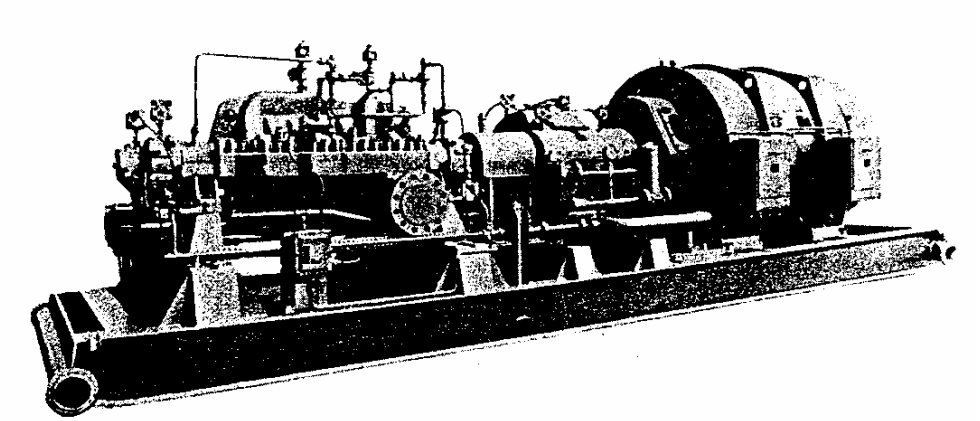
Marelli Bombas

Centrifugal Pump Type: DVMX



API PROCESS PUMP

USER INSTRUCTION MANUAL:

INSTALLATION, ASSEMBLY, MAINTENANCE

Doc. Rev. 31/01/2006

CONTENTS:

1 INTRODUCTION AND SAFETY

1.1 General

Marelli Bombas has a large experience in the development, design, and manufacturing of process pumps, for medium duty services of a high responsibility.
A clear indication of the quality and reliability of our pumps is the large list of references and the wide range of services in which they are working satisfactorily.

The manufacturing criteria are carefully chosen to guarantee the highest quality level, its design and construction are the result of an exhaustive analysis of market requirements. They are tailor made according to the particular specifications of every customer, being always respectful with the applicable environmental standard.

⚠ ***These instructions must always be kept close to the product.***

These instructions are intended to facilitate familiarization with the product and its permitted use. The product must operate in compliance with these instructions to 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. Repair activity must be always coordinated by operations personnel, and follow all plant safety requirements and applicable safety and health laws.

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

1.2 Disclaimer and Copyright

Marelli Bombas manufactures products to exacting International Quality Management System Standards. Genuine parts and accessories have been designed, tested and incorporated into the products to ensure their continued product quality and performance in use. The use of parts and accessories sourced from other vendors may affect the performance and safety features of the products. The failure to properly select, install or use authorized parts and accessories is considered to be misuse. Damage or failure caused by misuse is not covered by warranty. In addition, any modification of the products or removal of original components may impair the safety of these products in their use.

1.3 Marking and Directive's Conformity

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 and, where applicable, conform to Equipment for Potentially Explosive Atmospheres (ATEX).

Where applicable this document incorporates information relevant to these Directives. To establish approvals and if the product itself is CE marked, check the serial number plate and the Certification. (Refer to Section 3.3)

1.4 Duty Conditions

This product has been selected to meet the specifications indicated in pump data sheet. A copy should be kept with these instructions.

⚠ ***The product must operated only according to the parameters indicated in pump data sheet.***

The conditions of service stated on pump data sheet (for example liquid pumped, temperature or duty) can not be changed without contact Marelli Bombas (Refer also to Section 3.3).

1.5 Safety and Health

1.5.1 Summary of safety markings

The specific safety markings used in these User Instruction Manual are listed below. The non-observance of an instruction related to the markings would cause hazards.

⚠ DANGER This symbol indicates electrical safety instructions where non-compliance would affect personal safety.

⚠ This symbol indicates safety instructions where non-compliance would affect personal safety.

⚠ This symbol indicates safety instructions "for toxic and dangerous liquids", where non-compliance would affect protection of a safe life environment.

⚠ CAUTION This symbol indicates safety instructions where non-compliance would affect the

safe operation or protection of the pump or pump unit.

This symbol indicates ATEX directive application. It is used in User Instruction Manual where non-compliance in the hazardous area would cause the risk of an explosion.

Note: This sign indicates an important instruction that must be follow.

