FLOWSERVE

USER INSTRUCTIONS

INNOMAG® TB-MAG™
ASME and ISO Sealless

Horizontal close coupled, long coupled and vertical
ETFE lined, sealless chemical process pumps

Installation
Operation
Maintenance

PCN= 26999988 07-16 (E) Original instructions.

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

Experience In Motion

TABLE OF CONTENTS Page Page

INDEX Page

1 INTRODUCTION AND SAFETY

1.1 General

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

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

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

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

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

1.2 CE marking and approvals

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

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

To confirm the Approvals applying and if the product is CE marked, check the serial number plate markings and the Certification. (See section 9, *Certification*.)

1.3 Disclaimer

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

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

1.4 Copyright

1.5 Duty conditions

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

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

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

1.6 Safety

1.6.1 Summary of safety markings

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

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


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

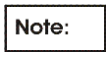

This symbol indicates "hazardous and toxic fluid" safety instructions where non-compliance would affect personal safety and could result in loss of life.


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

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


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


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



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

1.6.2 Personnel qualification and training

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

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

1.6.3 Safety action

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


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.

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.

NEVER DO MAINTENANCE WORK WHEN THE UNIT IS CONNECTED TO POWER


FOR LONG-COUPLED CONFIGURATIONS, COUPLING GUARDS ARE REQIRED AND MUST NOT BE REMOVED WHILE THE PUMP IS OPERATIONAL


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


NEVER use heat (risk of explosion) to disassemble any portion of the pump.

When dismantling the pump, always use Jacking bolts to separate the wet end from the drive end.


HIGH TEMPERATURES may be present. Pump surface temperature is directly related to the temperature of the working fluid. Never operate pump above the rated temperature of 121°C (250°F).


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

appropriate for the mass and in accordance with current local regulations.

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

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

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

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

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

Never loosen flange connection while system is under pressure.

CAUTION Always make certain pressure gages, indicating lights and safety devices are working.

ALWAYS know the EMERGENCY STOP location for the pump.

CAUTION NEVER RUN THE PUMP DRY. Use diamond-like-coated (DLC) parts for additional protection from dry running. DLC does not guarantee protection from dry running.

Never start this pump without proper prime (casing must be full of liquid).

CAUTION For long-coupled pumps, all bearing frames are shipped without oil.

CAUTION START THE PUMP WITH THE DISCHARGE VALVE PARTLY OPENED (Unless otherwise instructed at a specific point in the User Instructions.) This is recommended to minimize the risk of overloading and damaging the pump or motor at full or zero flow. Pumps may be started with the valve further open only on installations where this situation cannot occur. The pump outlet control valve may need to be adjusted to comply with the duty following the run-up process. (See section 5, *Commissioning start-up, operation and shutdown*.)

SUCTION VALVES TO BE FULLY OPEN WHEN PUMP IS RUNNING
Running the pump at zero flow or below the recommended minimum flow continuously will cause damage to the pump. Never operate this pump with the suction and / or discharge valve closed as this may lead to high surface temperatures.

CAUTION The direction of rotation is clockwise when viewed from the motor end. Rotation of the motor must be checked prior to starting the pump according to section 5.2.

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

CAUTION NEVER EXCEED THE MAXIMUM DESIGN PRESSURE (MDP) AT THE TEMPERATURE SHOWN ON THE PUMP NAMEPLATE AND INCLUDED IN SECTION 3.5.2.

CAUTION Driver may overload and de-couple if pumpage specific gravity is greater than originally assumed. Prolonged running while de-coupled will damage driver and impeller magnets.

Decoupling the pump may lead to increased surface temperatures.

CAUTION Never change conditions of service without approval of authorized Flowserve distributor.

Excessive amounts of dust collected on the pump housing may lead to an increase in surface temperature, possibly exceeding temperature limits. May require regular cleaning.

Always have this service manual available during any installation or maintenance.

1.6.4 Products used in potentially explosive atmospheres

Measures are required to:

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

The following instructions for pumps and pump units when installed in potentially explosive atmospheres must be followed to help ensure explosion protection. For ATEX, both electrical and non-electrical equipment must meet the requirements of European Directive 2014/34/EU (previously 94/9/EC which remains valid until April 20th 2016 during the transition). Always observe the regional legal Ex requirements eg Ex electrical items outside the EU may be required certified to other than ATEX eg IECEx, UL.

1.6.4.1 Scope of compliance

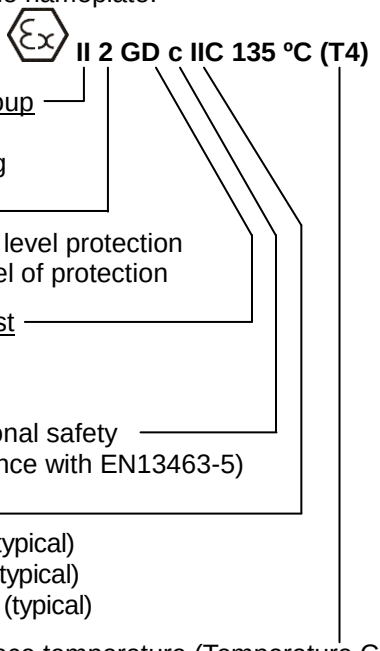
Use equipment only in the zone for which it is appropriate. Always check that the driver and pump equipment are suitably rated and/or certified for the classification of the specific atmosphere in which they are to be installed.

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

The output from a variable frequency drive (VFD) can cause additional heating effects in the motor and so, for pumps sets with a VFD, the ATEX Certification for the motor must state that it is covers the situation where electrical supply is from the VFD. This particular requirement still applies even if the VFD is in a safe area.

1.6.4.2 Marking

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



1.6.4.3 Avoiding excessive surface temperatures

ENSURE THE EQUIPMENT TEMPERATURE CLASS IS SUITABLE FOR THE HAZARD ZONE

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

The surface temperature on the pump is influenced by the temperature of the liquid handled. The maximum permissible liquid temperature depends on the ATEX temperature class and must not exceed the values in the table that follows.

Maximum permitted liquid temperature for pumps

Temperature class to EN13463-1	Maximum surface temperature permitted	Temperature limit of liquid handled
T6	85 °C (185 °F)	65 °C (149 °F) *
T5	100 °C (212 °F)	80 °C (176 °F) *
T4	135 °C (275 °F)	115 °C (239 °F) *
T3	200 °C (392 °F)	180 °C (356 °F) *
T2	300 °C (572 °F)	275 °C (527 °F) *
T1	450 °C (842 °F)	400 °C (752 °F) *

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

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

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

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

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

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

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

1.6.4.4 Preventing the build-up of explosive mixtures

 ENSURE THE PUMP IS PROPERLY FILLED AND DOES NOT RUN DRY

Ensure the pump and relevant suction and discharge pipeline system is totally filled with liquid at all times during the pump operation, so that an explosive atmosphere is prevented.

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

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

1.6.4.5 Preventing sparks

 To avoid the potential hazard from random induced current generating a spark, the baseplate must be properly grounded.

 Avoid electrostatic charge: do not rub non-metallic surfaces with a dry cloth; ensure cloth is damp.

Additional requirement for metallic pumps on non-metallic baseplates
When metallic components are fitted on a non-metallic baseplate they must be individually earthed.

If so equipped, to prevent a potential hazard from mechanical contact, the coupling guard must be non-sparking. For ATEX the coupling must be selected to comply with European Directive 2014/34/EU (previously 94/9/EC which remains valid until April 20th 2016 during the transition). Correct coupling alignment must be maintained.

1.6.4.6 Preventing leakage

 The pump must only be used to handle liquids for which it has been approved to have the correct corrosion resistance.

Avoid entrapment of liquid in the pump and associated piping due to closing of suction and discharge valves, which could cause dangerous excessive pressures to occur if there is heat input to the liquid. This can occur if the pump is stationary or running.

Bursting of liquid containing parts due to freezing must be avoided by draining or protecting the pump and ancillary systems.

If leakage of liquid to atmosphere can result in a hazard, install a liquid detection device or secondary containment.

1.6.4.7 Maintenance to avoid the hazard

 CORRECT MAINTENANCE IS REQUIRED TO AVOID POTENTIAL HAZARDS WHICH GIVE A RISK OF EXPLOSION

The responsibility for compliance with maintenance instructions is with the plant operator.

To avoid potential explosion hazards during maintenance, the tools, cleaning and painting materials used must not give rise to sparking or adversely affect the ambient conditions. Where there is a risk from such tools or materials, maintenance must be conducted in a safe area.

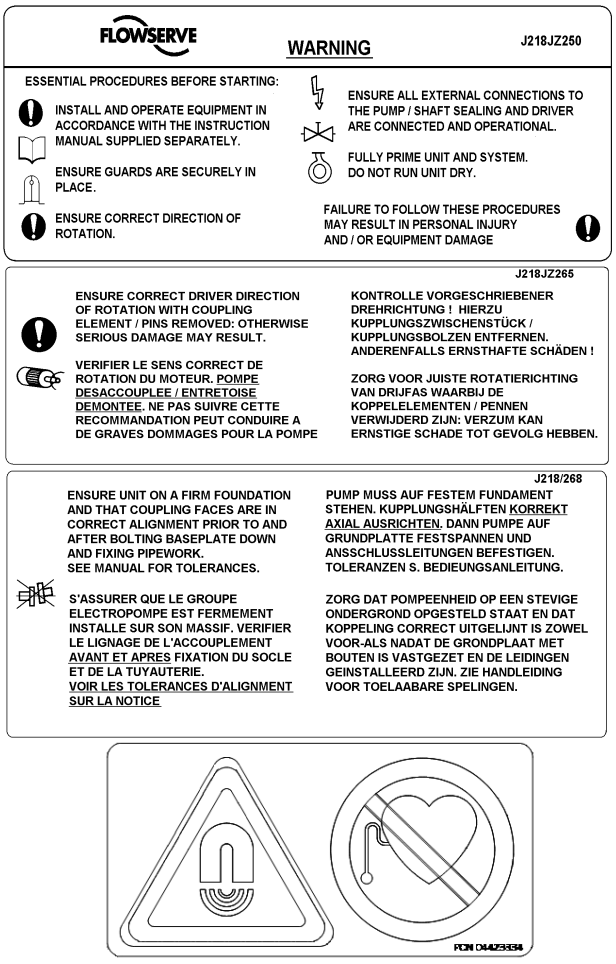
It is recommended that a maintenance plan and schedule is adopted. (See section 6, *Maintenance.*)

1.7 Nameplate and safety labels

1.7.1 Nameplate

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

1.7.2 Safety labels



1.8 Specific machine performance

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

1.9 Noise level

Attention must be given to the exposure of personnel to the noise, and local legislation will define when guidance to personnel on noise limitation is required, and when noise exposure reduction is mandatory. This is typically 80 to 85 dBA. The usual approach is to control the exposure time to the noise or to enclose the machine to reduce emitted sound.

You may have already specified a limiting noise level when the equipment was ordered, however if no noise requirements were defined, then attention is drawn to the following table to give an indication of equipment noise level so that you can take the appropriate action in your plant.

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

Similarly the motor noise provided in the table below is "pump and motor" noise that is 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 are in sound pressure level L_{pA} at 1 m (3.3 ft) from the machine, for "free field conditions over a reflecting plane".

Typical sound pressure level (Pump and Motor) LpA at 1 m (3.3 ft.) reference 20 µPa, dBA				
Pump Series	**3550 rpm**	**2900 rpm**	**1750 rpm**	**1450 rpm**
TB-MAG™ A/V/E	75	69	65	60
TB-MAG™ B/W/F	77	70	68	65
TB-MAG™ C/G	80	76	71	65

Notes: (1.) values are for the maximum usable motor size (2.) for 1180 and 960 rpm reduce 1450 rpm values by 2 dBA. For 880 and 720 rpm reduce 1450 rpm values by 3 dBA. (3.) Choosing a fan-cooled motor will increase noise levels. (4.) Placing valves, orifices, or flow meters near a pump will increase noise levels inside the pump.

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

2 TRANSPORT AND STORAGE

2.1 Consignment receipt and unpacking

Immediately after receipt of the equipment it must be checked against the delivery/shipping documents for its completeness and that there has been no damage in transportation. Any shortage and/or damage must

be reported immediately to Flowserve and must be received in writing within one month of receipt of the equipment. Later claims cannot be accepted.

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

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.

2.2 Handling

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

2.3 Lifting

⚠ A crane must be used for all pump sets or components in excess of 25 kg (55 lb.). Fully trained personnel must carry out lifting, in accordance with local regulations. Slings, ropes and other lifting gear should be positioned where they cannot slip and where a balanced lift is obtained. The angle between slings or ropes used for lifting must not exceed 60°.

