3 Dual Drive Secondary containment section Disassembly

1. Using slings and mechanical lifting means move the Secondary containment section to a suitable table and secure from movement.
2. Remove the plug from the top set screw access hole on the inboard adapter.

	⚠ CAUTION
⚠	Do not reuse set screws after removing the mag drive from the shaft. Replace all set screws with new Flowserve recommended components and installed per Section 8.10.2. Failure to follow these instructions could lead to vibration loosening of the mag drive.

3. Loosen the two set screws holding the inboard outer mag drive to the bearing frame shaft.
4. Attach the jack screw plate [TLG-2042-SI] with two 5/16-18 x .75 in. long screws into the treaded holes inside the Dual Drive outer magnet assembly.
5. Insert a 1/2 -13 x 4.5 in. long jack bolt into the center of the jack screw plate [TLG-2042-SI] and tighten the center jack bolt to free the outer magnet assembly.
6. Remove the inboard outer mag drive from the bearing frame shaft.
7. Remove the key from the shaft and discard if damaged.
8. Remove the 4 hex caps screws [6570.1] connecting the bearing frame to the inboard adapter.
9. Loosen and remove the hex caps screws [6570.1] on the outboard containment ring [1240].
10. Visually inspect the containment ring [1240]. If it appears loose, then you can remove it by lifting straight up off the outboard containment shell [0224] and skip the following step. However, if the pump has been in service for a long period of time, it is very common for the containment ring [1240] to be stuck to the bearing frame [1100]. In this case, use the following procedure:

    a. Insert (2) of the bolts you just removed, into the jack bolt holes on the containment ring [1240] and evenly tighten them until ring breaks free.

    b. Slightly rotate the containment ring [1240] to make it easier to grab.

    c. Lift the outboard containment ring [1240] straight up off the outboard containment shell [0224] and set aside.

11. Carefully lift and remove the containment shell [0224] straight up from the bearing frame.

	⚠ CAUTION
⚠	Removing the outboard containment shell exposes the strong magnetic field of the outboard inner mag drive. Use proper PPE, caution, and nonmagnetic tools or guards for the next step.

For B, C, F, G, sizes see steps 12 and13
For A, E sizes see steps 14.

12. Carefully remove the three hex head bolts mounting the mag drive yoke to the taper bushing.
13. Insert the three bolts into the threaded holes in the taper busing. Gently and evenly tighten the bolts until the mag drive yoke and taper bushing are loose.
14. Remove the two set screws holding the outboard inner mag drive yoke to the bearing frame shaft and discard.
15. The outboard inner mag drive assembly can now be removed from the bearing frame shaft.
16. Remove the key from the shaft keyway and discard if damaged. Replace with a new part at re-assembly.

17. Remove the three hex head bolts mounting the bearing retaining cap to the bearing frame and remove the bearing retaining cap.
18. Remove the bearing wave spring and discard. Replace with a new part at re-assembly.
19. At the inboard end of the shaft, remove the spiral bearing retaining ring and discard. Replace with a new part at re-assembly.
20. The bearing shaft assembly can be removed from the bearing frame. This may require the use of apress. The shaft bearing assembly can be pushed out in either direction whichever is convenient. Replace both bearings at re-assembly. Inspect shaft for nick, scratches, deformation that may inhibit reassembly or proper function and replace if any is found.

8.7 Work after the disassembly

	⚠ *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.

If replacement of any part is required, follow the procedures in the repair sections of this manual. Carefully clean and inspect all internal parts.

8.7.1 Casing lining

Inspect the casing [1100] lining for any abrasion, cracks, or delamination. Casing [1100] replacement is necessary if lining is breached. Minor scratches or cuts less than 0.040 in. (0.1 mm) depth are acceptable.

8.7.2 Silicon Carbide (SiC)

When inspecting the pump internals check all Silicon Carbide (SiC) parts for cracks, chips and scoring marks. Minor chips less than 0.020 in. (0.5 mm) are acceptable. If replacement of any part is required, follow the procedures in the repair sections of this manual. Carefully clean and inspect all internal parts.

8.7.3 Containment Shell

Use a torch (flashlight) to inspect inside the containment shell [0224], shaft [2100.1], and wear ring [1500.2].

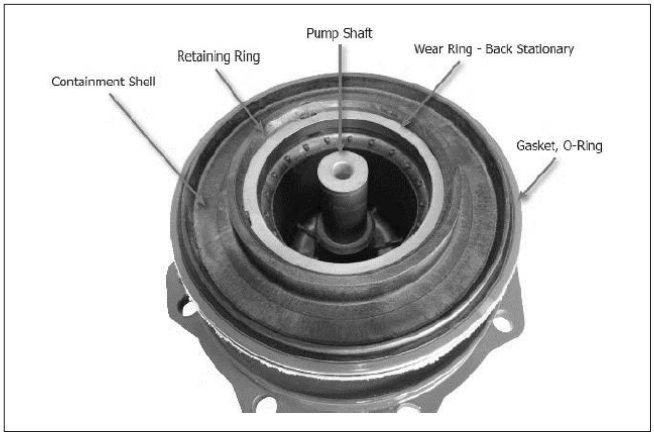


Figure 27: Containment Shell

8.7.4 Gasket, O-rings

After dismantling, discard and replace all O-rings [4610].

8.7.5 Impeller

The bushings [3300.2], thrust control valve [6210], and wear rings [2300.1, 2300.2] can be replaced if damaged. See section 8.8.3 for repair instructions.

8.7.6 Outer Magnet

Wipe the inside of the outer magnet assembly [7124] clean from all foreign particles.

8.7.7 Dual Drive

- ▷ Replace all O-ring's and gaskets.
- ▷ Inspect and wipe clean all O-ring's grooves and mating surfaces.
- ▷ Replace spiral bearing retaining ring.
- ▷ Replace bearing wave spring.
- ▷ Inspect taper bushing and replace if damaged.
- ▷ Inspect mag drives, clean remove all debris including magnetic particles.
- ▷ Inspect shaft for nicks, scratches or damage that could cause miss-assembly or improper operation. Replace if damaged.
- ▷ Replace both bearings.

8.8 Repair

8.8.1 Casing Repair

8.8.1.1 Casing Wear Ring Removal

1. Insert a flathead screwdriver into the casing [1100] notch opposite the plastic weld point on the retaining ring and pry out the retaining ring.
2. Lift out the thrust collar [3610] and front stationary wear ring [1500.1] with your fingers. Pull the front stationary retaining ring [2531.1] free.
3. Remove the locking key(s).

8.8.1.2 Casing Wear Ring Installation

1. Insert thrust collar [3610] (grooved side up) and align the keyway notch on the thrust collar with the casing [1100] keyway notch.
2. Insert and align the (SiC) front stationary wear ring [1500.1] with the keyway notch in the casing [1100].
3. Insert locking key(s) into all but one keyway.
4. Casings will have from two to six keyways. For example, if the casing has four, you must insert (3) locking keys leaving one keyway open.
5. Insert the keyed end of the front stationary retaining ring [2531.1] into the remaining keyway.
6. Press the front stationary retaining ring into the casing groove.
7. Trim the front stationary retaining ring end so it slightly overlaps the drive pin.
8. Line up the tip of the T-handle hex wrench at the end of the front stationary retaining ring.
9. Gently tap the front stationary retaining ring into position.
10. With a soldering iron, melt (plastic weld) the two ends of the front stationary retaining ring together.

8.8.2 Containment Shell Repair

8.8.2.1 Wear Ring Replacement

1. Place the centering tool over the shaft [2100.1]
2. Place the back stationary wear ring [1500.2] over the centering tool.
3. Align the back stationary wear ring grooves with the containment shell [0224] molded keys.
4. Insert the keyed end of the back stationary retaining ring [2531.2] into the open groove.
5. Apply pressure with your thumbs to inset the back stationary retaining ring .
6. Trim the back stationary retaining ring so it slightly overlaps the key (approximately 1/8”).
7. Place your T-handle hex wrench on the end of the back stationary retaining ring and gently tap it into place.
8. Remove the centering tool and melt the back stationary retaining ring together with a soldering iron.