1.5.2 Safety Instructions

All personnel involved in the installation, assembly , operation and maintenance of the unit must be qualified and correctly trained .
To operate preventing the injury to personnel and the damage to the environment and equipment these following instructions must be applied. For products used in potentially explosive atmospheres refer to Section 1.5.3)

CAUTION Prevent uncontrolled external pipe load. It is recommended that all the piping connected to the equipment be supported independently of the pump.

CAUTION Never run the pump dry

CAUTION Vent the pump. If the pump is not self venting type it is recommended to vent fully the pump casing before the start up in order to avoid pump and equipment damage. The appropriate safety precautions should be taken where the pumped liquids are hazardous.

CAUTION Ensure correct lubrication

CAUTION Start the pump with discharge valve not closed. It is recommended to install protection devices to avoid the risk of equipment overloading and damaging. (Refer to Section 5)

CAUTION The pump must operate with fully open inlet valve. Running the pump below the recommended minimum continuous stable flow will cause damage to the pump and seal.

DANGER Never do maintenance when the unit is connected to power.

Hazardous liquids. Pumping hazardous liquids care must be taken to avoid exposure to the liquid. Appropriate installation of the pump and special operators training must be considered. Also if the liquid is flammable and/or explosive, strict safety procedures must be applied. In any case gland packing must not be used with hazardous liquids.

Drain the pump and isolate pipes before dismantling the pump. The appropriate safety precautions should be taken where the pumped liquids are hazardous.

Handling components. Wearing of appropriate safety equipment is required when handling components with sharp corners. To lift heavy pieces above 20 kg (44 lb) use appropriate tools in accordance with current local regulations.

Guards must not be removed while the pump is running or connected to the power.

Hot and cold parts. When components or auxiliary heating supplies surface temperatures can be a danger to personnel entering the immediate equipment area action must be taken to avoid accidental contact. When complete protection is not possible, the equipment access must be limited to maintenance staff only, with clear visual warnings.

Note: Bearing housings must not be insulated so they can be hot.

1.5.3 ATEX Compliance for Products Used in Potentially Explosive Atmospheres

If the installation requires to be in compliance with European Directive 94/9/EC, the following instructions for pumps and pump units must be followed. Both electrical and non-electrical equipment must meet the requirements of European Directive 94/9/EC.

The Ex rating applies only to scope of supply. The party responsible for assembling the accessories and all the parts not in scope of supply shall select 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.

Use equipment only in the zone for which it is appropriate and only if it is certified for the classification of the specific atmosphere in which it must to be installed.

Measures are required to:

- Avoid excess temperature
- Prevent sparks
- Prevent leakage
- Prevent the built up of explosive mixtures
- Maintain the pump to avoid hazard

1.5.3.1 ATEX Marking

The equipment in scope of supply is marked on the main part in a visible place or directly on the nameplate.
An example of ATEX marking is shown below.

Ex II 3 GD c 450 °C (T1)

where:
II = Equipment Group (I or II)
3 = Category (M1/M2 or 1,2,3)
GD = Gas or Dust presence
c = Constructional safety acc. to EN13463-5
T1 = Temperature Class (T1,T2,T3….)
450 °C = Max Surface Temperature

1.5.3.2 Excessive Surface Temperatures

Ex <u>Check if the equipment temperature class is suitable for the hazard zone required.</u>

The equipment temperature class is engraved on the nameplate. Ensure that ambient temperature doesn't exceed –20 °C to 40 °C (-4 °F to 104 °F) according to ATEX directive.

The surface temperature on the pump during normal operating conditions is influenced by the temperature of the liquid handled. Since the pumps are designed for operating temperatures up to 400 °C (752 °F) the equipment temperature class engraved on nameplate is the lowest (staring from T1 as lower) between the liquid handled (according to Table 1.1) and the permissible temperature class of all the auxiliaries in scope of supply.

Temperature Class	Maximum Surface Temperature
T1	450 °C (842 °F)
T2	300 °C (572 °F)
T3	200 °C (392 °F)
T4	135 °C (275 °F)
T5	100 °C (212 °F)
T6	85 °C (185 °F)

Table 1.1 – Maximum Surface Temperature according to EN13463-1 -

The maximum surface temperature of the equipment must include the safety margin to the minimum ignition temperature of the potentially explosive atmosphere. For pumps and pump units it is taken into account the temperature rise at the seals and bearings due to the minimum permitted flow rate. As a result of the analysis the temperature limit of liquid handled is 50 °C (122 °F) lower than T1 class limit (stated on table 1.1) for T1 only and 25 °C (77 °F) lower than T class limit (stated on table 1.1) for the other temperature classes.