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

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

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

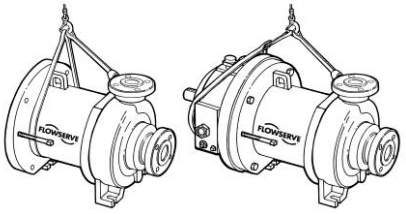
⚠ CAUTION Care must be taken to lift components or assemblies above the center of gravity to prevent the unit from flipping.

2.3.1 Bare pump

Horizontal pumps: Sling around the pump discharge nozzle and around the outboard end of the bearing housing or adaptor with separate slings. Choker hitches must be used at both attachment points and pulled tight. The sling lengths should be adjusted to balance the load before attaching the lifting hook.

Make sure the completion of the choker hitch on the discharge nozzle is toward the coupling end of the pump shaft as shown in Figure 2-1.

Figure 2-1



Vertical pumps: Place one sling around the pump discharge nozzle and one around the suction. Run the slings up through the adaptor lifting lug to keep pump from tipping when lifted.

2.3.2 Lifting pump, motor and baseplate assembly

The angle between slings or ropes used for lifting must not exceed 60°.

Horizontal pumps with motor installed: If the baseplate has lifting holes cut in the sides at the end (Type D, Type E bases and Type A when provided) insert lifting S hooks at the four corners and use slings or chains to connect to the lifting eye. Do not use slings through the lifting holes. (Figure 2-2)

For other baseplates, sling around the pump discharge nozzle, and around the outboard end of the motor frame using choker hitches pulled tight. The sling should be positioned so the weight is not carried through the motor fan housing. (Figure 2-3)

Figure 2-2

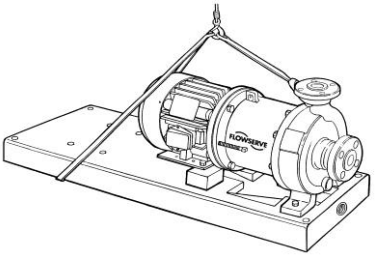
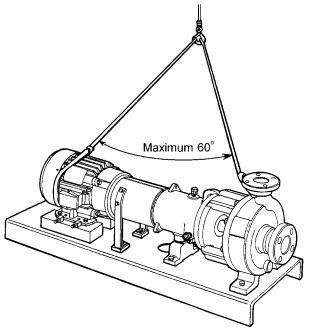
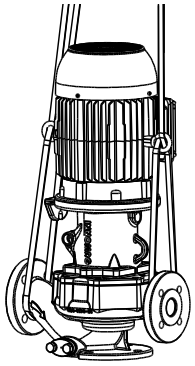


Figure 2-3



Vertical pumps with motor installed: Vertical pumps must use non-footed vertical motors with two eye bolts. Place one sling around the pump discharge nozzle and one around the suction. Run the slings up through the eye bolts on the motor to keep pump from tipping when lifted.



CAUTION Assembled units and their parts are heavy. Failure to properly lift and support this equipment can result in serious physical injury and/or equipment damage. Lift equipment only at the identified lifting points. Lifting devices such as eyebolts, slings, and spreaders must be rated, selected, and used for the entire load being lifted.

Crush hazard. The unit and the components can be heavy. Use proper lifting methods and wear steel-toed shoes at all times.

CAUTION Do not attach sling ropes to shaft ends.

CAUTION Make sure that the unit cannot roll or fall over and injure people or damage property.

These pumps use carbon or ceramic silicon carbide components. Do not drop the pump or subject it to shock loads as this can damage the internal ceramic components.

2.4 Storage

CAUTION Store the pump in a clean, dry location away from vibration. Leave piping connection covers in place to keep dirt and other foreign material out of pump casing.

The pump may be stored as above for up to 6 months. Consult Flowserve for preservative actions when a longer storage period is needed.

2.5 Recycling and end of product life

At the end of the service life of the product or its parts, the relevant materials and parts should be recycled or disposed of using an environmentally acceptable method and local requirements. If the product contains substances that are harmful to the environment, these should be removed and disposed of in accordance with current regulations.

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

3 DESCRIPTION

3.1 Configurations

The 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 for ISO pump sizes and ASME B73.3 for ASME pump sizes although a few exceptions do exist. Both have centerline discharge.

3.2 Nomenclature

The pump size will be noted on the nameplate as in this example: A161311100-AD0. See the following charts for pump identification codes.

TB-MAG™ ANSI-DIMENSIONAL PUMP IDENTIFICATION CODE

Wet End | **A1** | **613** | **1** | **1** | **1** | **0** | **0** | **-** | **A** | **D** | **0** | **Drive End**

Models (Suction x Discharge x Nominal Impeller Diameter)

Code	Pump Size	STD.	Drive Torque	Max.	Min.
A1	(1.5 x 1 x 6)	AA	0,1	6.65"	4.00"
AL/M/N	(1.5 x 1 x 6) Low Flow	AA	0,1	6.65"	4.00"
A3	(3 x 1.5 x 6)	AB	0,1	6.65"	4.00"
A4	(3 x 2 x 6)	--	0,1	6.65"	4.00"
B1	(1.5 x 1 x 8)	AA	0,1	8.25"	5.50"
BL/M/N	(1.5 x 1 x 8) Low Flow	AA	0,1	8.25"	5.50"
B3	(3 x 2 x 6)	--	0,1	7.00"	5.50"
B4	(3 x 1.5 x 8)	A50	0,1	8.25"	5.50"
B5	(3 x 2 x 6)	A10	0,1	7.00"	5.50"
B6	(4 x 3 x 6)	--	0,1	7.00"	5.50"
C1	(3 x 2 x 8)	A60	0,1	8.25"	5.50"
C2	(4 x 3 x 8)	A70	0,1	8.25"	5.50"
C3	(2 x 1 x 10)	A05	0,1	10.5"	5.50"
CL/M/N	(2 x 1 x 10) Low Flow	A05	0,1	10.5"	5.50"
C4	(3 x 1.5 x 10)	A50	0,1	10.5"	5.50"
C5	(3 x 2 x 10)	A60	0,1	10.5"	5.50"
C6	(4 x 3 x 10)	A70	0,1,2	10.5"	5.50"
C7	(4 x 3 x 10H)	A70	0,1,2	10.5"	8.00"
C8	(6 x 4 x 10H)	A80	0,1,2	10.5"	8.00"
C9	(6 x 4 x 8)	A80	0,1,2	8.25"	5.50"
V1	(2 x 1.5 x 6) Vertical	2015/15	0,1	6.65"	4.00"
W1	(2 x 1.5 x 8) Vertical	2015/17	0,1	8.25"	5.50"
W3	(3x2x6) Vertical	3020/17	0,1	8.25"	5.50"

Note: Drive Torque - availible drives per pump size.

Impeller Diameter

† **6.125** inches, (example: 665 = 6.65")

† Impeller trim for ANSI models must be specified in inches.

Bearing System

		Bushing	Shaft, Pump
S	**1** -	SiC	SiC
$	**2** -	SiC+DLC	SiC

Wear Rings/Thrust Collar System

		Impeller Wear Rings	Cont. Shell Wear Ring	Casing Wear Ring	Thrust Collar
S	**1** -	SiC	SiC	SiC	CF-PTFE
	2 -	SiC	SiC	CF-PTFE	SiC
$	**3** -	SiC	SiC	SiC	SiC
C9	**5** -	CF-PTFE	SiC	None	SiC
C$	**7** -	SiC	SiC+DLC	SiC+DLC	CF-PTFE
C$	**8** -	SiC	SiC+DLC	CF-PTFE	SiC
C$	**9** -	SiC	SiC+DLC	SiC+DLC	SiC
C9$	**B** -	CF-PTFE	SiC+DLC	None	SiC

Gasket (All Gaskets are 0.210" square cross section)

S	**1** -	FEP/FKM (Fluorocarbon)
	2 -	FKM (Fluorocarbon)
	3 -	EPDM (Ethylene Propylene)

Flanges (All Pumps Are ANSI-Dimensional, all flanges are ANSI 300# castings with various bolt patterns)

S	**0** -	ANSI (Class 150) Flanges
	1 -	ANSI (Class 300) Flanges
	2 -	ISO/DIN (PN16) Flanges
	3 -	JIS (10 kg/cm^2) Flanges

Option 2 (Construction)

		Impeller Body	Casing Casting/Lining	Casing Drain	Retaining Rings	Containment Shell Lining/Composite	Impeller Torque
S	**0** -	CF-ETFE	D.I./ETFE	Yes	CF-ETFE	CF-ETFE/Aramid	Standard
	1 -	CF-ETFE	D.I./ETFE	No	CF-ETFE	CF-ETFE/Aramid	Standard
C$	**4** -	CF-ETFE	D.I./ETFE	Yes	CF-ETFE	CF-ETFE/Aramid	Ultra
C$	**5** -	CF-ETFE	D.I./ETFE	No	CF-ETFE	CF-ETFE/Aramid	Ultra
C$	**6** -	CF-ETFE	316SS Unlined	No	CF-ETFE	CF-ETFE/Aramid	Standard

Drive Torque Option

0	-	Standard Torque
1	-	High Torque *($)*
2	-	Ultra High Torque *($$)*

Ultra High Torque is for "K,W" Motor Frame!

Motor Frame

NEMA C-Face

	A	-	56C	(A Series Only)
	B	-	143/5TC	
	C	-	182/4TC	
ta	**D**	-	213/5TC	
ta	**E**	-	254/6TC	(Max. A-Series)
	F	-	254/6 (4 Pole)	
$			284/6TSC	(Max. B-Series)
$	**G**	-	324/6TSC	
$	**H**	-	364/365TSC	
tc	**J**	-	284/6TC	
uc	**K**	-	324/6TC & 405TSC	

IEC B5

	M	-	80	(A Series Only)
	N	-	90S/L	
	P	-	100L/112M	
ta	**R**	-	132S/M	(Max. A-Series)
$	**S**	-	160M	
$	**T**	-	160M/L	(Max. B-Series)
tc	**U**	-	180M/L	
tc	**V**	-	200L	
uc	**W**	-	225S/M	
uc	**Y**	-	250M	
uc	**Z**	-	280S	

ta-A-Series Optional High Torque Drives $

tc-B/C-Series Optional High Torque Drives $

uc- Optional Ultra High Torque Drive $$

Product Group

	A	-	TB-Mag™ A	
	B	-	TB-Mag™ B	
	C	-	TB-Mag™ C	
	V	-	TB-Mag™ V	
	W	-	TB-Mag™ W	
LC	*$$* **L**	-	Long Coupled B/C	
SS	*$$$* **S**	-	Secondary Seal Unit B/C	

LC-Standard Long Coupled Bearing Frame for TB-Mag™ Models B1-C9, $$ Adder

SS-Long Coupled Bearing Frame equipped with Patented Secondary Sealing System for TB-Mag™ Models B1-C9, $$$ Adder

Material Guide

CF - Carbon Fiber
D.I. - Ductile Iron
ETFE - Ethylene-tetrafluoroethylene
PTFE - Polytetrafluoroethylene
SiC - Silicon Carbide (Ceramic)

S Standard Material/Options
C Consult Factory for Availability
C9 C9 Model Only
t High Torque Option
u Ultra High Torque Option
$ Price Adder

Rev. Date 5/21/2014

Not an exhaustive list. Available options subject to change without notice. Consult factory for availability and pricing.

TB-MAG™ ISO-DIMENTIONAL PUMP IDENTIFICATION CODE

Wet End | **E1** | **165** | **1** | **1** | **1** | **2** | **0** | **-** | **E** | **N** | **0** | **Drive End**

TB-mag Models

	Code		Pump Size	Drive Torque	Impeller Dia. (mm) Max.	Min.
	E0	-	TB050-032-125B	0,1	140	102
	E1	-	TB050-032-160A	0,1	169	102
	EL/M/N	-	TB050-032-160L/M/N	0,1	169	102
	E2	-	TB050-032-160B	0,1	169	102
	F1	-	TB050-032-200A	0,1	210	140
	FL/M/N	-	TB050-032-200L/M/N	0,1	210	140
	F2	-	TB050-032-200B	0,1	210	140
	G3	-	TB050-032-250B	0,1	267	140
	E3	-	TB065-050-160A	0,1	169	102
	E4	-	TB065-040-160B	0,1	169	102
	F3	-	TB065-040-200B	0,1	210	140
	F4	-	TB065-040-200A	0,1	210	140
	G4	-	TB065-040-250B	0,1	267	140
	F5	-	TB080-050-160B	0,1	178	140
	G1	-	TB080-050-200B	0,1	210	140
	G5	-	TB080-050-250B	0,1, 2	267	140
	G2	-	TB100-065-200B	0,1	210	140
	G6	-	TB100-065-250B	0,1, 2	267	140
	G9	-	TB125-080-200B	0,1, 2	210	140
	G7	-	TB125-100-250B	0,1, 2	267	210
	G8	-	TB150-125-250B	0,1, 2	267	210

Impeller Diameter

†	**165**	mm, (i.e. - 165, 140)

† Impeller trim for ISO models must be specified in mm.