8.8.2.2 Shaft Removal

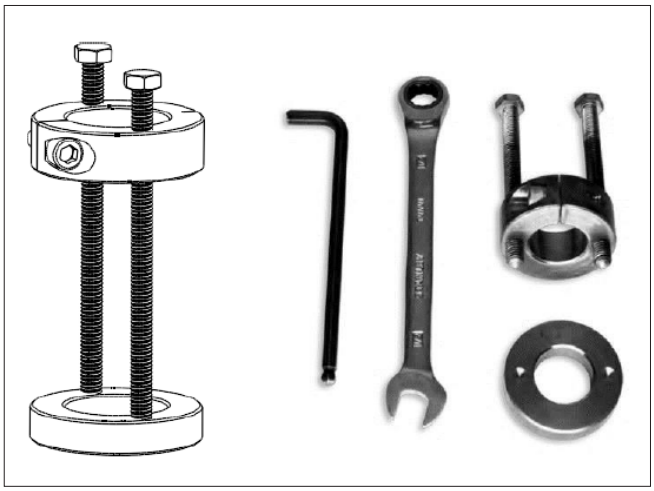


Figure 28: Shaft Removal with tools

1. Requires shaft removal tool part # TLG-2017-SI (A/V/E-Series) or TLG-2018-SI (B/C/W/F/G- Series).
2. Secure the containment shell [0224] upside down - use the adapter [1340] for this if nothing else is available.
3. Place the bottom half of the shaft removal tool over the shaft [2100.1], then gently slide it down the shaft.
4. Place the top half over the shaft [2100.1], lining up the bolts with the indentations on the bottom half of the shaft removal tool. Adjust the bolts so that the top of the tool is about 3/4 in. (19mm) down the shaft.
5. Using the hex wrench, tighten the top half to the shaft.
6. Evenly tighten the two bolts, alternating between them when you feel resistance.
7. Remove the shaft [2100.1] from the containment shell [0224]. Loosen and remove the shaft removal tool.

	⚠ ***CAUTION***
⚠	Do not use air or power tools. Do not over tighten the bolts or you may crack the shaft [2100.1].

8.8.2.3 Shaft Installation

1. Align the molded key inside the containment shell [0224] with the grooved end of the pump shaft [2100.1].
2. Place the shaft centering tool over the shaft [2100.1]
3. Place an aluminum block over the shaft to protect it and push the shaft in using an arbor press until the shaft is flush with the centering tool.
4. Remove the shaft centering tool.
5. Place the aluminum block directly on the shaft [2100.1] and press the shaft down the rest of the way down until it is firmly seated.

8.8.3 Impeller Repair

8.8.3.1 Bushing Removal

This procedure requires the Flowserve INNOMAG bushing installation / removal kit, part # TLG-2016- AA.

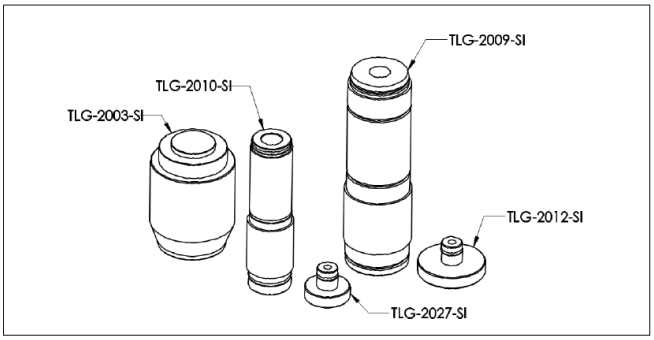


Figure 29: Bushing installation / removal kit.

	⚠ CAUTION
⚠	Make sure the bushing removal tool is perfectly centered to prevent damaging the inside of the impeller [2200]. We recommend placing a shop towel under the impeller [2200] to prevent damage to the SiC when it falls free.

1. For A/V/E-Series impellers, insert TLG-2027-SI into TLG-2010-SI and center it on the thrust control valve [6210]. For B/C/W/F/G-Series use TLG-2009-SI with TLG-2012-SI inserted.
2. With the arbor press, carefully push the bushings down with the removal tool until the first bushing [3300.2] and spacer [2460] dislodge.
3. Lift the impeller [2200] and remove the first bushing [3300.2] and spacer [2460] to allow room for removing the second bushing [3300] and thrust control valve [6210].
4. Continue pressing down on the arbor press until the second bushing and thrust control valve dislodge.
5. When the second bushing and thrust control valve are free, remove the impeller [2200].
6. Remove the second bushing and thrust control valve from the bushing removal tool.

8.8.3.2 Bushing Installation

1. This procedure requires the Flowserve INNOMAG TB-MAG bushing installation / removal kit,
2. Part # TLG-2016-AA.
3. Place the eye of the impeller [2200] on part TLG-2003- SI of the bushing installation toolkit. The stepped end is designed to support all TB-MAG impellers.
4. Locate the molded key in the impeller [2200].
5. On the underside, the thrust control valve [6210] groove must line up with the molded key.
6. Place the thrust control valve over the O-ring on the short, stepped end of bushing installation tool part TLG-2010-SI (A/V/E Series) or TLG-2009-SI (B/C/W/F/G Series)
7. Line up the thrust control valve groove with the molded key.
8. Carefully insert the thrust control valve by hand until it stops, making sure that it is perfectly aligned.
9. Make sure the bushing installation tool is perfectly centered.
10. With an arbor press, apply slow, even pressure to the bushing installation tool part # TLG-2010- SI (A/V/E Series) or TLG-2009-SI (B/C/W/F/G Series) to push the thrust control valve [6210] into place. It will stop when it is firmly seated.

	⚠ CAUTION
⚠	Do not use excessive force, as this may damage the thrust control valve and the impeller.

1. Align the large SiC bushings [3300] separated by the plastic spacer [2460] on the bushing tool part # TLG-2010-SI (A/V/E Series) or TLG-2009 (B/C/W/F/G Series).
2. Make sure the bushings are held securely by the rubber O-rings on the bushing installation tool.
3. Align the bushings with the molded key.
4. Press the bushings in until they are firmly seated using an arbor press.

8.8.3.3 Back Rotating Wear Ring Installation

1. Place the back rotating wear ring [2300.2] on the impeller [2200] and align the notches.
2. Place the PVC trimming sleeve over the wear ring [2300.2].
3. Place an aluminum spacer block over the trimming sleeve and press the wear ring into place with the arbor press.
4. Insert the retaining pin into the slot on the impeller [2200].
5. Force the pin into place using needle nose pliers.
6. Push the rest of the way with a screwdriver.
7. Once the pin is completely inserted, use a soldering iron to melt (plastic weld) it in place.

8.8.3.4 Front Rotating Wear Ring Installation

1. Place the front rotating wear ring [2300.1] on the impeller [2200] and align the notches.
2. Place the aluminum spacer over the wear ring [2300.1] and press into place with the arbor press.
3. Insert the retaining pin into the slot on the impeller [2200].
4. Force the pin into place using needle nose pliers.
5. Push the rest of the way with a screwdriver.
6. Once the pin is completely inserted, use a soldering iron to melt (plastic weld) it in place.