In any case the responsibility for compliance with the specified maximum liquid temperature is with the plant operator.

Motor, mechanical seal and all the auxiliaries must be appropriate for the installation zone and Temperature class required.

The oil quality and level must be checked periodically according to maintenance schedule. In case of high liquid temperature it's suggested to use the proper bearing housing cooling device in order to keep the bearings at the optimum operating temperature.

The equipment material must be properly selected according to the liquid handled and to the duty conditions stated on data sheet (see also maintenance routines on Section 6.4).

Never check the direction of rotation by starting the pump unfilled this can cause a high temperature resulting from contact between rotating and stationary components.

Never run the pump against a closed discharge valve. This can cause high surface temperatures. If this can occur it is recommended that user fits an external surface temperature protection device.

Provide cleaning routines to avoid the presence of dangerous dust layers around hot parts.

1.5.3.3 Prevent Sparks

Ex <u>Provide an adequate earth contact for the equipment in order to avoid sparks generated form induced current.</u>

When a complete equipment (pump and motor on a common baseplate) is supplied use the proper earth connection provided.
If only the bareshaft pump is in the scope of supply it is user responsibility to provide a proper earth contact.

The coupling guard must be non-sparking.

Use a coupling in compliance with 94/9/EC and provide maintenance routine to check the correct alignment.

1.5.3.4 Prevent Leakage

Ex If the liquid handled is dangerous and a leakage could cause a hazard it is recommended the installation of a liquid detection device.

Where a loss of a seal barrier fluid or external flush can be a potential hazard it must be provided a flow control monitoring device.

Ensure that the used construction materials have the correct corrosion resistance required by the liquid handled.

1.5.3.5 Prevent the Build Up of Explosive Mixtures

Ex Before starting ensure the pump is properly filled and vented. Avoid dry run.

Ensure the pump, suction and discharge pipeline system is totally filled with liquid at all times during the pump operation.
Ensure that seal chamber, auxiliary shaft seal systems and any heating and cooling systems are properly filled. In case of risk provide a dry run protection device.

1.5.3.6 Maintain the pump to avoid the hazard

Ex The responsibility for compliance with maintenance instructions is with the plant operator. The correct maintenance is required to avoid potential hazards.

During maintenance operation the risk of spark generation must be reduced, if not possible the maintenance must be conducted in a safe area.

It is recommended to adopt a maintenance plan and schedule.

1.6 Label Description

Each machine is equipped with a label on which you find all the data requested by the Machine Directive CE 89/392 and other relevant applicable directives which facilitate the identification of the machine.
For an eventual spare part order please cite the machine number of the pump.

1.7 Noise Level

Pump noise level depend to the motor type, pump condition of service (flow and head …), and also to plant layout.

In case pump noise level exceeds 85 dBA attention must be given to limit the exposure of plant operating personnel to the noise. One solution is to control exposure time to the noise or to enclose the machine to reduce emitted sound.

For the equipment noise level see relevant documents stored with the data sheet in the job technical book.

2 TRANSPORT AND STORAGE

2.1 Unpacking

At the arrival of the machine has to be carried out an accurate inspection to make sure that during transport did not occur any damage. If this should be the case, please contact Marelli Bombas and cite the equipment serial number.
Sometimes for safety reasons components and accessories are separately packed inside the main packing.
After the removal of the pump please accurately check the contents of the packing.
Marelli Bombas is free from any obligation to reply on every request of compensation for damages advanced by the customer or third persons.

2.2 Handling

CAUTION The structure of the packing and the employed materials are chosen according to shape, dimensions and weight of the machine, which has to be shipped.
Packing may be unloaded taking care of size and weights (weights are recorded on the nameplates fixed to the components).
Select the proper lifting vehicles according to size and weights that have to be lifted. Always take care to avoid distortion during handling operations.

⚠ A crane must be used for all pump sets in excess of 20 kg (44 lb). Fully trained personnel must carry out lifting, in accordance with local regulations.

2.3 Storage

CAUTION Store the equipment in a clean, dry location away from vibration. Leave piping connection covers in place to keep dirt and other foreign material out of pump casing. Turn pump at intervals to prevent bearings and seal damage.