Bearing System

			Bushing	Shaft, Pump
S	**1**	-	SiC	SiC
C$	**2**	-	SiC+DLC	SiC+DLC

Wear Rings/Thrust Collar System

			Imp. Wear Ring	Cont. Shell Wear Ring	Case Wear Ring	Case Thrust Collar
S	**1**	-	SiC	SiC	SiC	CF-PTFE
	2	-	SiC	SiC	CF-PTFE	SiC
	3	-	SiC	SiC	SiC	SiC
G9	**5**	-	CF-PTFE	SiC	None	SiC
C$	**7**	-	SiC	SiC+DLC	SiC+DLC	CF-PTFE
C$	**8**	-	SiC	SiC+DLC	CF-PTFE	SiC+DLC
C$	**9**	-	SiC	SiC+DLC	SiC+DLC	SiC+DLC

Gasket (All Gaskets are 5.3mm square cross section)

S	**1**	-	FEP/FKM (Fluorocarbon)
	2	-	FKM (Fluorocarbon)
	3	-	EPDM (Ethylene Propylene)

Flanges (All Pumps Are ISO Dimensional, all flanges are ISO PN25 castings with various bolt patterns)

S	**2**	-	ISO/DIN (PN16/25) Flanges
	3	-	JIS (10 kg/cm^2) Flanges
	0	-	ANSI (Class 150) Flanges

Construction

			Impeller Body	Casing Casting/Lining	Casing Drain	Retaining Rings	Containment Shell Lining/Composite	Impeller Torque
S	**0**	-	CF-ETFE	D.I./ETFE	Yes	CF-ETFE	CF-ETFE/Aramid	Standard
	1	-	CF-ETFE	D.I./ETFE	No	CF-ETFE	CF-ETFE/Aramid	Standard
C$	**4**	-	CF-ETFE	D.I./ETFE	Yes	CF-ETFE	CF-ETFE/Aramid	Ultra
C$	**5**	-	CF-ETFE	D.I./ETFE	No	CF-ETFE	CF-ETFE/Aramid	Ultra

S - Standard Material/Options
C - Consult Factory for Availability
$ - Price Adder
G9 - G9 pump only

Material Guide
CF - Carbon Fiber
D.I. - Ductile Iron
ETFE - Ethylene-tetrafluoroethylene
PTFE - Polytetrafluoroethylene
SiC - Silicon Carbide (Ceramic)

Drive Torque Option

0	-	Standard Torque
1	-	High Torque
2	-	Ultra High Torque

Ultra High Torque is for "K,W,Y,Z" Motor Frame Only!

Motor Frame

NEMA C-Face				
	A	-	56C	(E Series Only)
	B	-	143/5TC	
	C	-	182/4TC	
te	**D**	-	213/5TC	
te	**E**	-	254/6TC	(Max. E-Series)
	F	-	254/6 (4 Pole)	
$			284/6TSC	(Max. F-Series)
$	**G**	-	324/6TSC	
$	**H**	-	364/365TSC	
tg	**J**	-	284/6TC	
ug	**K**	-	324/6TC & 405TSC	
IEC B5				
	M	-	80	(E Series Only)
	N	-	90S/L	
	P	-	100L/112M	
te	**R**	-	132S/M	(Max. E-Series)
$	**S**	-	160M	
$	**T**	-	160M/L	(Max. F-Series)
tg	**U**	-	180M/L	
tg	**V**	-	200L	
ug	**W**	-	225S/M	
ug	**Y**	-	250M	
ug	**Z**	-	280S	

te-E-Series Optional High Torque Drives
tg-F/G-Series Optional High Torque Drives
ug- Optional Ultra High Torque Drive $$

Product Group

	E	-	TB-Mag™ E
	F	-	TB-Mag™ F
	G	-	TB-Mag™ G
LC	**L**	-	Long Coupled F/G
SS	**S**	-	Secondary Seal Unit F/G

(ANSI DIMENSIONAL BEARING FRAME ONLY)

LC-Standard Long Coupled Bearing Frame for TB-Mag F/G Series, $$ Adder
SS-Long Coupled Bearing Frame equipped with Patented Secondary Sealing System for TB-Mag F/G Series, $$$ Adder

Rev. Date 5/11/2016

Not an exhaustive list. Available options subject to change without notice. Consult factory for availability and pricing.

3.3 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 – AA-1.5x1x6
- Pump Code: Example – A161311100-AD0
- Serial Number: Example – 44000
- Impeller Diameter / Max Impeller Diameter (in. or mm.)
- Duty Point (Flow/TDH)(gpm / ft. or m^3/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) @ 38°C (100 °F)
- Customer Pump Tag #
- Process Liquid Being Pumped
- CE/ATEX Marking: Flowserve Innomag® pumps are certified to European Directive 2014/34/EU (previously 94/9/EC which remains valid until April 20th 2016 during the transition). The certification level is: Group II, Category 2, Gas, T4 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.

3.4 Design of major parts

3.4.1 Pump casing

Ductile iron armor 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).

3.4.2 Impeller

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

3.4.3 Wetted Bearings System

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.

3.4.4 Containment Ring

One-piece ductile iron 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.

3.4.5 Outer Magnet Assembly

One-piece ductile iron 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.

3.4.6 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.

3.4.7 Adapter

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

3.4.8 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.

3.4.9 Accessories

Accessories may be fitted when specified by the customer

3.5 Performance and operating limits

This product has been selected to meet the specifications of the purchase order. See Section 1.5.
The following data is included as additional information to help with your installation. It is typical, and factors such as temperature and materials may influence this data. If required, a definitive statement for your particular application can be obtained from Flowserve.

3.5.1 Operating limits

Normal maximum ambient temperature:
+40 ºC (104 ºF).
Normal minimum ambient temperature:
-20 ºC (-4 ºF).
Maximum pump speed: refer to the nameplate.

3.5.2 Pressure-Temperature Rating

The pump pressure and temperature limits are included in the Figure 3-1. 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.

⚠ 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.

Figure 3-1

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

3.5.3 Energy Efficiency Operation of Pumps

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:

a) Design the pipe system for minimum friction losses
b) Ensure that the control system switches off the pump when not required
c) In a multi-pump system run the minimum number of pumps
d) Try to avoid systems which by-pass excess flow
e) Avoid as far as possible controlling pump flow by throttle valves
f) When commissioned, check that the pump operates at the duty specified to Flowserve
g) If it has been found that the pump head and flow exceed that required, trim the pump impeller diameter
h) Ensure that the pump is operating with sufficient NPSH available.
i) 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
j) Notes for VFD usage
    a) make sure that the motor is compatible with VFD
    b) Do not over-speed the pump without checking the power capability with Flowserve
    c) On systems with high static head, speed reduction is limited. Avoid running the pump at a speed which gives low or zero flow
    d) Do not run at a low speed and flow rate which lets solid settle out of suspension in the pipe work
    e) Do not use a VFD for a fixed flow requirement; it will introduce power losses

k) Select high efficiency motors
l) 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
m) If the pump system pipe work or equipment is changed or process duty is changed, check that the pump is still correctly sized
n) Periodically check that the pipe system has not become corroded or blocked
o) 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.

4 INSTALLATION

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

4.1 Location

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

4.2 Part assemblies

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 4.5 and 4.8.

4.3 Foundation

CAUTION A pump should be located near the supply of liquid and have adequate space for operation, maintenance, and inspection. Baseplate mounted pumps are normally placed on a concrete foundation, which has been poured on a solid footing. The foundation must be able to absorb any vibration and to form a permanent, rigid support for the pumping unit.

a) Prepare site - Inspect foundation for dirt, oil, chips, water, etc. and remove any contaminants.
b) Install mounting bolts using hole pattern determined by baseplate size. Sleeve-type and J-type bolts are commonly used to allow movement for final bolt adjustment. Follow best company standards and practices.
c) If not supplied, guarding shall be fitted as necessary to meet the requirements of ISO 12100 and EN953.

4.3.1 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.

4.3.2 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:

- Foundation-mounted, grouted design (Figure 4-1)
- Stilt mounted, or free standing. (Figure 4-2.)

Figure 4-1

Figure 4-2

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

Stilt mounted baseplates, on the other hand, 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 1.25 mm/m (0.015 in./ft) 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 0.17 mm/m (0.002 in./ft) is offered on the Flowserve Type E "Ten Point" baseplate in Figure 4-1.
- The baseplate must be designed to allow the user to final field align the pump and driver to within their own particular standards and to compensate for any pump or driver movement that occurred during handling. Normal industry practice is to achieve final alignment by moving the motor to match the pump. Flowserve practice is to confirm in our shop that the pump assembly can be accurately aligned. Before shipment, the factory verifies that there is enough horizontal movement capability at the motor to obtain a "perfect" final alignment when the installer puts the baseplate assembly into its original, top levelled, unstressed condition.

4.3.3 Stilt and spring mounted baseplates

Flowserve offers stilt and spring mounted baseplates. (See Figure 4-2 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.

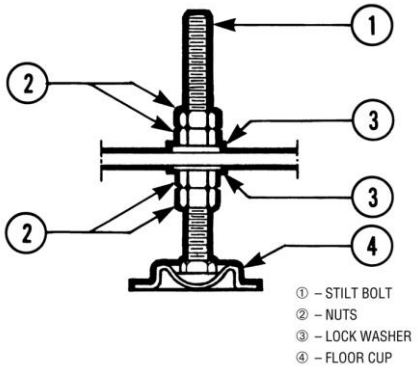
General instructions for assembling these baseplates are given below. For dimensional information, please refer to the appropriate Flowserve "Sales print."

4.3.3.1 Stilt mounted baseplate assembly instructions

Refer to Figure 4-3.

a) Raise or block up baseplate/pump above the floor to allow for the assembly of the stilts.
b) Predetermine or measure the approximate desired height for the baseplate above the floor.
c) Set the bottom nuts [2] above the stilt bolt head [1] to the desired height.
d) Assemble lock washer [3] down over the stilt bolt.
e) Assemble the stilt bolt up through hole in the bottom plate and hold in place.
f) Assemble the lock washer [3] and nut [2] on the stilt bolt. Tighten the nut down on the lock washer.
g) 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.
h) 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.
i) Tighten the top and bottom nuts at the lock washer [3] first then tighten the other nuts.
j) 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.

Figure 4-3



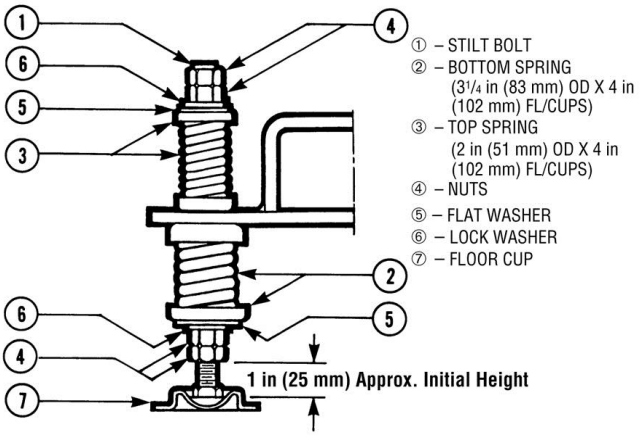
4.3.3.2 Stilt/spring mounted baseplate assembly instructions

Refer to Figure 4-4.

a) Raise or block up baseplate/pump above the floor to allow for the assembly of the stilts.
b) Set the bottom nuts [4] above the stilt bolt head [1]. This allows for 51 mm (2 in.) upward movement for the final height adjustment of the suction/discharge flange.
c) Assemble the lock washer [6] flat washer [5] and bottom spring/cup assembly [2] down over the stilt bolt [1].
d) Assemble the stilt bolt/bottom spring up through hole in the bottom plate and hold in place.
e) Assemble top spring/cup assembly [3] down over stilt bolt.
f) Assemble flat washer [5], lock washer [6] and nuts [4] on the stilt bolt.

g) Tighten down top nuts, compressing the top spring approximately 13 mm (0.5 in.). Additional compression may be required to stabilize the baseplate.
h) 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 down to the floor.
i) 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.
j) Recompress the top spring to the compression established in step g, and lock the nuts in place.
k) 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.