8.8.3.5 Impeller Trimming

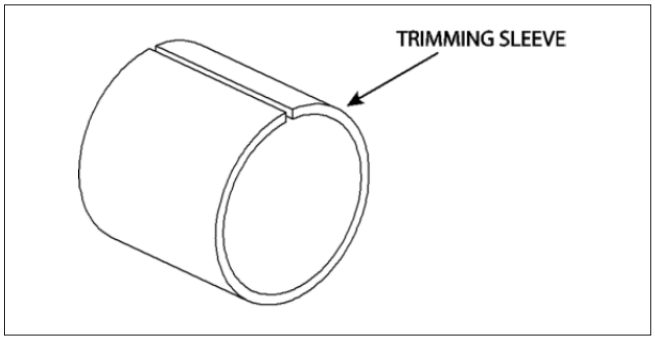


Figure 30: Trimming Sleeve

1. Place the trimming sleeve over the impeller [2200] to protect it from damage.
2. Measure the current diameter of the impeller [2200].
3. Insert the impeller into the lathe and tighten the jaws.
4. Set the trim 1/4 in. (6 mm) less than the current diameter. A good practice to trim an impeller is cutting 1/8in. (3mm) at a time.
5. Trim the first pass at a slow speed.
6. Use the hobby knife to clean off the loose plastic on the impeller in order to get an accurate measurement.
7. Check the diameter again with the caliper.
8. Set the lathe for 1/4 in. (6 mm) less than the current diameter measurement.
9. Trim this layer at a slow speed.
10. Clean off any loose plastic that would interfere with diameter measurements.
11. Use the caliper to measure the current diameter.
12. Repeat the proceeding four steps until you reach the desired diameter.
13. Chamfer the right edge of the impeller.
14. Chamfer the same amount off the left edge.
15. Loosen the jaws and remove the Impeller.
16. Remove the trimming sleeve and trim any remaining loose plastic.

8.9 Wet End reassembly

	NOTICE
	Thoroughly clean all parts before assembly. Make sure all parts are free of dirt, metallic particles, etc.

	⚠ CAUTION
	With TB-MAG B/C/W/F/G Series pumps, we highly recommend following the shop assembly procedure (Section 8.9.2) to minimize the chance of damaging the SiC. Due to the brittle nature of SiC, all assemblies must be handled with care to avoid chipping or cracking.

8.9.1 Piping connected reassembly

1. Align and slide the impeller [2200] magnet assembly onto the pump shaft [2100.1] located inside the containment shell [0224].
2. Place the assembly into the containment ring [1240].
3. Insert the assembled impeller [2200] and containment shell [0224]. Carefully align the impeller and casing [1100] wear rings. Hold the assembly and install the containment ring [1240]. Make sure the arrow on the ring points upward.
4. Tighten (8/12) hex cap screws w/lock washer.
5. Torque the hex caps screws [6570.1] to the specification in Table 10.

6. Extend the jackscrews on the drive end. Align the drive end and push it in until the jackscrews meet the wet end.
7. Retract the jackscrews until the two pump halves are mated.
8. Insert and tighten the (4) adapter [1340] hex caps screws.
9. Torque the hex caps screws [1340] to the specification in Table 10.

8.9.2 In-Shop reassembly

1. With the casing [1100] face down, insert the impeller [2200].
2. When the impeller is in place, rotate it by hand to make sure it spins freely.
3. Align the shaft [2100.1] in the containment shell [0224] with the bushings [3300].
4. Lower the containment shell [0224] into place.
5. Place the containment ring [1240] over the containment shell and align the bolt holes.
6. Make sure the arrow on the containment ring [1240] points toward the discharge flange.
7. Insert and hand-tighten the (8/12) casing bolts [6570.1] with lock washers.
8. Torque the (8/12) casing bolts [6570.1] to the specification in Table 10.

8.9.3 Dual Drive Secondary containment section Reassembly

	NOTICE
⚠	During assembly of rubber O-rings, apply the recommended lubricant to the joint to prevent pinching and cutting. Recommended rubber O-ring lubricant: Castrol Iloform™ Solid Stick Wax or equivalent lubricant compatible with the process fluid and O-ring compounds used in the pump. Plastic encapsulated seals do not need assembly lube.

1. During assembly of rubber O-rings, apply the recommended lubricant to the joint to prevent pinching and cutting. Recommended rubber O-ring lubricant: Castrol Iloform™ Solid Stick Wax or equivalent lubricant compatible with the process fluid and O-ring compounds used in the pump. Plastic encapsulated seals do not need assembly lube.
2. Inspect and clean debris from all components especially the shaft and bearing frame bearing seats.
3. Press bearings to shaft until they are fully seated against the bearing shoulders.
4. Install spiral retaining ring into the snap ring groove on the inboard end of the bearing frame
5. From the outboard end of the bearing frame carefully align the shaft with bearings into the bearing frame until the inboard bearing touches the retaining ring.
6. Install wave spring over the shaft on the outboard end of bearing housing until it touches the bearing face. Spring should be centered in the bearing bore.
7. Place the bearing cap over the shaft on the outboard end of bearing housing until it touches the wave spring. Bearing cap should be centered in the bearing bore outer diameter.
8. Install 3, ¼-20 (M6) lock washers and fasteners. Torque per Table 10, bearing retaining cap.
9. For B, C, F, G, sizes see steps 9 thru 16
10. For A, E sizes see steps 17 thru 26
11. Remove set screw supplied with the taper bushing. It is not needed for this assembly.
12. Install taper bushing inside the outboard inner mag drive hub aligning the through holes with the threaded holes in the mag drive yoke.
13. Lightly install the three ¼-20 (M6) lock washers and fasteners. Do not torque at this time.
14. Place key in outboard end of shaft.
15. Apply a light coating of copper based anti-seize grease to shaft end.
16. Align keyway of outboard inner mag drive taper bushing with key on shaft and Install to the outboard end of the shaft.
17. Face of shaft end and taper bushing shall be flush ±0.06 in (1.5 mm). Hold in place while performing the next step.
18. Gradually tighten the fasteners to torque shown in Table 10, taper bushing fasteners. This may require several iterations until the fasteners and taper bushing are fully seated. Recheck fastener torque.
19. For A, E sizes the inner mag drive is direct mounted to the shaft with a key and set screws.
20. Place key in outboard end of shaft.
21. Apply a light coating of copper based anti-seize grease to shaft end.
22. Align keyway of outboard inner mag drive taper bushing with key on shaft and Install to the outboard end of the shaft.

23. Face of shaft end and yoke inner face should be flush ±0.03 in (0.75 mm). Hold in place while performing the next step.

> ⚠ ***CAUTION***
>
> Only use new set screws to prevent vibration loosening of the mag drive.

24. Use a small amount of acetone or alcohol to clean the set screws and the mag drive. threads so they are free of oil, grease and debris.
25. Install the set screws about two to four threads deep into the mag drive.
26. Apply a small amount of blue, medium strength, removable liquid thread locker to the set screw threads only.
27. Tighten the two set screws to the shaft starting with the set screw on the key.
28. Torque per Table 10: Fastener Torques
29. Check runout is less than 0.005 in [0.13 mm] TIR. Re-adjust as needed.

> ⚠ ***WARNING***
>
> Use nonmagnetic tools or a nonmagnetic guard while working inside the mag drive hub. This area is a strong magnetic field. Appropriate PPE Is required. (see existing magnet warnings). Contact Flowserve for information on guard.

30. Inspect all O-ring grooves and mating surfaces, thoroughly clean prior to O-ring install.
31. Install standard ETFE O-ring to Containment shell.
32. Install O-Ring and Containment shell to outboard end of bearing frame shaft assembly.
33. Install standard Containment Ring to outboard end of bearing frame shaft assembly. Torque fasteners per Table 10.
34. Using O-ring lubricant, install O-ring to inboard end of bearing frame.
35. Remove pipe plug from top port of inboard secondary containment adapter.
36. Inspect interior of inboard secondary containment adapter for debris and metal chips. Thoroughly remove all debris and metal chips prior to installation.

> ⚠ ***WARNING***
>
> Metal chips will be attracted to the magnets and cause catastrophic malfunction during normal running.

37. Using O-Ring lubricant on the joint, install the inboard secondary containment adapter to the bearing frame.

> ***NOTICE***
>
> Orient the bottom drain of the adapter with the bottom drain of the bearing frame.