Normally the equipment is delivered for a short-term installation.

For more than 6 months storing period consult Marelli Bombas. In any case, before installation on the plant, the pump should be carefully cleaned by eliminating eventual foreign bodies which could compromise the correct functioning.

2.4 Dismissing

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

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 local regulations at all times.

3 GENERAL INFORMATION

3.1 Pump

Centrifugal pump, near centreline construction, horizontally split casing, double volute. Both suction and discharge are on side position.
Between Bearing pump multistage pumps equipped with double suction or single suction impellers. Perfect axial balancing due to the crossover and impellers installation. Oil lubricated bearing support. Designed in compliance with API 610.
DVMX are the most suitable pumps for clean fluids, with a slight content of solid particles in suspension, corrosive or hot liquids up to 400 °C (752 °F).
Most common applications are:
Oil Industry
Petrochemical/Chemical
Pharmaceutical Industry
Fertilisers
Cellulose and Paper Mills
Textile Industry
Marine and Navy
Power Stations
Steel Mills
General Industry Services

3.1.1 Nomenclature

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

DVMX 3x4x9

DVMX = pump type
8 = nominal discharge size (inches)
10 = nominal suction size (inches)
21 = nominal impeller diameter (inches)

3.2 Main Part Descriptions

3.2.1 Pump casing

Near centerline construction, double volute horizontally split casing for single or double suction impellers. Side-Side configuration according to API 610. The casing is vented and drained by vent and drain connections. The pump has two horizontal split cover plates and is equipped with two bearing housings supported by a pair of brackets extending from the casing bottom half. The arrangement require to dismantle the suction and discharge pipe to allow the impeller dismantling. The pump casing is fitted with case wear rings. Pressure plugs are located on suction and delivery nozzles. The pump casing is equipped with a balancing line for packings and mechanical seals.

3.2.2 Impeller

The impellers are single suction or a double suction both closed design equipped with wear rings. The opposed impellers design generate a perfect axial balance. The impellers are mounted as a sliding fit on the shaft retained by spacers and a lock nut. The impellers are fitted with interchangeable wear rings. They are carefully balanced after machining.

3.2.3 Shaft

The shaft is designed to be in compliance with API 610 maximum deflection. Keyed cylindrical drive end and rigidity permit to operate safely.

3.2.4 Stuffing Box

It is extra deep type design to allows standard assembly of conventional packing or mechanical seal (single or double type) supplied by the most important seal manufacturer.
The seal chamber can be cooled or heated by a cooling/heating chamber provided if required. A seal case ring fitted between the packing performs the function of flushing out and internal cooling of packings, if necessary, with flushing oil. The gland flange is designed to provide external water cooling of the packing and shaft sleeve.

3.2.5 Bearing Housings

This pump is a between bearing pump according to API definition. This means that there are two bearing housings located on each side of the impeller allowing the possibility of high suction pressure without extra loads on thrust bearings (shaft going through the pumps).
The bearing housings are designed with cooling water jackets. This cooling jacket located apart from the bearings, is designed to avoid any thermal differential elongation that could misfit the motor

alignment. Also the bearing housings are designed to collect the accidental leaks from the mechanical seals or from the packing which can be recovered through a threaded orifice.
Oil splash type lubrication by ring facilitates the oil circulation within each bearing and ensure the correct bearing life. Other bearing lubrication systems such as forced feed lubrication are available if required.

The bearing configuration is as follow:

- type 6300 ball bearing on coupling end
- type 7300 angular contact ball bearing type to absorb the residual axial pump thrust.

The bearing on all types of housings must be cooled when hot liquids are to be handled (temperature higher then 120 °C / 248 °F).

The oil level is ensured by a sight oil gauge.
The axial adjustment of the rotor is set by the sleeve holding the oil ring.

3.3 Performance and Operating Limits

This product has been selected to meet the duty conditions stated on the data sheet (see also Section 1.4 and Table 3.1).

Changes in the hydraulic system may affect the pump's performance and cause damage to the unit and to the personnel. In case the process require changing on:

specific gravity, minimum continuous stable flow, viscosity, pump speed, NPSH available, temperature, suction pressure, flow and head required,

Marelli Bombas must be involved to evaluate the suitability of the installed equipment to operate at different duty conditions.