Figure 4-4



4.3.3.3 Stilt/spring mounted baseplates - motor alignment (Long-Couple pumps only)

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

a) Level the baseplate by using the stilt adjusters. (Shims are not needed as with grouted baseplates.)
b) After the base is level, it is locked in place by locking the stilt adjusters.
c) 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 0.38 mm (0.015 in.) parallel, and 0.0025 mm/mm (0.0025 in./in.) angular alignment. If this is not the case, check to see if the driver mounting fasteners are centered in the driver feet holes.
d) 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.
e) 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.
f) Lock the stilt adjusters.

The remaining steps are as listed for new grouted baseplates.

4.4 Grouting

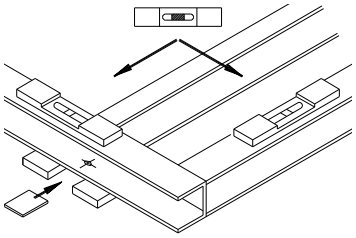
Where applicable, grout in the foundation bolts. Foundation bolts should only be fully tightened when the grout has cured.

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. Polycrete baseplates cannot be grouted in the same way, see their User Instructions 71569284 (E) for installation and use. If in any doubt, please contact your nearest service center for advice.

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

4.4.1 Baseplate Inspection

a) Completely clean the underside of baseplate.
b) Inspect for any damage that would impede proper installation or future use of the baseplate.
c) Confirm baseplate hole pattern for proper mounting bolt installation.
d) Lower the baseplate carefully onto mounting bolts. Caution: Must adhere to proper transport and lifting procedures.
e) Level the baseplate using shims and/or wedges. Use machinist's levels to maintain a flat and level surface.



f) Max difference across length 3.2 mm (0.125 in.)
g) Max difference across width 1.5 mm (0.059 in.)
h) Secure baseplate using mounting bolts to prevent unwanted movement during operation. Torque bolts to appropriate company standards and practices.
i) Perform final inspection to verify that baseplate is securely mounted, level, and ready to be used.

4.5 Piping

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

4.5.1 Suction and discharge piping

CAUTION Never use the pump as a support for piping.

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

The following is the recommended procedure for attaching piping to the TB-MAG™ pump (see section 6.5 for torque values)

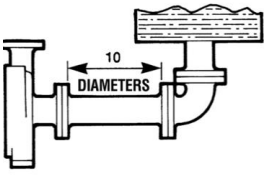
- Check the surface of both flanges (pump/pipe) to ensure they are clean, flat, and without defects
- Lubricate the fasteners
- Hand tighten all of the fasteners in a crisscross pattern
- The fasteners should be torqued in increments – based a crisscross pattern
- See torque chart in Section 6.5
  - The first increment should be 75% of full torque
  - The second increment should be at the full torque
  - Verify that the torque value of the 1st fastener is still at the full torque value. Re-torque all fasteners after 24 hours or after the first thermal cycle.
- Re-torque all fasteners at least annually

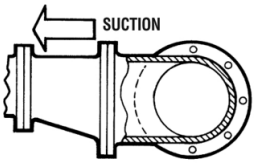
4.5.2 Suction piping

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

Figure 4-5 illustrates the ideal piping configuration with a minimum of 10 pipe diameters between the source and the pump suction. In most cases, horizontal reducers should be eccentric and mounted with the flat side up as shown in Figure 4-6 with a maximum of one pipe size reduction. Never mount eccentric reducers with the flat side down. Horizontally mounted concentric reducers should not be used if there is any possibility of entrained air in the process fluid. Vertically mounted concentric reducers are acceptable. In applications where the fluid is completely de-aerated and free of any vapour or suspended solids, concentric reducers are preferable to eccentric reducers.

Figure 4-5 ***Figure 4-6***





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

Refer to the Centrifugal Pump IOM Section of the H.I. Standards for additional recommendations on suction piping. (See section 10.)

Refer to section 3.4 for performance and operating limits.

4.5.3 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, 3 m/s (10 ft/sec) or higher, a rapidly closing discharge valve can cause a damaging pressure surge. A dampening arrangement should be provided in the piping.

4.5.4 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 should be strictly followed:

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

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

4.5.5 Auxiliary piping

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

4.5.5.1 Pumps fitted with heating/cooling jackets

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

4.6 Electrical connections

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

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

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

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

A device to provide emergency stopping must be fitted. If not supplied pre-wired to the pump unit, the controller/starter electrical details will also be supplied within the controller/starter. For electrical details on pump sets with controllers see the separate wiring diagram.

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

CAUTION For close coupled 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.

4.7 Protection systems

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

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

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

If leakage of product from the pump 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.

4.7.1 Auxiliary equipment – instrumentation

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

4.7.1.1 Leak detection

An intrinsically-safe, optical leak detection system is available for TB-MAG™ pumps.

4.7.1.2 Temperature probe

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

4.7.1.3 ThermicSense Installation

The ThermicSense 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

a) Verify that rubber gasket / o-ring is secured to temperature sensor tip.
b) Insert temperature sensor tip into the thermowell and hand tighten.
c) Use a 1/2 in. wrench to fully secure the sensor to the thermowell.

CAUTION Do not over-tighten.

d) Adjust direction of sensor sheathing before tightening compression fitting.
e) Ensure sensor tip is fully pressed into thermowell.

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

f) Hand-tighten the compression fitting.
g) Use a 1/2" wrench to fully tighten the compression fitting and secure sensor sheathing.

CAUTION Do not over tighten the fitting.

h) Affix the PTFE drain gasket to thermal well.
i) Insert the completed ThermicSense assembly into the casing drain and insert bolts (1/2 in.-13 ASME, M12x1.75 ISO) with lock washers.
j) Tighten bolts evenly to maintain alignment and torque to 13.5 Nm (10 lbf•ft)
k) Install wire leads to appropriate temperature monitor per manufacturer instructions and guidelines.

4.8 Final Shaft alignment check

4.8.1 Close-coupled pumps

Alignment between the pump shaft and motor shaft is built in by precise machining of the parts that position these shafts. Parallel alignment of 0.18 mm (0.007 in.) and angular alignment of 0.002 mm/mm (0.002 in./in.) can be expected.

4.8.2 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 ºC (212 ºF), the unit should be run at the actual operating temperature, shut down and the alignment checked immediately.

a) Level baseplate if appropriate.
b) Mount and level pump if appropriate. Level the pump by putting a level on the discharge flange. If not level, adjust the foot piece by adding or removing shims between the foot piece [3134] and the bearing housing.
c) Check initial alignment. If pump and driver have been remounted or the specifications given below are not met, perform an initial alignment as described in section 4.5. 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 0.38 mm (0.015 in.) FIM (full indicator movement) parallel, and 0.0025 mm/mm (0.0025 in./in.) FIM angular.
   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.
d) Run piping to the suction and discharge to the pump. There should be no piping loads transmitted to the pump after connection is made. Recheck the alignment to verify that there are no significant changes.
e) Perform final alignment. Check for soft-foot under the driver. An indicator placed on the

coupling, reading in the vertical direction, should not indicate more than 0.05 mm (0.002 in.) movement when any driver fastener is loosened. Align the driver first in the vertical direction by shimming underneath its feet.

f) When satisfactory alignment is obtained the number of shims in the pack should be minimized. It is recommended that no more than five shims be used under any foot. Final horizontal alignment is made by moving the driver. Maximum pump reliability is obtained by having near perfect alignment. Flowserve recommends no more than 0.05 mm (0.002 in.) parallel, and 0.0005 mm/mm (0.0005 in./in.) angular misalignment.

g) Operate the pump for at least an hour or until it reaches final operating temperature. Shut the pump down and recheck alignment while the pump is hot. Piping thermal expansion may change the alignment. Realign pump as necessary.

5 COMMISSIONING, START-UP, OPERATION AND SHUTDOWN

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

5.1 Pre-commissioning procedure

CAUTION Long coupled bearing frames are shipped without oil. For long coupled pumps, fill the bearing housing [3200] with correct grade of oil to the correct level, according to Section 6.15.

5.2 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.

CAUTION 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.

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

5.3 Priming and auxiliary supplies

5.3.1 Auxiliary supplies

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

5.3.2 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.

5.4 Starting the pump

a) CAUTION CLOSE the discharge valve. Fully open the suction valve. Pump requires a flooded suction.

b) Ex Do not operate pump with suction valve closed. Operating pump more than a few minutes after suction valve closed may cause bearing failure.

c) 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.

d) Ex Continuous operation against a closed discharge valve may cause pump to overheat.

e) Start motor and check the outlet pressure.

f) If the pressure is satisfactory, SLOWLY open the outlet valve.

g) CAUTION Do not run the pump with the outlet valve closed for a period longer than 10 seconds.

h) If NO pressure, or LOW pressure, STOP the pump. Refer to section 7, *Troubleshooting,* for fault diagnosis.

5.5 Running the pump

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

CAUTION External flush or quench should be started before the pump is run and allowed to flow for a period after the pump has stopped.

5.5.1 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 are based on those standards.

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

Vibration velocity – unfiltered		Horizontal pumps ≤ 15 kW (20 hp)	Horizontal pumps > 15 kW (20 hp)
		mm/s (in./sec) r.m.s.	
Normal	**N**	≤ 3.0 (0.12)	≤ 4.5 (0.18)
Alarm	**N** x 1.25	≤ 3.8 (0.15)	≤ 5.6 (0.22)
Shutdown trip	**N** x 2.0	≤ 6.0 (0.24)	≤ 9.0 (0.35)

Where a unit is utilized in a vertical shaft configuration, the following apply:

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

5.5.2 Stop/start frequency

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

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

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

5.6 Stopping and shutdown

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

5.7 Hydraulic, mechanical and electrical duty

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

5.7.1 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 consumed is also directly proportional to SG. It is therefore important to check that any change in SG will not overload the pump driver or over-pressurize the pump.

5.7.2 Viscosity

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

5.7.3 Pump speed

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

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

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

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

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

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

6 MAINTENANCE

6.1 General

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

Any work on the machine must be performed when it is at a standstill. It is imperative that the procedure for shutting down the machine is followed

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

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

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

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

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

Do not spray air or compressed inert gas on skin. Do not direct an air or gas jet towards other people. Never use air or compressed inert gas to clean clothes.

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

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

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

When operating with CHARGEABLE LIQUIDS with conductivities of $<10^{-8}$ S/m, inert gases (e.g. nitrogen) must be used to flush the pump. Before removal of the pump it is recommended to wait one hour to allow static peak charges to be eliminated.

CAUTION ALWAYS make certain that no toxic or flammable fumes / vapors remain in the pump casing [1100] or surrounding area.

6.2 Maintenance schedule

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

a) Any auxiliary systems installed must be monitored, if necessary, to ensure they function correctly.
b) If the pump is long coupled, bearing isolators and mechanical seals must be adjusted correctly to prevent leakage. Any fluid leakage from the pump is unusual.
c) Check for any leaks from gaskets and seals (if present). Pump is designed to be leak-free, any

leak is abnormal. If a mechanical seal is present, the correct functioning of the shaft seal must be checked regularly.

d) If the pump is long coupled, check bearing lubricant level, and if the hours run shows a lubricant change is required.
e) Check that the duty condition is in the safe operating range for the pump.
f) Check vibration, noise level and surface temperature to confirm satisfactory operation.
g) Check dirt and dust is removed from areas around close clearances, bearing housings (if present) and motors.
h) If long coupled, check coupling alignment and re-align if necessary.

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

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

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

6.2.1 Preventive Maintenance Guidelines

Different applications call for different preventative maintenance schedules. Applications that involve pumping abrasives, or applications that are likely to precipitate solids should be examined on a regular basis to ensure that accumulating solids (if any) are removed. There are many factors that can necessitate periodic preventative maintenance and inspection, but for clean, continuously operating services, preventative maintenance can usually be done without disassembling the pump. See recommended spare parts list for more information.

Devices/techniques to help monitor the pump externally:

a) Install pressure gauges on the suction and discharge
b) Regularly monitor the process conditions
c) Use the motor's fan to check for free rotation
d) Use a shaft power monitor to protect the pump as well as monitor pump performance
e) Check vibration, noise level and surface temperature to confirm satisfactory operation.

For preventative maintenance schedule recommendations that are specific to your application, please contact your authorized local distributor.

If ABRASIVE SOLIDS are present within the fluid, additional wear of the pump should be expected. Intervals between inspections should be shortened compared to usual times.