38. Carefully align the two parts to prevent pinching and damage to the O-Ring.
39. Torque fasteners per Table 10.
34. Install key to inboard end of shaft.
41. Loosen set screws of inboard outer mag drive so they won't interfere with the shaft or key during installation.
42. Align keyway of inboard outer mag drive with key on shaft and install until outer groove is aligned with the end of the inboard secondary containment adapter.
43. Torque set screws per Table 10
44. Check runout at ID of inner drive is less than 0.005 in [0.13 mm] TIR.
45. Using O-ring lubricant, install O-ring to inboard secondary containment adapter inboard end.
46. Recommended O-ring lubricant: Castrol Iloform™ Solid Stick Wax or equivalent lubricant compatible with the process fluid and O-ring compounds used in the pump.

8.10 Drive End

8.10.1 Drive End Disassembly

> ⚠ ***CAUTION***
>
> The outer magnet assembly [7124] contains very strong magnets. Use caution inserting the jack screw. Under normal circumstances a visual inspection and wiping clean the inside of the outer magnet is sufficient.

8.10.1.1 NEMA Drive End Disassembly

1. Remove the metal pipe plug [6569] from the top of the adapter [1340].
2. Locate and loosen the (2) set screws on the on the outer magnet assembly [7124] with T- handle hex wrench - 3/16 in. (A/V/E), 1/4 in. (B/C/W/F/G).
3. Insert a 1/2 in. - 13 x 6 in. jack bolt into the center of the NEMA outer magnet assembly.
4. Tighten the jack bolt to free the outer magnet assembly. 3/4 in. socket wrench recommended due to the magnetic forces.

5. Carefully remove the outer magnet assembly.
6. Remove (4) hex caps screws from the adapter [1340].
7. Remove the adapter [1340] from the motor.

8.10.1.2 IEC Drive End Assembly

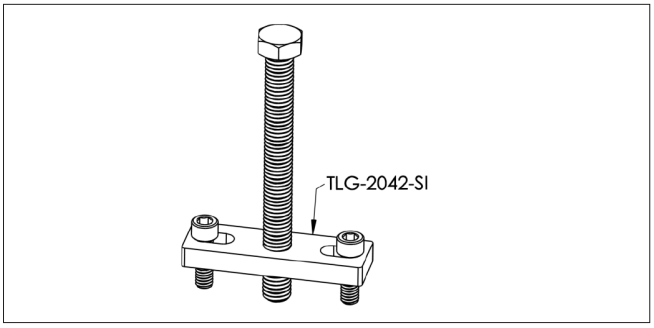


Figure 31: Jack screw plate

1. Remove the metal pipe plug [6569] from the top of the adapter [1340].
2. Locate and loosen the (2) set screws on the on the outer magnet assembly [7124] with T- handle hex wrench - 3/16 in. (A/V/E), 1/4 in. (B/C/W/F/G).
3. Attach the jack screw plate [TLG-2042-SI] with (2) M8 x 1.25 x 30mm screws into the treaded holes inside the IEC outer magnet assembly [7124].
4. Insert a 1/2 in. -13 x 6 in. jack bolt into the center of the jack screw plate [TLG-2042-SI] and tighten the center jack bolt to free the outer magnet assembly.
5. Carefully remove the outer magnet assembly [7124].
6. Remove (4) hex caps screws from the adapter [1340].
7. Remove the adapter [1340] from the motor.

8.10.2 Drive End Assembly

⚠	***⚠ CAUTION***
	The outer magnet assembly [7124] contains very strong magnets.

8.10.2.1 NEMA Drive End Assembly

1. Line up the adapter [1340] holes with the threaded holes on the motor. (NEMA motors 324 frame and larger require an adapter plate.)
2. Insert (4) hex caps screws with lock washers and tighten until no gap is present between the adapter [1340] and the motor mounting face.
3. Note the placement of the set screws on the outer magnet assembly [7124] in relation to the drive pins before installation. Set screw (A) will be directly across from the drive pins. Set screw (B) will be perpendicular to the drive pins.
4. Remove both set screws from the mag drive.

⚠	***⚠ CAUTION***
	Only use new set screws to prevent vibration loosening of the mag drive.

5. Use a small amount of acetone or alcohol to clean the set screws and the mag drive. threads so they are free of oil, grease and debris.
6. Install the set screws about two to four threads deep into the mag drive.
7. Apply a small amount of blue, medium strength, removable liquid thread locker to the set screw threads only.
8. Align outer magnet assembly [7124] drive pins with the key groove on the motor shaft. Do not use blunt force on front face of the outer magnet assembly. If difficult, verify motor shaft meets manufacture's tolerances and is free of burrs.
9. Torque set screws per Table 10: Fastener torques.
10. Use a ruler or straight edge, visually align the groove on the outer magnet assembly [7124] with the outer edge of the adaptor [1340].
11. Looking through the top hole on the adapter [1340], line up the row of dowel pins on the outer magnet assembly [7124] with the hole.
12. Grab the opposite side of the outer magnet assembly and rotate it 180°. Visually inspect concentricity of outer magnet assembly with adapter [1340].
13. Tighten the visible set screw (A) first, then rotate the outer magnet assembly 90° counterclockwise to locate and tighten the second set screw (B).

8.10.2.2 IEC Drive End Assembly

1. The IEC adapters (ADP-1005-SI, ADP-1015-SI) require the installation of dowel pins for the following motor sizes: 100L, 112M & 132S/M

	⚠ ***CAUTION***
	The pin installation is permanent. Check the motor configuration before you begin.

2. IEC 80 & IEC 90 do not require dowel pins.
3. IEC 100L and 112M require (6) dowel pins installed on the inner ring of unpainted dowel pin holes.
4. IEC 132S/M requires (6) dowel pins installed on the outer ring of unpainted dowel pin holes.
5. Firmly pound the (6) dowel pins in with a hammer until they are firmly seated. The properly installed dowel pin will be flush with the adapter [1340] face.
6. Motors larger than IEC 132 require an adapter plate. To install, align the inner holes on the adapter plate with the holes on the bottom of the adapter [1340].
7. IEC 160 & IEC 180 requires the installation of adapter plate ADP-1125-SI. IEC 200 requires the installation of adapter plate ADP-1135-SI.
8. Insert and tighten the (4) hex caps screws to the adapter plate.
9. Once properly configured, align the bolt holes on the motor with the threaded holes on the adapter [1340].
10. Insert and tighten the (4) Hex Cap Screws with lock washers.
11. Note the placement of the set screws on the outer magnet assembly [7124] in relation to the key notch before installation. Set screw (A) will be directly across from the key notch. Set screw (B) will be perpendicular to the key notch.
12. Remove both set screws from the mag drive.

	⚠ ***CAUTION***
	Only use new set screws to prevent vibration loosening of the mag drive.

13. Use a small amount of acetone or alcohol to clean the set screws and the mag drive. threads so they are free of oil, grease and debris.
14. Install the set screws about two to four threads deep into the mag drive.
15. Apply a small amount of blue, medium strength, removable liquid thread locker to the set screw threads only.
16. Make sure a key is installed in the motor shaft keyway. Align the key groove on the outer magnet assembly [7124] with the key on the motor shaft and install.
17. The outer magnet assembly has a groove around the magnet end for easy alignment. Locate this alignment groove on the outer magnet assembly.
18. Place a ruler or other straight edge in the alignment groove and push the outer magnet assembly in until it is flush with the outer edge of the adapter [1340].
19. Remove metal plug from the top of the adapter [1340].
20. Look inside the outer magnet assembly [7124] and rotate it until the motor key points downward.
21. Set screw (A) should now be visible through the hole on top of the adapter [1340]. Tighten set screw (A) with the T-handle hex wrench.
22. Rotate the outer magnet assembly [7124] until the motor key points to the right.
23. Set screw (B) should now be visible through the hole on top of the adapter. Tighten set screw (B) with the T-handle hex wrench.
24. Replace the metal plug on the adapter and drive end assembly is complete.
25. Torque set screws per Table 10: Fastener torques.