6.2.2 Routine inspection (daily/weekly)

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

a) Check operating behaviour. Ensure noise, vibration and bearing temperatures are normal.
b) Check that there is no abnormal fluid or lubricant leak from seals (if present) and that any sealant systems (if fitted) are full and operating normally.
c) If long coupled, check the level and condition of oil lubricant.
d) If long coupled, check pump running records for hourly usage to determine if bearing lubricant requires changing.

CAUTION Check any auxiliary supplies eg heating/cooling (if fitted) are functioning correctly.

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

6.2.3 Periodic inspection (six monthly)

a) CAUTION Check foundation bolts for security of attachment and corrosion.
b) If long coupled, check pump running records for hourly usage to determine if bearing lubricant requires changing.
c) If long coupled, check the coupling for correct alignment and worn driving elements.

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

6.3 Spare parts

6.3.1 Ordering of spares

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

1) Pump serial number.
2) Pump size.

3) Part name – taken from section 8.
4) Part number – taken from section 8.
5) Number of parts required.

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

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

6.3.2 Storage of spares

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

6.3.3 Recommended spares

For two years operation (as per VDMA 24296).

FIN no.	Designation	Number of same size pumps (including stand-by)						
		2	3	4	5	6/7	8/9	10(+)
2200	Impeller Assembly	1			2			20%
0224	Containment Shell Assembly	1			2			20%
3610, 1500.1, 2530.1	Suction Ring Kit	1			2			20%
4610	Gasket / O-ring	1	2		3			30%
7124	Outer Magnet Assembly	-	-	-	1			2
-	Power end	-	-	-	-	-	1	2

6.4 Tools required

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

6.4.1 Readily available in standard tool kits, and dependent on pump size:

- 9/16, 1/2, 5/8, 3/4, 15/16 in. Wrench & Socket
- 17, 19, 24 mm Spanner & Socket
- Allen keys, up to 10 mm across flats
- 3/16 in. & 1/4 in. T-Handle Allen Wrench
- Wire Cutter
- Soldering Iron
- Range of screwdrivers
- Soft mallet
- Jackscrew Bolts
  - 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 [7124]: 1/2 in. - 13 x 4.5 in.
  - IEC Outer Magnet [7124]: (2) M8 -1.25 x 30 mm, M12 - 1.75 x 100+mm jackscrew and jackscrew plate (TLG-2042-SI)
- Needle Nose Pliers
- Arbor Press
- Lathe
- Caliper
- Hobby Knife

6.4.2 Flowserve Innomag® Specialized Equipment:

- Shaft Removal Tool
  a) A/V/E Series Part # TLG-2017-AA
  b) B/C/W/F/G Series Part # TLG -2018-AA
- Shaft Centering Tool
  a) A/V/E Series Part # TLG-2013-SI
  b) B/C/W/F/G Series Part # TLG-2015-SI
  c) C Series ('H' Models) Part **#** TLG-2014-SI
- Bushing Installation / Removal Kit
  a) Part # TLG-2016-AA
- Dial test indicator
- Impeller Trimming Sleeve
  a) A/V/E Series Part # TLG-2033-AA
  b) B/C/W/F/G Series Part # TLG-2023-AA

6.5 Fastener torques

Fastener	Screw size	Torque Nm (lbf•ft)
All except where otherwise stated	M8 (5/16in.)	16 (12)
	M10 (3/8in.)	25 (18)
	M12 (1/2in.)	35 (26)
	M16 (5/8in.)	80 (59)
	M20 (3/4in.)	130 (96)

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

6.6 Disassembly

The preventative maintenance and disassembly procedures are intended for use during standard field inspection or service. The disassembly can take place while the pump is piped up or in a maintenance shop. If at all possible, it is recommended to perform all repairs using the shop procedures to reduce the risk of damage to SiC parts.

⚠ Lock out driver power to prevent accidental start-up that could result in serious personal injury. Lock out and/or disconnect power.

⚠ CAUTION Shut off all valves controlling flow to and from the pump. Isolate the pump from the system and relive any remaining system pressure.

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

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

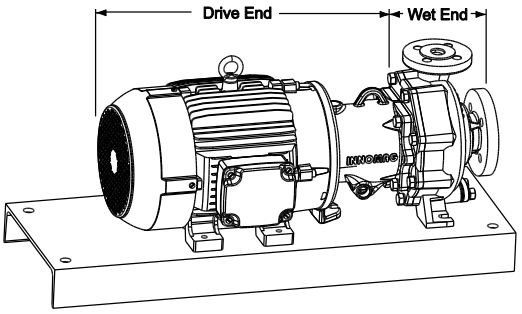
Refer to sectional drawings for part numbers and identification. (See section 8, *Parts lists and drawings*.)

Ex When operating with chargeable liquids with conductivities of $<10^{-8}$ S/m, inert gases (e.g. nitrogen) must be used to flush the pump. Before removal of the pump it is recommended to wait one hour to allow static peak charges to be eliminated.

6.6.1 Drive / 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.

⚠ CAUTION 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.



6.6.1.1 Close-Coupled and Vertical Pumps

a) Remove the bolt(s) connecting the adapter foot [3134] to the base and any bolts connecting the motor to the base.
b) Remove the (4) hex caps screws on the adapter [1340].
c) 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 6.4.1) 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.

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

6.6.1.2 Long-Coupled Pumps

a) Remove the metal drain plug [6569.2] below the sight glass [3856] on the bearing frame [3200] to drain the oil.
b) Drain the oil into an oil pan and replace the oil plug [6569.2].
c) Remove the coupling guard and coupling from the motor and bearing frame shafts.
d) Remove the bolts connecting the motor to the baseplate.
e) Move the motor aside to allow space for wet end/adaptor [1340] separation.
f) Remove the bolts (2) connecting the support foot [3134] to the base.
g) Remove the (4) hex caps screws on the adapter [1340].
h) 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 6.4.1) through the jack bolt holes in the containment ring [1240].

i) Firmly hold the bearing frame [3200/1340] and with smooth, continuous force, pull it away from the wet end.

j) Place the bearing frame [3200/1340] aside for disassembly of the wet end.

6.6.2 Wet End Disassembly

6.6.2.1 Wet End Disassembly – Piped Up

When handling hazardous and/or toxic fluids, skin, eye and respiratory protection are 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 to all federal, state, local and company environmental regulations.

CAUTION For larger pumps (TB-MAG™ B/C/W/F/G-Series) we recommend having two people perform the following procedures in order to decrease the chance of damaging or breaking the SiC components.

a) 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].

b) 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:

c) 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].

d) Firmly hold the containment shell [0224] and use your index fingers and thumbs to support the containment ring [1240].

e) Pull the assembly back in a straight line until it is clear of the casing [1100].

f) 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.

g) Lift and remove the impeller [2200] from the containment shell [0224].

6.6.2.2 Wet End Disassembly – In Shop

a) Remove all flange and casing [1100] feet hex caps screws.

b) Place a piece of cardboard or a shop towel on the workspace to protect the plastic on the flange.

c) Lay the wet end face down on the suction flange in the work area.

d) Loosen and remove the hex caps screws [6570.1] on the containment ring [1240] with a wrench.

e) Visually inspect the containment ring [1240]. If it appears loose then you can remove all the hex caps 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:

f) 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].

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

h) Lift the containment ring [1240] with your fingers while holding down the containment shell [0224] with your thumbs.

i) Lift the containment ring [1240] straight up off of the containment shell [0224] and set aside.

j) Carefully lift and remove the containment shell [0224] straight up from the impeller [2200].

k) Carefully lift and remove the impeller [2200] straight up from the casing [1100].

6.7 Examination of parts

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

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

6.7.1 Casing lining

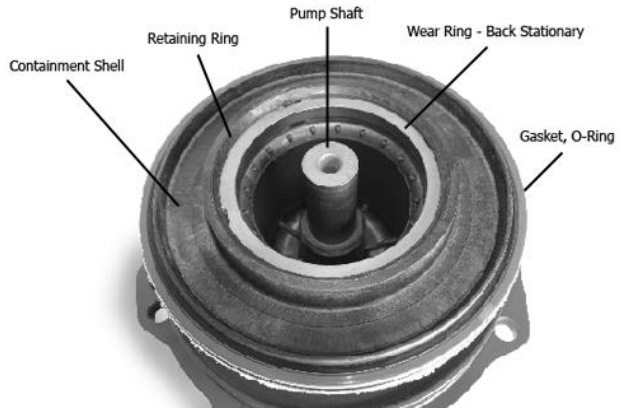
Inspect the casing [1100] lining for any abrasion, cracks or delamination. Casing [1100] replacement is necessary if lining is breached. Minor scratches or cuts less than 0.1 mm (0.040 in.) depth are acceptable.

6.7.2 Silicon Carbide (SiC)

When inspecting the pump internals check all Silicon Carbide (SiC) parts for cracks, chips and scoring marks. Minor chips less than 0.5 mm (0.020 in.) 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.

6.7.3 Containment Shell

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



6.7.4 Gasket, O-ring

After dismantling, discard and replace the O-ring [4610].

6.7.5 Impeller

The bushings [3300.2], thrust control valve [6210], and wear rings [2300.1, 2300.2] can be replaced if damaged. See section 6.10 for repair instructions.

6.7.6 Outer Magnet

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

6.8 Casing Repair

6.8.1 Casing Wear Ring Removal

a) Insert a flathead screwdriver into the casing [1100] notch opposite the plastic weld point on the retaining ring and pry out the retaining ring.
b) 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.
c) Remove the locking key(s).

6.8.2 Casing Wear Ring Installation

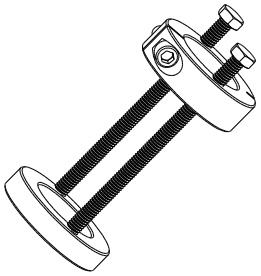
a) Insert thrust collar [3610] (grooved side up) and align the keyway notch on the thrust collar with the casing [1100] keyway notch.
b) Insert and align the (SiC) front stationary wear ring [1500.1] with the keyway notch in the casing [1100].
c) Insert locking key(s) into all but one keyway.
d) Casings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

6.9 Containment Shell Repair

6.9.1 Wear Ring Replacement

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

6.9.2 Shaft Removal



a) Requires shaft removal tool part # TLG-2017-SI (A/V/E-Series) or TLG-2018-SI (B/C/W/F/G-Series).
b) Secure the containment shell [0224] upside down - you can use the adapter [1340] for this if nothing else is available.
c) Place the bottom half of the shaft removal tool over the shaft [2100.1], then gently slide it down the shaft.
d) 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 19mm (3/4 in.) down the shaft
e) Using the allen wrench, tighten the top half to the shaft
f) Evenly tighten the two bolts, alternating between them when you feel resistance.

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

g) Remove the shaft [2100.1] from the containment shell [0224]. Loosen and remove the shaft removal tool.

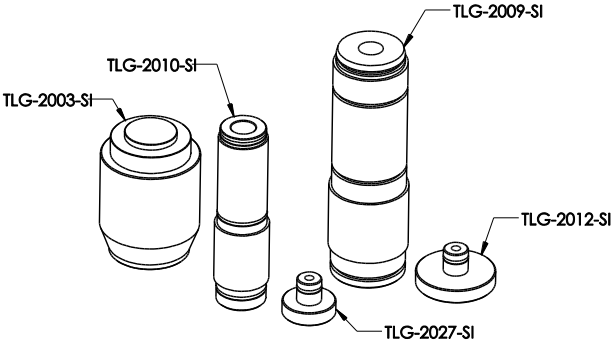
6.9.3 Shaft Installation

a) Align the molded key inside the containment shell [0224] with the grooved end of the pump shaft [2100.1].
b) Place the shaft centering tool over the shaft [2100.1]
c) 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.
d) Remove the shaft centering tool.
e) 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.

6.10 Impeller Repair

6.10.1 Bushing Removal

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



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.

a) 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.
b) With the arbor press, carefully push the bushings down with the removal tool until the first bushing [3300.2] and spacer [2460] dislodge.
c) 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].
d) Continue pressing down on the arbor press until the second bushing and thrust control valve dislodge.
e) When the second bushing and thrust control valve are free, remove the impeller [2200].
f) Remove the second bushing and thrust control valve from the bushing removal tool.

6.10.2 Bushing Installation

a) This procedure requires the Flowserve Innomag® TB-MAG™ bushing installation / removal kit, part # TLG-2016-AA.
b) 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.
c) Locate the molded key in the impeller [2200].

d) On the underside, the thrust control valve [6210] groove must line up with the molded key.
e) 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)
f) Line up the thrust control valve groove with the molded key.
g) Carefully insert the thrust control valve by hand until it stops, making sure that it is perfectly aligned.
h) Make sure the bushing installation tool is perfectly centered.
i) 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.

j) 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).
k) Make sure the bushings are held securely by the rubber o-rings on the bushing installation tool.
l) Align the bushings with the molded key.
m) Press the bushings in until they are firmly seated using an arbor press.

6.10.3 Back Rotating Wear Ring Installation

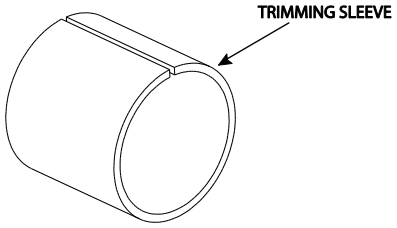
a) Place the back rotating wear ring [2300.2] on the impeller [2200] and align the notches.
b) Place the PVC trimming sleeve over the wear ring [2300.2].
c) Place an aluminum spacer block over the trimming sleeve and press the wear ring into place with the arbor press.
d) Insert the retaining pin into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

6.10.4 Front Rotating Wear Ring Installation

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

6.10.5 Impeller Trimming

a) CAUTION Place the trimming sleeve over the impeller [2200] to protect it from damage.
b) Measure the current diameter of the impeller [2200].



c) Insert the impeller into the lathe and tighten the jaws.
d) Set the trim 6 mm (1/4 in.) less than the current diameter. If you have never trimmed an impeller [2200] before, then we recommend only cutting 3 mm (1/8 in.) at a time.
e) Trim the first pass at a slow speed.
f) Use the hobby knife to clean off the loose plastic on the impeller in order to get an accurate measurement.
g) Check the diameter again with the caliper.
h) Set the lathe for 6 mm (1/4 in.) less than the current diameter measurement.
i) Trim this layer at a slow speed.
j) Clean off any loose plastic that would interfere with your diameter measurements.
k) Use the caliper to measure the current diameter.
l) Repeat the proceeding four steps until you reach the desired diameter.
m) Chamfer the right edge of the impeller.
n) Chamfer the same amount off the left edge.
o) Loosen the jaws and remove the Impeller.
p) Remove the trimming sleeve and trim any remaining loose plastic.

6.11 Wet End Assembly

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 6.11.2) 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.

6.11.1 Piped Up Assembly

a) Align and slide the impeller [2200] magnet assembly onto the pump shaft [2100.1] located inside the containment shell [0224].
b) Place the assembly into the containment ring [1240].
c) 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.
d) Tighten (8/12) hex cap screws w/lock washer.
e) Torque the hex caps screws [6570.1] to the specification in the Torque Table.
f) Extend the jackscrews on the drive end. Align the drive end and push it in until the jackscrews meet the wet end.
g) Retract the jackscrews until the two pump halves are mated. Insert and tighten the (4) adapter [1340] hex caps screws to the torque given in the torque table in Figure 6-1.

6.11.2 In-Shop Assembly

a) With the casing [1100] face down, insert the impeller [2200].
b) When the impeller is in place, rotate it by hand to make sure it spins freely.
c) Align the shaft [2100.1] in the containment shell [0224] with the bushings [3300].
d) Lower the containment shell [0224] into place.
e) Place the containment ring [1240] over the containment shell and align the bolt holes.
f) Make sure the arrow on the containment ring [1240] points toward the discharge flange.
g) Insert and hand-tighten the (8/12) casing bolts [6570.1] with lock washers.
h) Tighten the hex cap screws [6570.1] with a wrench and then torque them to the rating in Figure 6-1.

Figure 6-1

Screw Size ISO (ASME)	Torque Nm (lbf•ft)
M10 (3/8 in.)	27 (20)
M12 (1/2 in.)	61 (45)
M16 (5/8 in.)	122 (90)

6.12 Drive End Disassembly

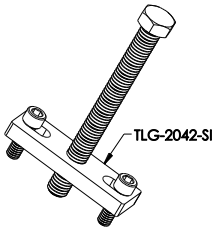
CAUTION The outer magnet assembly [7124] contains very strong magnets. Use caution inserting the jack screw. Under normal circumstances a visual inspection and wiping clean the inside of the outer magnet is sufficient.

6.12.1 NEMA Drive End Disassembly

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

6.12.2 IEC Drive End Disassembly

a) Remove the metal pipe plug [6569] from the top of the adapter [1340].
b) Locate and loosen the (2) set screws on the on the outer magnet assembly [7124] with T-handle allen wrench - 3/16 in. (A/V/E), 1/4 in. (B/C/W/F/G).



c) 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].
d) 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.
e) Carefully remove the outer magnet assembly [7124].
f) Remove (4) hex caps screws from the adapter [1340].
g) Remove the adapter [1340] from the motor.

6.13 Drive End Assembly

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

6.13.1 NEMA Drive End Assembly

a) Line up the adapter [1340] holes with the threaded holes on the motor. (NEMA motors 324 frame and larger require an adapter plate.)
b) Insert (4) hex caps screws with lock washers and tighten until no gap is present between the adapter [1340] and the motor mounting face.
c) 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.
d) 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.
e) Use a ruler or straight edge, visually align the groove on the outer magnet assembly [7124] with the outer edge of the adaptor [1340].
f) 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.
g) Grab the opposite side of the outer magnet assembly and rotate it 180°. Visually inspect concentricity of outer magnet assembly with adapter [1340].
h) Tighten the visible set screw (A) first, then rotate the outer magnet assembly 90° counterclockwise to locate and tighten the second set screw (B).

6.13.2 IEC Drive End Assembly

a) 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.
b) IEC 80 & IEC 90 do not require dowel pins.
c) IEC 100L and 112M require (6) dowel pins installed on the inner ring of unpainted dowel pin holes.
d) IEC 132S/M requires (6) dowel pins installed on the outer ring of unpainted dowel pin holes.
e) 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.
f) 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].
g) IEC 160 & IEC 180 requires the installation of adapter plate ADP-1125-SI. IEC 200 requires the installation of adapter plate ADP-1135-SI.
h) Insert and tighten the (4) hex caps screws to the adapter plate.
i) Once properly configured, align the bolt holes on the motor with the threaded holes on the adapter [1340].
j) Insert and tighten the (4) Hex Cap Screws with lock washers.
k) 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.
l) 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.
m) The outer magnet assembly has a groove around the magnet end for easy alignment. Locate this alignment groove on the Outer magnet assembly.
n) 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].
o) Remove metal plug from the top of the adapter [1340].
p) Look inside the outer magnet assembly [7124] and rotate it until the motor key points downward.

q) Set screw (A) should now be visible through the hole on top of the adapter [1340]. Tighten set screw (A) with the T-handle allen wrench.
r) Rotate the outer magnet assembly [7124] until the motor key points to the right.
s) Set screw (B) should now be visible through the hole on top of the adapter. Tighten set screw (B) with the T-handle allen wrench.
t) Replace the metal plug on the adapter and drive end assembly is complete.

6.14 Bearing Frame Assembly

a) 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.
b) Replace and lubricate the outer o-ring on the mechanical seal [4200]. Be careful to keep the seal faces clean and dry.
c) 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
d) Align the four mounting holes on the adapter [1340] with the four mounting holes on the seal [4200].

Note: The spacers must remain in place until the seal [4200] has been bolted into the assembly.

e) 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.
f) Clean and Inspect the mating surfaces
g) Lower the bearing frame [3200] onto the adapter [1340].
h) Tighten the hex cap screws [6570.7] with lock washers [3541.7]. Torque to 61 Nm (45 lbf•ft.).

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

i) Place the shaft extension tool (Part # TLG-2030-SI) over the shaft [2100.2].
j) Tighten the shaft extender to the shaft with the lower set screw with an allen wrench.
k) Insert the top of the dial test indicator into the upper hole on the shaft extender and tighten the screw.
l) 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.
m) If concentricity of 0.05 mm (0.002 in.) or less cannot be achieved, the damaged components should be replaced.
n) 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 0.05mm (0.002in.).

6.14.1 Seal Chamber Pressure Test Procedure

CAUTION The pump must be stopped during this test.

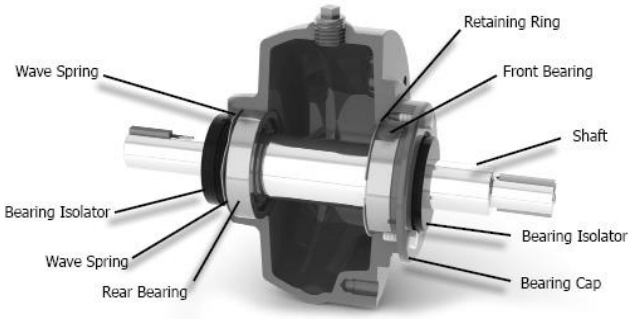
a) You will need an air accumulator with a pressure gauge for this test. The total volume of the accumulator tank should be 28 litres (1 cubic foot, 7.5 gallon). A larger or smaller accumulator can be used, but the pressure drop must be adjusted. See the following chart:

Accumulator Volume			**Allowable Pressure Drop in 5 minutes**	
litres	ft^3	US gallons	bar	psig
7.6	0.27	2	0.55	8
18.9	0.67	5	0.21	3
28.4	**1.0**	**7.5**	**0.14**	**2**
37.9	1.34	10	0.10	1.5
45.4	1.60	12	0.09	1.25
53.0	1.87	14	0.08	1.1
56.8	2.0	15	0.07	1
75.7	2.67	20	0.05	0.75

b) Plug one adapter drain connection [6569.3] so that the seal chamber is isolated. Use PTFE pipe thread tape to ensure a proper seal.
c) Connect the accumulator hose to the barbed hose adapter pipe fitting.
d) Tighten the accumulator hose clamp.
e) Pressurize the accumulator and seal cavity to 1.7 bar (25 psig).
f) Check all fittings and connections for leakage (soap solution type test). Bubbles indicate leaks.
g) 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 1.7 bar (25 psig).

h) Measure pressure decay. Pressure drop should be less than that indicated in the table in step (a).
i) Vent pressure from cavity upon completion of the test and reconnect any leak sensors or drain lines to the adapter [1340].

6.15 Bearing Frame Disassembly



CAUTION If the bearing frame [3200] will not be opened, the unit must remain horizontal to prevent oil leakage through the bearing isolators.

CAUTION 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.

a) 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.
b) Remove the coupling guard if it is installed.
c) Remove the coupling and turn the motor aside to allow room to pull back the bearing frame.
d) Remove the (2) hex caps screws holding the bearing frame feet to the baseplate.
e) Remove the (4) hex caps screws on the adapter [1340].
f) Separate bearing frame [3200] and adapter [1340] from pump end. Use jackscrews in the (2) jackscrew holes.
g) Pull the bearing frame assembly straight back from the adapter.
h) Remove the (3) hex caps screws [6570.3, 6570.4] to separate the foot from the adapter.
i) Secure the adapter [1340] to the work surface with a C clamp.

Note: The adapter o-ring should be replaced before re-assembling onto the pump.

j) Remove the outer magnet hex bolt [6570.5]. If the outer magnet does not pull free, you will need to use our outer magnet removal kit.
k) Attach the outer drive [7124] puller bracket with (2) 3/8in.-16 socket head cap screws.
l) Insert the jackbolt into the tapped center hole and tighten until the outer magnet [7124] loosens.
m) Pull the outer magnet assembly [7124] out of the adapter [1340] and set aside.
n) Install the (4) 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.
o) Once spacers are in place, remove the 4 screws securing the mechanical seal [4200] to the adapter [1340].
p) Remove the (3) hex caps screws [6570.7] securing the adapter to the bearing frame.
q) Slide the bearing frame off of the adapter with the seal still attached to the shaft.
r) Loosen the (4) mounting setscrews holding the seal onto the shaft and gently slide the mechanical seal off of the shaft.

Note: Replace the inner and outer o-rings on the mechanical seal before re-assembly.

s) If the bearing frame [3200] will not be opened, set it aside.
t) Remove the (3) hex caps screws [6570.6] from the bearing cap [3260] and pry the bearing cap loose with a small flat head screw driver.
u) If the bearing isolator [4305] needs to be replaced, the unit can be pressed out by hand.
v) 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.
w) 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.
x) If the rear bearing isolator [4305] needs to be replaced, the unit can be pulled out by hand.
y) 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.

6.16 Drive / Wet End Assembly

6.16.1 Close Coupled and Vertical Assembly

a) Position the pump in place and secure it to the baseplate and piping (piped-up assembly) or to the bench (in-shop assembly).
b) Insert (2) jackbolts into adapter and fully extend
c) Align the motor with the pump and slide forward until jackbolts make contact with the pump containment ring [1240].
d) Carefully retract the (2) jackbolts evenly and slide the motor toward the pump until the adapter [1340] mates with the containment ring [1240].
e) Remove the (2) jackbolts completely.
f) Insert and tighten the (4) adapter bolts.
g) Insert and tighten the adapter foot [3134] bolt and any bolts connecting the motor to the baseplate.
h) Check for free rotation of the pump by manually rotating the motor fan.