8.11 Long Coupled Bearing Frame

8.11.1 Long Coupled Bearing Frame Assembly

1. Install the sight glass [3856], drain [3569.2] and plugs [6569.1] if not already installed. Wrap the threads with thread seal tape to form a tight seal.
2. Replace and lubricate the outer O-ring on the mechanical seal [4200]. Be careful to keep the seal faces clean and dry.
3. Replace the inner O-ring on the mechanical seal before re-assembly. Lubricate the inner O- ring of the seal before assembling the bearing frame onto the adapter
4. Align the four mounting holes on the adapter [1340] with the four mounting holes on the seal [4200].

	⚠ ***CAUTION***
	The pin installation is permanent. Check the motor configuration before you begin.

5. Set the seal [4200] into the bore of the adapter [1340]. Thread the (4) 10-24 screws in a few turns only. Do not tighten the screws yet.
6. Clean and inspect the mating surfaces.
7. Lower the bearing frame [3200] onto the adapter [1340].
8. Tighten the hex cap screws [6570.7] with lock washers [3541.7] and Torque to specifications in Table 10.

	NOTICE
	Depending on the condition of the bearing frame assembly, steps 9 through 14 are optional. The bearing frame is factory machined so that the run out cannot be greater than 0.002 in.(0.05 mm). However, corrosion of the mating faces could affect the concentricity of the bearing frame [3200] and adapter. If corrosion is present, follow these steps.

9. Place the shaft extension tool (Part # TLG-2030-SI) over the shaft [2100.2].
10. Tighten the shaft extender to the shaft with the lower set screw with a hex wrench.
11. Insert the top of the dial test indicator into the upper hole on the shaft extender and tighten the screw.
12. Measure the concentricity of the bearing frame shaft [2100.2] and the mechanical seal [4200] bore on the adapter [1340]. Using the dial test indicator, measure the run out of the seal bore.
13. If concentricity of 0.002 in. (0.05 mm) or less cannot be achieved, the damaged components should be replaced.
14. Using the indicator mounted to the shaft extension, measure the perpendicularity of the machined surface on the inside of the adapter. The face should be perpendicular to the shaft within 0.002 in. (0.05 mm).
15. Lightly grease the bore of the outer magnet assembly [7124] and install it onto the shaft [2100.2], aligning the keyways. Push the outer magnet assembly all the way in until it bottoms out on the shaft shoulder. If necessary, the outer magnet assembly may be tapped in using a hammer and a large wooden or plastic dowel on the inside surface. Do not strike the outer rim of the outer magnet assembly.

	⚠CAUTION
	If using a hammer, the opposite end of the shaft must be braced to prevent thrust damage to the shaft bearings.

16. Lightly grease the shaft keys [6700.2] and insert them into the keyways. Gently tap until flush with the end of the shaft [2100.2].

	NOTICE
	If this method proves difficult, it may be easier to first insert the shaft keys [6700.2] into the shaft keyways, then install the outer magnet assembly [7124] onto the shaft.

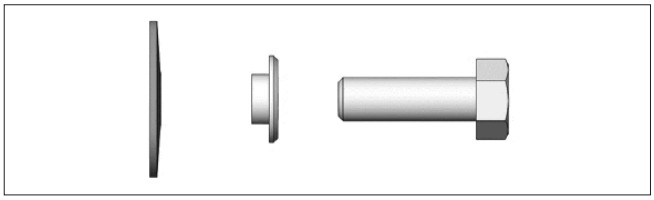


Figure 32: Magnet hex bolt

17. Install the outer magnet hex bolt [6570.5], nylon sleeve, and washer [2905] as shown into the end of the shaft [2100.2]. Tighten the outer magnet hex bolt until the washer makes contact with the outer magnet assembly, then tighten an additional 3/4 – 1 full turn.

8.11.1.1 Seal Chamber Pressure Test Procedure

	⚠CAUTION
	The pump must be stopped during this test.

1. You will need an air accumulator with a pressure gauge for this test. The total volume of the accumulator tank should be 1 cubic foot, 7.5 gallon (28 litres).
2. Plug one adapter drain connection [6569.3] so that the seal chamber is isolated. Use PTFE pipe thread tape to ensure a proper seal.
3. Connect the accumulator hose to the barbed hose adapter pipe fitting.
4. Tighten the accumulator hose clamp.
5. Pressurize the accumulator and seal cavity to 25 psig (1.7 barg).
6. Check all fittings and connections for leakage (soap solution type test). Bubbles indicate leaks.

7. The pressure in the accumulator will drop immediately due to expansion and seating of the O- rings. This is normal. Wait 1-2 minutes and re-pressurize the seal chamber to 25 psig (1.7 barg).
8. Measure pressure decay. Pressure drop shall be less than 2.0 psig (0.14 barg)over 5 minutes.
9. Vent pressure from cavity upon completion of the test and reconnect any leak sensors or drain lines to the adapter [1340].

8.11.2 Long Coupled Bearing Frame Disassembly

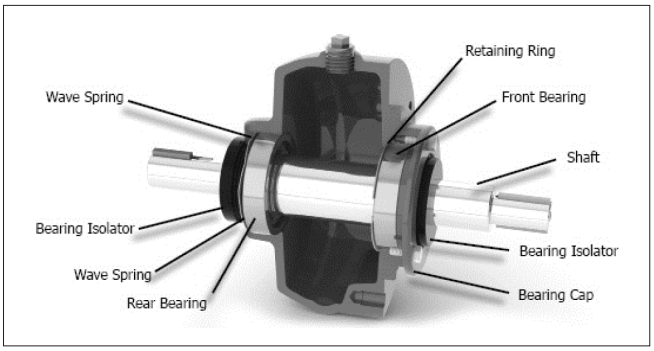


Figure 33: Long Coupled Bearing Frame

⚠CAUTION

- If the bearing frame [3200] will not be opened, steps 1 and 2 can be skipped. The unit must remain horizontal to prevent oil leakage through the bearing isolators.
- Extremely strong magnets. The use of non-magnetic tools and work surface is highly recommended. The work area must be clean and free of any ferrous particles.

1. Remove the metal plug [6569.2] below the sight glass [3856] to drain the oil. Drain the oil into an oil pan and replace the oil plug.
2. Remove the coupling guard if it is installed.
3. Remove the coupling and turn the motor aside to allow room to pull back the bearing frame.
4. Remove the (2) hex caps screws holding the bearing frame feet to the baseplate.
5. Remove the (4) hex caps screws on the adapter [1340].
6. Separate bearing frame [3200] and adapter [1340] from pump end. Use jackscrews in the (2) jackscrew holes.
7. Pull the bearing frame assembly straight back from the adapter.
8. Remove the (3) hex caps screws [6570.3, 6570.4] to separate the foot from the adapter.
9. Secure the adapter [1340] to the work surface with a C clamp.

NOTICE

The adapter O-ring shall be replaced before re-assembling onto the pump.

10. Remove the outer magnet retention screw [6570.5]. Remove the washer [2905] and nylon sleeve, then reinstall the screw. This is to prevent damage to the shaft thread during the next steps.
11. Attach the jack screw plate [TLG-2042-SI] with (2) 3/8in.-16 socket head cap screws into the treaded holes inside the outer magnet assembly [7124].

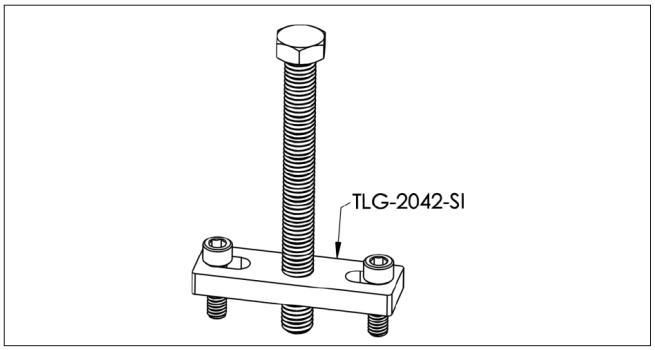


Figure 34: Jack screw plate

12. Apply a copper based anti-seize grease to the 1/2in.-13 jack bolt, insert it into the tapped center hole, and tighten until the outer magnet assembly [7124] loosens.
13. Pull the outer magnet assembly [7124] out of the adapter [1340] and set aside. Remove the outer magnet retention screw [6570.5] and both shaft keys [6700.2].
14. Install the (2) spacers / installation clips onto the mechanical seal at this time. The spacers are used to prevent damage to the internal components when not bolted into the bearing frame assembly.
15. Once spacers are in place, remove the (4) screws securing the mechanical seal [4200] to the adapter [1340].
16. Remove the (3) hex cap screws [6570.7] securing the adapter to the bearing frame.
17. Slide the bearing frame out of the adapter with the seal still attached to the shaft.

18. Loosen the (6) set screws holding the seal onto the shaft and gently slide the mechanical seal off the shaft.

> ***NOTICE***
>
> Replace the inner and outer O-rings on the mechanical seal before re-assembly.

19. If the bearing frame [3200] will not be opened, set it aside.
20. Remove the (3) hex cap screws [6570.6] from the bearing cap [3260] and pry the bearing cap loose with a small flat head screwdriver.
21. If the bearing isolator [4305] needs to be replaced, the unit can be pressed out by hand.
22. Slide the shaft [2100.2] and front bearing [3011.2] out of the bearing frame straight up until the retaining ring [6544] can be seen. Using a screwdriver, lift the retaining ring by prying under the notched end and remove the retaining ring [6544] from the assembly.
23. The shaft [2100.2] can now be removed from the bearing frame. There is very little clearance between the bearing [3011.1] and the bearing frame [3200] opening. It can be very difficult to remove if the shaft [2100.2] is not held perfectly straight when pulling through the opening.
24. If the rear bearing isolator [4305] needs to be replaced, the unit can be pulled out by hand.
25. The wave spring [4263] can be removed by hand for inspection and / or replacement. If the bearings [3011] need to be replaced, use a 3- jaw puller to remove.

8.12 Drive/Wet End Assembly

8.12.1 Close-Coupled and Vertical Assembly

1. Position the pump in place and secure it to the baseplate and piping (piped assembly) or to the bench (in-shop assembly).
2. Insert (2) jack bolts into adapter and fully extend.
3. Align the motor with the pump and slide forward until jack bolts contact the pump containment ring [1240].
4. Carefully retract the (2) jack bolts evenly and slide the motor toward the pump until the adapter [1340] mates with the containment ring [1240].
5. Remove the (2) jack bolts completely.
6. Insert and tighten the (4) adapter bolts.
7. Insert and tighten the adapter foot [3134] bolt and any bolts connecting the motor to the baseplate.
8. Check for free rotation of the pump by manually rotating the motor fan.

8.12.2 Long Coupled Assembly

All bearing frames [3200] are shipped without oil. The bearing frame must be filled to the center of the site glass before starting. Do not overfill. The oil level shall be checked when the pump is stopped. See the following table for the recommended oil.

Viscosity cSt @ 104°F (40°C)	46
Temperature range	23 to 172°F (-5 to 78°C)
Designation to ISO3448 and DIN51524 part 2	ISO VG46
Mineral Oil	Quality mineral oil with rust and oxidation inhibitors ISO VG46
Synthetic Oil	ISO VG46
Oil Change Interval	4000 hours or at least every six months

Reference to figure 20 for wet end

> ***NOTICE***
>
> It normally takes 2 hours for bearing temperature to stabilize and the final temperature will depend on the ambient, rpm, pumped liquid temperature and pump size.

> ***⚠ CAUTION***
>
> The maximum temperature that the bearing can be exposed to is 220°F (105°C).

1. Position the pump in place and secure it to the baseplate and piping (piped assembly) or to the bench (in-shop assembly).
2. For sealed units only: lubricate the O-ring [4610.2] and install it into the groove in the adapter [1340].
3. Insert (2) jack bolts into adapter and fully extend.
4. Align the bearing frame with the pump and slide it forward until the jack bolts make contact with the pump containment ring [1240].
5. Carefully retract the (2) jack bolts evenly and slide the adapter [1340] toward the pump until it mates with the containment ring [1240].
6. Remove the (2) jack bolts completely.
7. Insert and tighten the (4) adapter bolts.
8. Insert and tighten support foot [3134] bolts into baseplate.
9. Align the motor and coupling per the manufacturers specifications and secure the pump and motor to the base plate.
10. Install a coupling guard over the exposed shafts and coupling.

11. Once the pump has been bolted to the base plate and leveled, remove the plug [6569.1] from the top of the bearing frame unit [3200] and pour in the recommended oil. The unit must be filled to the center of the sight glass [3856] before starting. Refer 6.2 for lubrication.
12. Do not overfill. The oil level shall be checked when the pump is stopped.

	NOTICE
	The following steps only apply to the mechanically sealed version of the bearing frame.

13. Tighten the mechanical seal's (6) set screws to the shaft.
14. Remove the (2) hex cap screws from the spacers / installation clips and remove the spacers from the seal.

8.12.3 Dual Drive Secondary containment section/Wet End Re-assembly

1. Apply O-Ring lubricant to the secondary containment inboard Adapter O-ring and SC Containment ring mating features.
2. Insert two jack bolts into adapter and fully extend.
3. Position the Secondary containment section in line with the wet end maintaining a minimum 6 inch [150mm] linear distance between the impeller mag drive containment shell and inboard outer mag drive.
4. Using jack bolts gradually allow the two assemblies to merge.

	⚠ WARNING
	Strong magnetic attraction, containment shell can be damage. Be careful to prevent o-ring damage. If O-ring damage is suspected immediately replace the O-rings.

5. Fasteners and torque per Table 10. (Copper based Anti-seize grease on all fasteners)

8.12.4 Dual Drive Secondary containment section/Drive End Re-assembly

1. Insert (2) jack bolts into adapter and fully extend.
2. Position the Secondary containment section in line with the outboard adapter, mag drive, motor assembly maintaining a minimum 6 inch (150mm) linear distance between the two halves of the outboard mag drive.
3. Slide the outboard drive toward the Secondary containment section until jack bolts contact the outboard containment ring [1240].
4. Carefully retract the (2) jack bolts evenly and slide the drive motor toward the Secondary containment section until the outboard adapter [1340] mates with the containment ring [1240].
5. Remove the (2) jack bolts completely.
6. Insert and tighten the (4) adapter bolts.
7. Insert and tighten the adapter foot [3134] bolt and any bolts connecting the motor to the baseplate.
8. Check for free rotation of the pump by manually rotating the motor fan.
9. Torque all fasteners according to Table 10.

	⚠ WARNING
	Strong magnetic attraction, containment shell can be damage. Be careful to prevent o-ring damage. If O-ring damage is suspected immediately replace the O-rings.

8.13 Inspecting after reassembly

	⚠ CAUTION
	▷ Check the pump is free to rotate by turning the motor fan wheel. ▷ To ensure there are no component leaks, pressure and leak tests on the pump at 1.3 times the nominal pressure is required. This includes the wet end, and the secondary containment field if equipped.

	⚠ WARNING
	While leak testing, the Wet End must be pressurized prior to with secondary containment field and at the same or higher pressure. Pressurizing the secondary containment field without pressurizing the wet end will damage the primary containment shell, shaft and bearings.

9 Troubleshooting Guide

The following is a guide to troubleshooting problems with Flowserve INNOMAG TB-MAG pumps. Common problems are analyzed, and solutions offered. If a problem exists that is not covered by one of the examples, refer to one of the books listed in Annex D, Additional Sources of Information, or contact a Flowserve sales engineer, distributor, or representative for assistance.