6.16.2 Long-Coupled Assembly

CAUTION All bearing frames [3200] are shipped without oil. See the following table for the recommended oil:

Mineral Oil	Synthetic Oil
Quality mineral oil with rust and oxidation inhibitors. Mobil DTE Heavy / Medium ISO VG 68 or equivalent.	Royal Purple, Conoco Syncon 68 or equivalent

Note: It normally takes 2 hours for bearing temperature to stabilize and the final temperature will depend on the ambient, rpm, pumpage temperature and pump size.

The recommended oil lubricant has 68 cSt viscosity at 40 °C (104 °F) with temperature range from -5 to 80 °C (23 to 176 °F). Multiple manufacturers make this type of oil with designation ISO VG 68 according to ISO 3448 and DIN51524 part 2.

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

a) Position the pump in place and secure it to the baseplate and piping (piped-up assembly) or to the bench (in-shop assembly).
b) Insert (2) jackbolts into adapter and fully extend
c) Align the bearing frame with the pump and slide forward until jackbolts make contact with the pump containment ring [1240].
d) Carefully retract the (2) jackbolts evenly and slide the motor toward the pump until the adapter [1340] mates with the containment ring [1240].
e) Remove the (2) jackbolts completely.
f) Insert and tighten the (4) adapter bolts.
g) Insert and tighten support foot [3134] bolts into baseplate.
h) Align the motor and coupling per the manufacturers specifications and secure the pump and motor to the base plate.
i) Install a coupling guard over the exposed shafts and coupling.
j) 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.

k) Do not overfill. The oil level should be checked when the pump is stopped.

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

l) Tighten the mechanical seal's (4) set screws to the shaft with a 1/8 in. allen wrench.
m) Remove the (4) socket head cap screws from the spacers / installation clips with a 9/64 in. allen wrench.
n) Remove the (4) hex caps screws from the spacers / installation clips and remove the spacers from the seal with 5/16 in. wrench.

Notes:

7 TROUBLESHOOTING

7.1 Faults, causes and remedies

The following is a guide to troubleshooting problems with Flowserve Innomag TB-MAG pumps. Common problems are analyzed and solutions offered. Obviously, it is impossible to cover every possible scenario. If a problem exists that is not covered by one of the examples, refer to one of the books listed in Section 10, 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 developed				
				⇓	Insufficient capacity delivered			
					⇓	Pump does not deliver liquid		
						⇓	**POSSIBLE CAUSES**	**POSSIBLE 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.	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 overheated.
				●	●	●	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 $NPSH_A > NPSH_R$, proper submergence, losses at strainers and fittings.
●	●				●	●	Insufficient margin between suction pressure and vapor pressure.	
	●		●	●	●		Excessive amount of air or gas in liquid.	Check and purge pipes and system.

FAULT SYMPTOM

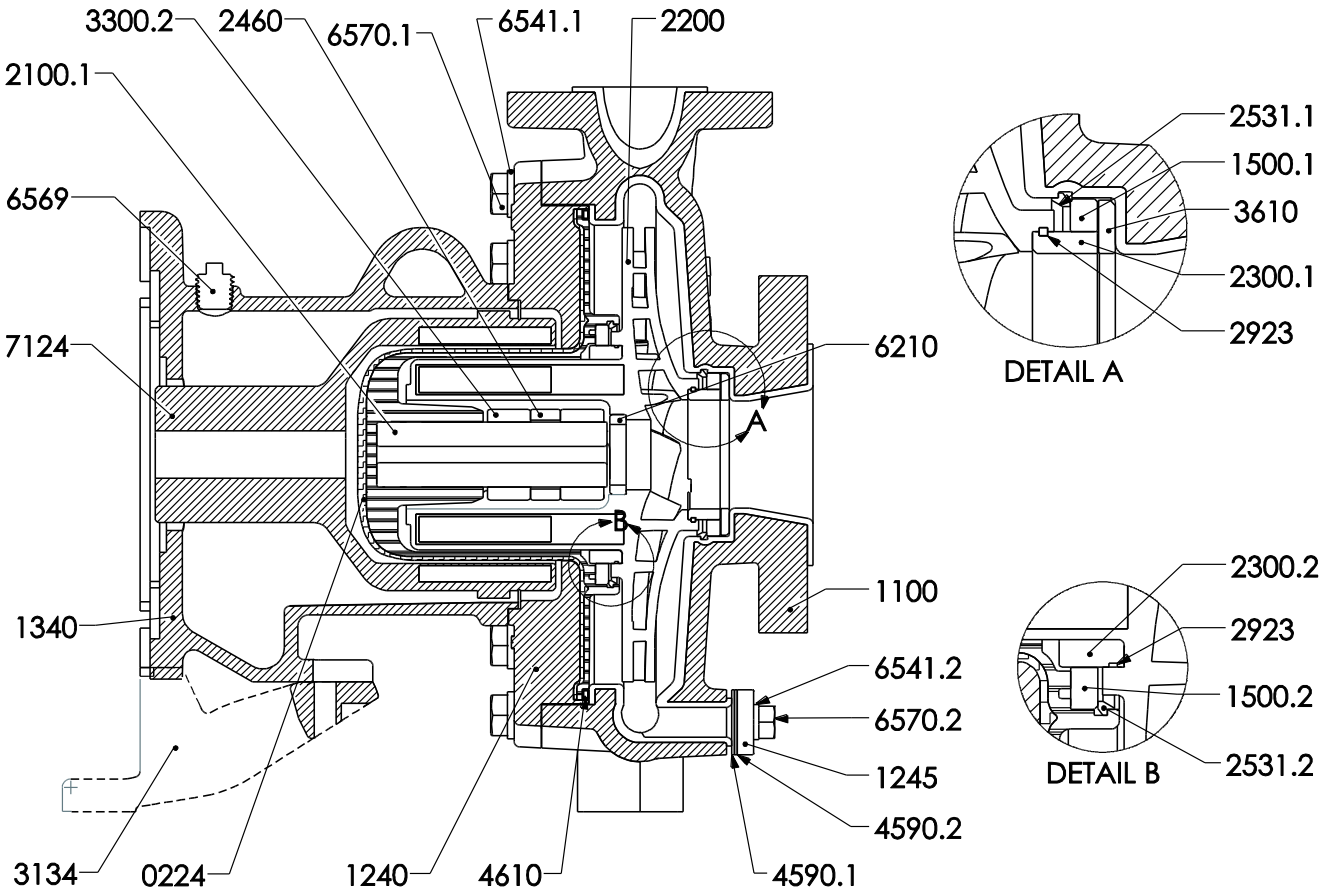
Pump overheats and seizes								
⇓	Pump vibrates or is noisy							
	⇓	Pump requires excessive power						
		⇓	Pump loses prime after starting					
			⇓	Insufficient pressure developed				
				⇓	Insufficient capacity delivered			
					⇓	Pump does not deliver liquid		
						⇓	**POSSIBLE CAUSES**	**POSSIBLE REMEDIES**
			●		●	●	Air or vapor pocket in suction line.	Check suction line design for vapor pockets.
			●		●		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.

FAULT SYMPTOM

Pump overheats and seizes	Pump vibrates or is noisy	Pump requires excessive power	Pump loses prime after starting	Insufficient pressure developed	Insufficient capacity delivered	Pump does not deliver liquid	POSSIBLE CAUSES	POSSIBLE 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.

8 PARTS LISTS AND DRAWINGS

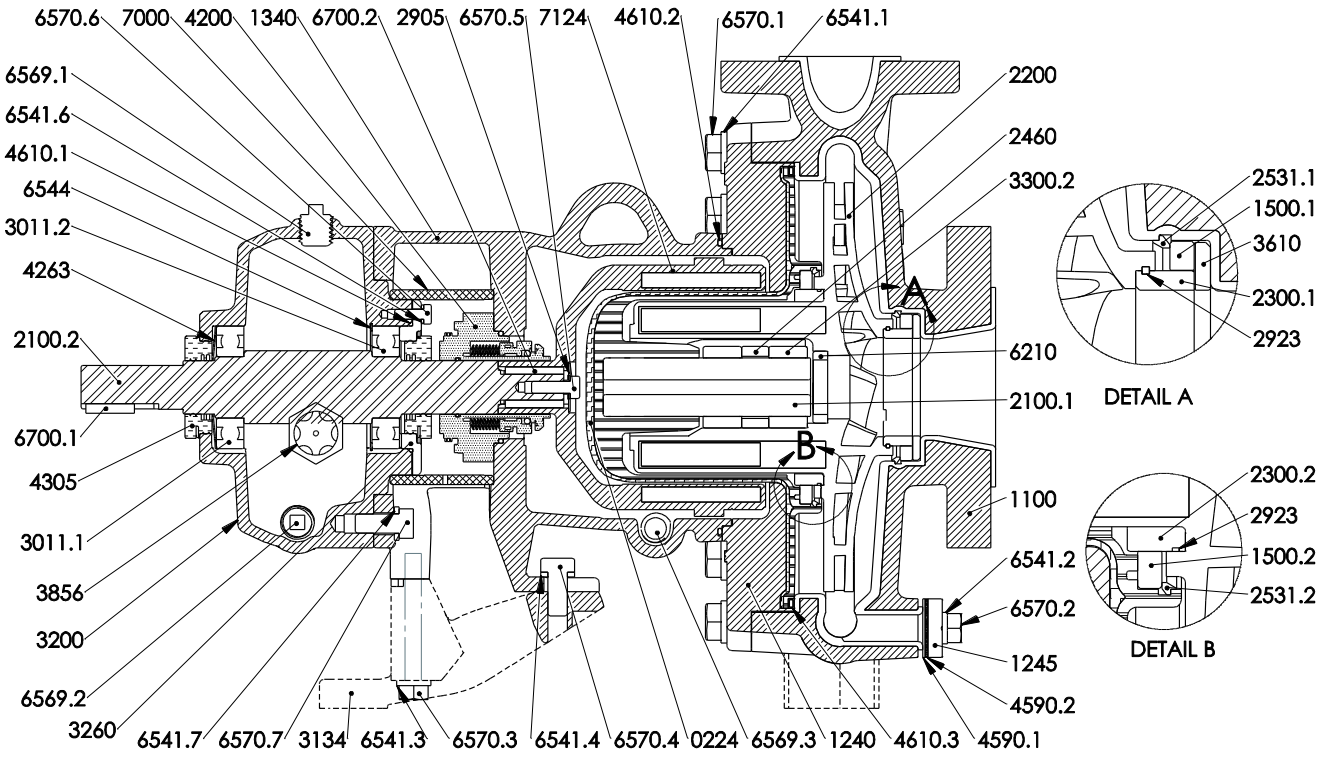
8.1 Sectional drawing



FIN	Description	HI Reference		FIN	Description	HI Reference
0224	Containment Shell	231		2923	Pin	9C
1100	Casing	1		3134	Support Foot	20
1240	Clamping Ring	239		3300.2	Bushing, Bearing	235
1245	Flange	370		3610	Thrust Collar	72
1340	Adapter	19		4590.1	Gasket, PTFE	371
1500.1	Casing Wear Ring	7		4590.2	Gasket, Neoprene	372
1500.2	Casing Wear Ring	27		4610	O-Ring	73
2100.1	Shaft	6		6210	Balance Disc	14
2200	Impeller	2		6541.1	Lock Washer	301
2300.1	Impeller Wear Ring	8A		6541.2	Lock Washer	301
2300.2	Impeller Wear Ring	8B		6569	Plug	302
2460	Spacer Sleeve	236		6570.1	Screw	300
2531.1	Split Retaining Ring	9A		6570.2	Screw	300
2531.2	Split Retaining Ring	9B		7124	Outer Magnet Rotor	232