Fault Symptom

Pump overheats and seizes	Pump vibrates or is noisy	Pump requires excessive power	Pump loses prime after starting	Insufficient pressure dev eloped	Insufficient capacity delivered	Pump does not deliver liquid	Possible Causes	Posiible Remedies
							A. System troubles	
●				●		●	Pump not primed or filled with liquid.	Check complete filling. Re-prime pump and verify that suction pipe is full of liquid. Check the suction pipe for high points that can trap air.
	●		●		●	●	Pump or suction pipe not completely filled with liquid.	Vent and/or prime.
						●	Discharge pipe clogged or valve shut.	Confirm that any discharge valves or control valves are not stuck shut. Inspect discharge pipe for blockage.
				●	●	●	Suction pipe clogged or valve shut.	Confirm that any suction valves or control valves are not stuck shut. Check strainer device. Inspect suction pipe for blockage.
●						●	Head requirement higher than anticipated or undersized impeller. (Pump casing and pipes immediately before and after the pump heat up)	Confirm than discharge line is not blocked, or valve is not stuck shut. Pump may require a larger impeller to overcome system head.
				●		●	Clogged impeller	Open pump and clear blockage from impeller.
		●		●			Clogged thrust balancing passages in impeller.	Open pump and clean blockage from grooves in between impeller and bushings.
	●			●			Decoupled Impeller or decoupled outer drive on secondary containment.	Shut off pump. Verify that the motor spins smoothly by hand. If motor will not spin by hand, open pump for inspection. If motor spins by hand, confirm that the impeller is sized for operating conditions and liquid specific gravity. Verify the viscosity of the liquid is not too high. Note that the impeller and/or outer magnet may be weakened if over-heated. Check discharge valve is only partially open during direct on line starting of secondary containment pump assemblies.
				●	●	●	Suction pipe volume too large for priming chamber.	Calculate volume of the suction pipe. It is recommended that the priming chamber volume should be 3 times the suction pipe volume. Decrease suction pipe volume. Move pump closer to source.
	●		●		●	●	Suction lift too high or level too low.	Check NPSHA > NPSHR, proper submergence, losses at strainers and fittings.
●	●				●	●	Insufficient margin between suction pressure and vapor pressure.	
	●		●	●	●		Excessive amount of air or gas in liquid.	Check and purge pipes and system.
			●		●	●	Air or vapor pocket in suction line.	Check suction line design for vapor pockets.

Pump overheats and seizes	Pump vibrates or is noisy	Pump requires excessive power	Pump loses prime after starting	Insufficient pressure dev eloped	Insufficient capacity delivered	Pump does not deliver liquid	Possible Causes	Posiible Remedies
							A. System troubles	
			●		●		Air leaks into suction line.	Check suction pipe is airtight.
	●		●		●	●	Inlet of suction pipe insufficiently submerged.	Check 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. Increase impeller size or motor speed. Remedy or CONSULT FLOWSERVE.
		●					Total head of system lower than pump design head.	Check system losses. Decrease impeller size or motor speed. Remedy or CONSULT FLOWSERVE.
		●					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.	Verify flow with instrumentation or batch cycle time and adjust as needed. 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.
	●						Piping or pump not properly anchored.	Tighten mounting bolts on pump feet and baseplate. Confirm that the suction and discharge pipes are properly supported per Hydraulic Institute recommendations.
	●						Improperly designed foundation.	Check setting of baseplate: tighten, adjust, grout base as required.
	●			●	●		Partially clogged impeller is unbalanced.	Open pump and clear blockage from the impeller.
●	●	●					Rotating part rubbing on stationary part internally.	If burning smell coming from back of pump, the outer magnet is installed incorrectly. Confirm that the groove on the outer magnet assembly lines up with the edge of the adapter. Re-align and replace components as necessary. Check and CONSULT FLOWSERVE, if necessary.
●	●						Bearings worn	Replace bearings.
		●		●	●		Wearing ring surfaces worn.	Replace worn wear ring/surfaces.
	●						Impeller damaged or eroded.	Replace or CONSULT FLOWSERVE.
		●					Abrasive solids in liquid pumped.	Check and CONSULT FLOWSERVE.
	●						Excessive thrust caused by a mechanical failure inside the pump.	Check wear condition of impeller, its clearances and liquid passages.
●							Pump maximum temperature exceeded.	Open the pump. Replace parts as needed. CONSULT FLOWSERVE.

							Possible Causes	Posiible Remedies
							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.

Table 12: Troubleshooting guide

10 Decommissioning and Recommissioning

10.1 Decommissioning

10.1.1 Preparatory measures

When necessary, implement a flushing procedure prior to switching the pump set off if the pumped fluid may solidify or contains suspended solids that may accumulate.

When decommissioning the unit, proceed as follows:

1. Shut-off the motor power supply.
2. Close the regulating control valve at the discharge end.
3. Close the control valve at the suction end.
4. Drain the pump if there is a risk of freezing.

	**⚠ CAUTION** ▷ If draining the pump produces explosive, harmful, or crystalline products, take the necessary measures to protect persons and the environment. ▷ If the pump must be dispatched elsewhere, it must be free of any dangerous product. ▷ In the event of prolonged stoppage of the pump, it must be rinsed and then protected internally with a suitable anti-corrosion product.

10.1.2 Disconnect electrical supply

	**⚠ WARNING** Work on the product by unqualified personnel. Risk of death from electric shock. ▷ Work must be carried out only by personnel specialized in electrical installations. 1. Switch off power supply. 2. Secure against switching on again. 3. Disconnect motor terminals and secure cable ends.

10.1.3 Disassembly and emptying

	**⚠ WARNING** Opening the connections. Risk of leaking hot, toxic, corrosive, or burning conveyance. 1. Observe the valid safety regulations. 2. Wear appropriate personal protective equipment.

	**⚠ WARNING** Hanging loads. Risk of crushing. Only use suitable lifting equipment.

	**NOTICE** Leaking of pumped fluids or lubricants. Risk for environmental damage. ▷ Contain, collect, and dispose of leaking fluids correctly.

10.1.4 Cleaning

	**⚠ WARNING** When cleaning a pump, verify that the cleaning agent and neutralizing agent are compatible with the process fluid used in the system.

Consumables: Cleaning agent and neutralizing agent

✓ Pump is at a workstation with cleaning table suitable for chemical works.

1. Flush pump with cleaning agent.
2. If necessary, flush the pump with neutralizing agent.
3. Flush pump with neutral liquid.
4. Blow through the pump to dry it with dry gas (e.g., nitrogen).

10.1.5 Preserving of pumps with Metallic Casing

Consumables: Suitable preservation media (e.g., Klübertop K01-601 or equivalent)

✓ Pump is correctly disconnected, emptied and cleaned.

1. Fill pump with preservative.
2. Turn pump shaft when filling.
3. Contain leaking fluid and dispose of correctly.
4. Close pump openings with locking caps and plugs.

↳ Pump is preserved for 6 months in storage.

10.2 Recommissioning

Follow the instructions in Chapter 6, prior to start the installation/commissioning works perform below checks.

1. Visual inspection for damage.
2. Renew gaskets.
3. Check the ease of movement of the shaft.
4. After disassembly of the pump, a pressure test is mandatory ensuring the maximum allowable pump pressure is not exceeded.

11 Returns and Disposal

11.1 Returns

Due to potential hazardous substance exposure, the manufacturer does not accept returns of used equipment. Contact your INNOMAG sales representative for more information.

11.2 Disposal and recycling

At the end of the equipment service life, the relevant materials and parts should be recycled or disposed of using local environmental regulation methods. If the product contains substances which are harmful to the environment, then the removal or disposal of the equipment must be in accordance with local/regional regulations.

	⚠ *WARNING*
	Refer to Safety Data Sheets and make sure that hazardous substances or toxic fluids are disposed of safely and that the correct personal protective equipment is used. All activities involving hazardous substances or toxic fluids must follow published safety standards.

12 Technical Data

12.1 Technical limits

	NOTICE
	Below information can be used for general guidance. The equipment is always selected according to the specifications and conditions referred to on the pump datasheet. Contact Flowserve in case of doubt.