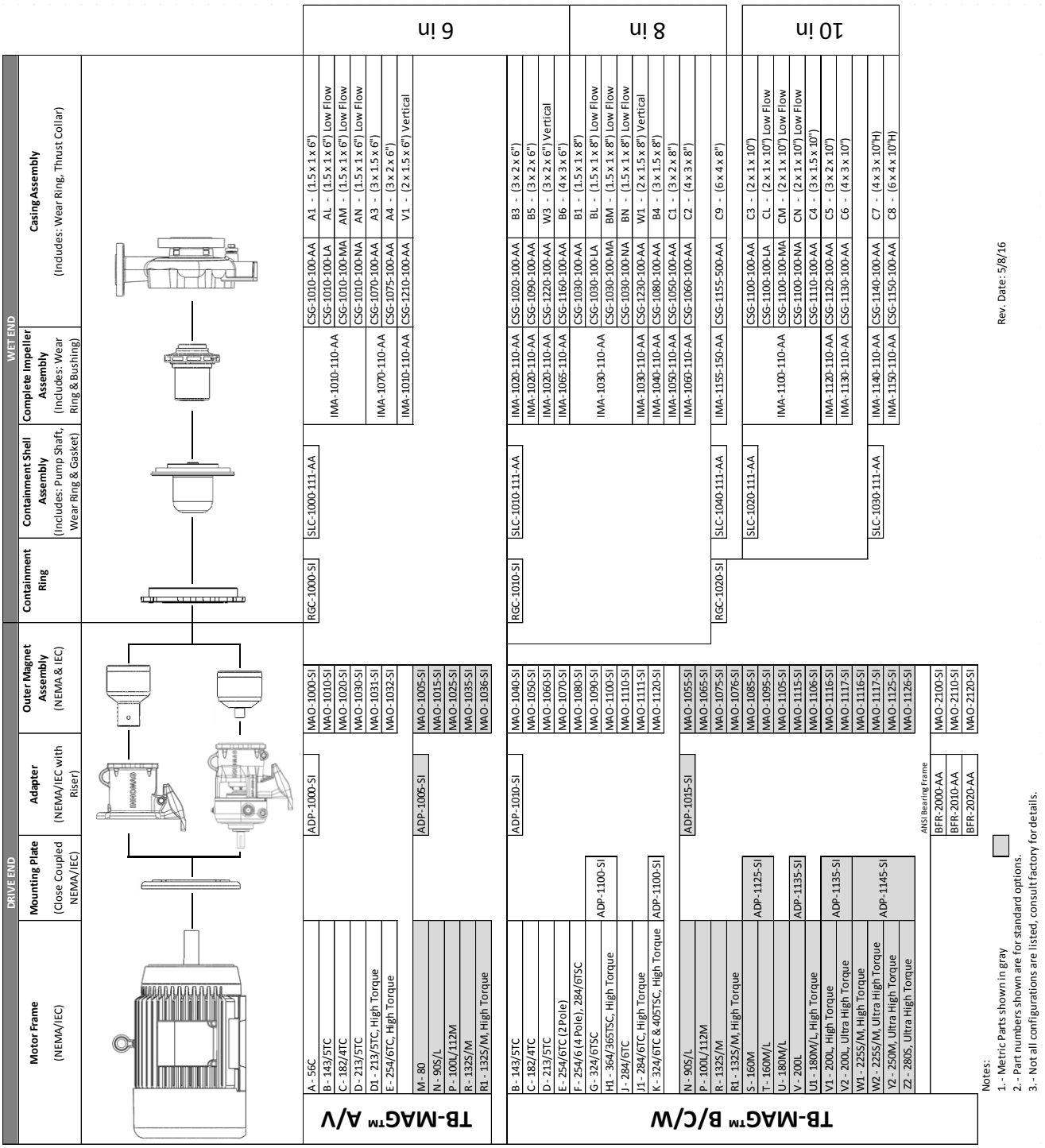
Note: Vertical models have different casing configuration but are otherwise identical.

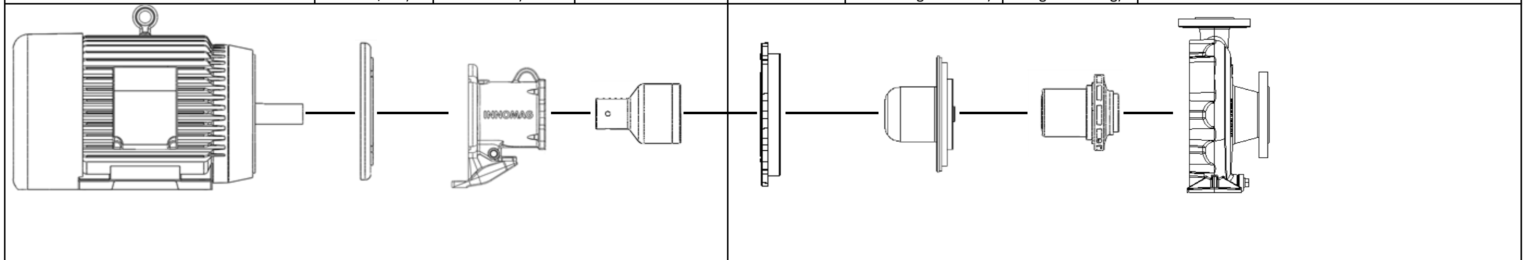
8.2 Long Couple Sectional Drawing (optional secondary containment seal shown)



FIN	Description	HI Reference		FIN	Description	HI Reference
0224	Containment Shell	231		4590.1	Gasket, PTFE	371
1100	Casing	1		4590.2	Gasket, Neoprene	372
1240	Clamping Ring	239		4610.1	O-Ring	
1245	Flange	370		4610.2	O-Ring (Sealed Units Only)	
1340	Adaptor	71		4610.3	O-Ring	73
1500.1	Casing Wear Ring	7		6210	Balance Disc	14
1500.2	Casing Wear Ring	27		6541.1	Lock Washer	301
2100.1	Shaft	6		6541.2	Lock Washer	301
2100.2	Shaft	12		6541.3	Lock Washer	
2200	Impeller	2		6541.4	Lock Washer	
2300.1	Impeller Wear Ring	8A		6541.5	Lock Washer	
2300.2	Impeller Wear Ring	8B		6541.6	Lock Washer	
2460	Spacer Sleeve	236		6541.7	Lock Washer	
2531.1	Split Retaining Ring	9A		6544	Circlip	
2531.2	Split Retaining Ring	9B		6569.1	Plug	
2905	Washer			6569.2	Plug	
2923	Pin	9C		6569.3	Plug	
3011.1	Radial Ball Bearing	18		6570.1	Screw	300
3011.2	Radial Ball Bearing	16		6570.2	Screw	300
3134	Support Foot	20		6570.3	Screw	
3200	Bearing Housing	19		6570.4	Screw	
3260	Bearing Cover			6570.5	Screw	
3300.2	Bushing, Bearing	235		6570.6	Screw	
3610	Thrust Collar	72		6570.7	Screw	
3856	Oil Sight Gauge			6700.1	Key	46
4200	Mechanical Seal (Optional)	89		6700.2	Key	
4263	Spring Plate			7000	Guard Assembly	
4305	Shaft Seal Ring	47		7124	Outer Magnet Rotor	232

8.3 Parts Interchangeability Chart





Series	Motor Frame (NEMA/IEC)	Mounting Plate (Close Coupled NEMA/IEC)	Adapter (NEMA/IEC with Riser)	Outer Magnet Assembly (NEMA & IEC)	Containment Ring	Containment Shell Assembly (Includes: Pump Shaft, Wear Ring & Gasket)	Complete Impeller Assembly (Includes: Wear Ring & Bushing)	Casing Assembly (Includes: Wear Ring, Thrust Collar)	Casing Code	Size
DRIVE END					WET END					
TB-MAG™ E	A - 56C		ADP-1000-SI	MAO-1000-SI	RGC-1005-SI	SLC-1000-111-AA	IMA-1400-110-AA	CSG-1400-120-AA	E0 - (TB050-032-125B)	
	B - 143/5TC		ADP-1400-SI(E0)	MAO-1010-SI						
	C - 182/4TC			MAO-1020-SI						
	D - 213/5TC			MAO-1030-SI			IMA-1010-110-AA	CSG-1015-120-AA	E1 - (TB050-032-160A)	160mm
	D1 - 213/5TC, High Torque			MAO-1031-SI				CSG-1015-120-LA	EL - (TB050-032-160A) Low Flow	
	E - 254/6TC, High Torque			MAO-1032-SI				CSG-1015-120-MA	EM - (TB050-032-160A) Low Flow	
								CSG-1015-120-NA	EN - (TB050-032-160A) Low Flow	
	M - 80		ADP-1005-SI	MAO-1005-SI				CSG-1515-120-AA	E2 - (TB050-032-160B)	
	N - 90S/L		ADP-1405-SI(E0)	MAO-1015-SI			IMA-1070-110-AA	CSG-107A-120-AA	E3 - (TB065-050-160A)	
	P - 100L/112M			MAO-1025-SI				CSG-1570-120-AA	E4 - (TB065-050-160B)	
	R - 132S/M			MAO-1035-SI						
	R1 - 132S/M, High Torque			MAO-1036-SI						
TB-MAG™ F/G	B - 143/5TC		ADP-1010-SI	MAO-1040-SI	RGC-1015-SI	SLC-1010-111-AA	IMA-1020-110-AA	CSG-1590-120-AA	F5 - (TB080-050-160B)	
	C - 182/4TC			MAO-1050-SI			IMA-1030-110-AA	CSG-1035-120-AA	F1 - (TB050-032-200A)	200mm
	D - 213/5TC			MAO-1060-SI				CSG-1035-120-LA	FL - (TB050-032-200A) Low Flow	
	E - 254/6TC (2 Pole)			MAO-1070-SI				CSG-1035-120-MA	FM - (TB050-032-200A) Low Flow	
	F - 254/6 (4 Pole), 284/6TSC			MAO-1080-SI				CSG-1035-120-NA	FN - (TB050-032-200A) Low Flow	
	G - 324/6TSC	ADP-1100-SI		MAO-1090-SI			IMA-1530-110-AA	CSG-1535-120-AA	F2 - (TB050-032-200B)	
	H1 - 364/365TSC, High Torque			MAO-1100-SI			IMA-1540-110-AA	CSG-1585-120-AA	F3 - (TB065-040-200B)	
	J - 284/6TC			MAO-1110-SI			IMA-1040-110-AA	CSG-1085-120-AA	F4 - (TB065-040-200A)	
	J1 - 284/6TC, High Torque			MAO-1111-SI			IMA-1050-110-AA	CSG-1550-120-AA	G1 - (TB080-050-200B)	
	K - 324/6TC & 405TSC, High Torque	ADP-1100-SI		MAO-1120-SI			IMA-1060-110-AA	CSG-1565-100-AA	G2 - (TB100-065-200B)	
							IMA-1670-150-AA	CSG-1670-520-AA	G9 - (TB125-080-200B)	
	N - 90S/L		ADP-1015-SI	MAO-1055-SI						
	P - 100L/112M			MAO-1065-SI	RGC-1025-SI	SLC-1020-111-AA	IMA-1600-110-AA	CSG-1600-120-AA	G3 - (TB050-032-250B)	250mm
	R - 132S/M			MAO-1075-SI	RGC-1035-SI	SLC-1040-111-AA*	IMA-1605-110-AA	CSG-1605-120-AA	G4 - (TB065-040-250B)	
	R1 - 132S/M, High Torque			MAO-1076-SI				CSG-1610-120-AA	G5 - (TB080-050-250B)	
	S - 160M	ADP-1125-SI		MAO-1085-SI			IMA-1630-110-AA	CSG-1630-120-AA	G6 - (TB100-065-250B)	
	T - 160M/L			MAO-1095-SI						
	U - 180M/L			MAO-1105-SI	RGC-1025-SI	SLC-1030-111-AA	IMA-1140-110-AA	CSG-1640-120-AA	G7 - (TB125-100-250B)	
	V - 200L	ADP-1135-SI		MAO-1115-SI	RGC-1035-SI	SLC-1050-111-AA*	IMA-1650-110-AA	CSG-1650-120-AA	G8 - (TB150-125-250B)	
	U1 - 180M/L, High Torque			MAO-1106-SI						
	V1 - 200L, High Torque	ADP-1135-SI		MAO-1116-SI						
	V2 - 200L, Ultra High Torque			MAO-1117-SI						
	W1 - 225S/M, High Torque	ADP-1145-SI		MAO-1116-SI						
	W2 - 225S/M, Ultra High Torque			MAO-1117-SI						
	Y2 - 250M, Ultra High Torque			MAO-1125-SI						
	Z2 - 280S, Ultra High Torque			MAO-1126-SI						

* For ultra high torque options

Notes:
1. - Metric Pump/Parts shown in gray
2. - Part numbers shown are for standard options.
3. - Not all configurations are listed, consult factory for details.

Rev. Date: 5/8/2016

8.4 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 should be obtained from the Purchaser and retained with these User Instructions.

9 CERTIFICATION

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

10 OTHER RELEVANT DOCUMENTATION AND MANUALS

10.1 Supplementary User Instruction manuals

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

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

10.2 Change notes

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

10.3 Additional sources of information

Reference 1:
NPSH for 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.

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