12.1.1 Allowable Nozzle Loads

Maximum Forces and moments allowed on pump flanges vary based on the pump size. When these forces and moments are minimized, there is a corresponding reduction in misalignment, hot bearings, worn couplings, vibration, and possible failure of the pump casing. The following points shall be strictly followed:

- ▷ Prevent excessive external pipe load
- ▷ Provision must be made to support piping external to the pump to prevent excessive nozzle loads, maintain pump/driver alignment and avoid pipe induced vibrations.
- ▷ Do not exceed maximum loads shown in GA drawing
- ▷ Never draw piping into place by applying force to pump flanges.
- ▷ Do not mount expansion joints so that their force, due to internal pressure, acts on the pump flanges.

Contact your local Flowserve Sales office, Distributor, or Representative for further details.

	⚠ *WARNING*
	Failure to follow nozzle load requirements could lead to: • Overheating • internal damage • excessive vibration • excessive wear • additional maintenance at shorter intervals

12.2 Nameplate

Every TB-MAG sealless pump unit has a nameplate to provide information on your pump. The nameplates are located on the side of each casing. It is recommended that the purchaser record the serial number and use it for reference when requesting information, service, or parts from your supplier.

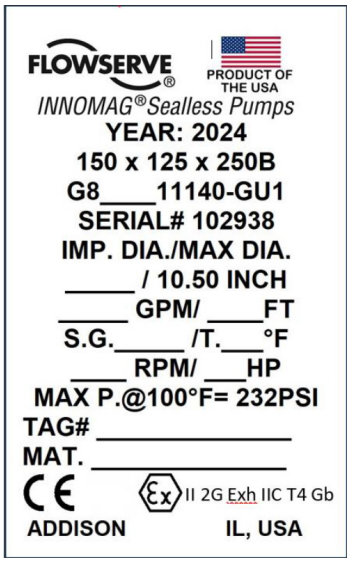
Permanent records for this pump are kept by the serial number and it, therefore, must be used with all correspondence and spare parts orders. Tag includes the following:

- ▷ Manufacture year: Example – 2016
- ▷ Pump Designation/Size: Example – A1.5x1x6
- ▷ Pump Code: Example – A161311100-AD0
- ▷ Serial Number: Example – 44000
- ▷ Impeller Diameter / Max Impeller Diameter (in. or mm.)
- ▷ Duty Point (Flow/TDH) (gpm / ft. or m3/hr / m)
- ▷ Process Liquid Specific Gravity and Temperature (°F or °C)
- ▷ Pump RPM / Pump power (HP or kW) @ Duty Point
- ▷ Design Pressure (psig or barg) @ 100 °F (38°C)
- ▷ Customer Pump Tag #
- ▷ Process Liquid Being Pumped
- ▷ CE/ATEX Marking: Flowserve INNOMAG pumps are certified to European Directive 2014/34/EU The certification level is: Group II, Category 2, Gas, T4 250 °F (121 ° C)

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

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

12.2.1 Marked Nameplate (example)



12.3 Noise level

Refer to Chapter 2.7.4 “Noise Hazards” for noise level and sound pressure level

12.4 Performance and operating limits.

The following data is included as additional information to help with your installation. It is typical, and factors such as temperature and materials may influence this data. If required, a definitive statement for your application can be obtained from Flowserve.

12.4.1 Operating limits

Normal maximum ambient temperature: 104 ºF (+40 ºC).

Normal minimum ambient temperature: -4 ºF (-20 ºC).

Maximum pump speed: In general, INNOMAG pumps can safely operate at speeds up to 3600 rpm. However, some models with larger diameter impellers have a maximum safe operating speed of 1800 rpm. Refer to the pump data sheet and nameplate for maximum speed of your specific pump.

Pumped fluid temperature limits: -20 °F (-29 °C) To 250 °F (121 °C). Other limitations may apply see 12.4.2.

Pressure: maximum 362 psi (25 bar). Other limitations may apply see12.4.2.

Mag drive torque limits: Derating of mag drives may be required at fluid temperatures above 150 °F (66 °C). Contact your Flowserve representative.

12.4.2 Pressure-Temperature Rating

The pump pressure and temperature limits are included in the Table 13. PN 16 flanges are standard for ISO models while Class 150 flanges are standard for ASME models. Find the maximum allowable pressure for the supplied pump, given the flange drilling pattern and operating temperature.

	⚠ CAUTION
⚠	The maximum discharge pressure must be less than or equal to the P-T rating. Discharge pressure may be approximated by adding the suction pressure to the differential pressure developed by the pump.

	Temperature - °F (°C)				
	-20 (-29)	0 (-18)	100 (38)	200 (93)	250 (121)
	Pressure - psig (barg)				
ASME B16.42 Class 150	250 (17.2)	250 (17.2)	250 (17.2)	235 (16.2)	225 (15.5)
ASME B16.42 Class 300	362 (25)	362 (25)	362 (25)	300 (20.7)	300 (20.7)
EN 1092-2 (ISO) PN 16	232 (16)	232 (16)	232 (16)	232 (16)	232 (16)
EN 1092-2 (ISO) PN 25	362 (25)	362 (25)	362 (25)	300 (20.7)	300 (20.7)
JIS B2239 10K	203 (14)	203 (14)	203 (14)	203 (14)	203 (14)

Table 13: Pressure-Temperature Rating

12.4.3 Energy Efficiency

The pump supplied will have been selected from Flowserve’s extensive product line to have optimum efficiency for the application. If supplied with an electric motor, then the motor will meet or exceed current legislation for motor efficiency. However, it is the way the pump is operated which has the greatest impact on the amount and cost of energy used during the operating life of the pump. The following are key points in achieving minimum operating cost for the equipment:

1. Design the pipe system for minimum friction losses
2. Ensure that the control system switches off the pump when not required
3. In a multi-pump system run the minimum number of pumps
4. Try to avoid systems which by-pass excess flow

5. Avoid as far as possible controlling pump flow by throttle valves
6. When commissioned, check that the pump operates at the duty specified to Flowserve
7. If it has been found that the pump head and flow exceed that required, trim the pump impeller diameter
8. Ensure that the pump is operating with sufficient NPSH available.
9. Use variable speed drives for systems which require variable flow. A VFD for an induction motor is a particularly effective way of achieving speed variation and energy/cost reduction.
10. Notes for VFD usage:

- ▷ Make sure that the motor is compatible with VFD.
- ▷ Do not over-speed the pump without checking the power capability with Flowserve.
- ▷ On systems with high static head, speed reduction is limited. Avoid running the pump at a speed which gives low or zero flow.
- ▷ Do not run at a low speed and flow rate which lets solid settle out of suspension in the pipe work.
- ▷ Do not use a VFD for a fixed flow requirement; it will introduce power losses.

11. Select high efficiency motors.
12. If replacing a standard motor with a high efficiency motor it will run faster and the pump could take more power. Reduce the impeller diameter to achieve energy reduction.
13. If the pump system pipe work or equipment is changed or process duty is changed, check that the pump is still correctly sized.
14. Periodically check that the pipe system has not become corroded or blocked.
15. Periodically check that the pump is operating at the flow, head and power expected and that the efficiency has not reduced with erosion or corrosion damage.

Annex A: Parts and Accessories List

Accessories

Accessories may be fitted when specified by the customer.

Other accessories

Accessories may be fitted when specified by the customer. Consult your Flowserve representative.

Annex B: Technical Terms, Acronyms, and Abbreviations

Annex C: Additional Sources of Information

Reference 1:

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

Reference 2:

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

Reference 3:

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

Reference 4:

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

Reference 5:

ANSI B31.3 - Process Piping.

Reference 6:

ANSI HI 5.1-5.6, Sealless rotodynamic pumps.

ISO 15783, Seal-less rotodynamic pumps – Class II-Specification.

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.

Annex D: Supplementary User Instructions

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 protection envelope.

Notes:

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PUIOM003114-02 (EN/LTR) July 2026