Technical Data	
Capacity	≤ xxxx m^3/h for 50 Hz ≤ xxxx m^3/h for 60 Hz
Head	≤ xxxx m for 50 Hz ≤ xxxx m for 60 Hz
Suction Pressure	Up to xxxx bar
Temperature	- xxxx °C to + xxxx °C
Discharge Flanges Size	3 inch to 10 inch
Sealing	Mechanical or Packing Seal
Direction of Rotation	Clockwise - Counterclockwise

Table 3.1 – Operating Limits -

4 INSTALLATION

4.1 Positioning

The pump has to be mounted in the best possible position to assure an easy installation of the suction and the delivery tubes and enough space must be provided for handling and lifting during maintenance operations.

⚠ The pump/pump unit must be located taking care to guarantee an easy access for inspection during normal duty or for the maintenance operations.

4.2 Support Base and Foundations

⚠ CAUTION The foundation should be sufficiently strong to absorb vibration and to form a permanent, rigid support for the base plate. This is important in maintaining the alignment for a flexibly coupled unit.

Marine type pump units should be directly bolted to the engine bearers.
Grout type pump units should be bolted to a concrete foundation block.
In case of concrete foundation the foundation bolts must be embedded in the concrete, located by a drawing or template.

⚠ CAUTION pump should not be considered as a fixed point to the plant. These motor-pump units are aligned at works, with base plates resting on ground level. After the base plate has been bolted and anchored to the foundation block, the alignment must be checked.

4.3 Alignment and Grouting

- Prepare the foundation block for wedging the pump set. To do this, level the parts of the concrete block where the wedges will be put (on each side of the anchor bolts).
- Slide the anchor bolts into the holes of the foundation block provided for this purpose.
- Place the pump unit on the foundation, with the coupling halves disconnected, in its final position as compared to the centre-line determined by the site (longitudinal centre-line, centre-line of the suction and delivery flanges, height of pump set).

⚠ CAUTION Don't reconnect the coupling until the alignment operations have been completed.

- Support the base plate on metal wedges having a small taper. Place the metal wedges close to the foundation bolts (one each side). Use metal wedges with thickness not less than 10 mm (0.39 inch.). Do not multiply metal wedges of slight thickness.

The metal wedges will help to:
- ensure a perfect shaft alignment
- keep the pump unit in horizontal position

- Level the pump units as follow (see also fig. 4.1):

1. Adjust the metal wedges until the shafts of the pump and driver are levelled.
2. Check the coupling faces as well as the suction and discharge flanges of the pump for horizontal or vertical position by means of a level.
3. Make corrections if necessary by adjusting the supports or wedges under the base plate.

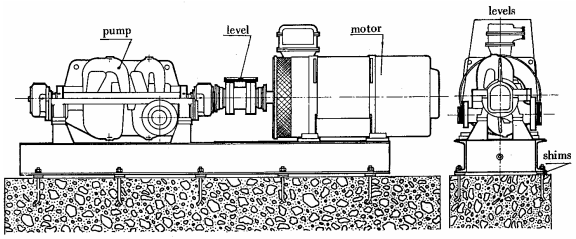


Figure 4.1 – Leveling and metal wedges location -

4. Grout the cement into the anchor bolt holes of the foundation block and let it harden according to the quality of the mortar used.

CAUTION Before tightening the anchor bolts make sure that the mortar inside the foundation bolt holes is properly dried.

4.3.1 Pump Unit Alignment

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

During the anchor bolts tightening it must be checked the half couplings angular and parallel misalignment by means of clock gauges (see fig. 4.2 and 4.3) or by a ruler (for angular misalignment) and feeler gauges (for parallel misalignment) according to the coupling type fitted to the pump shaft.

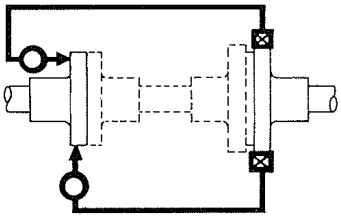


Figure 4.2 – Alignment check -

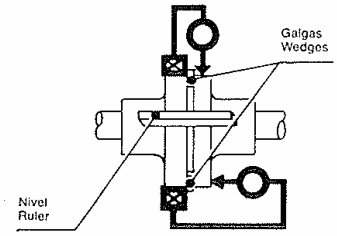


Figure 4.3 – Alignment check -

Maximum permissible misalignment (parallel and angular) at operating temperature:

- 0.1 mm (0.004 inch.) on the clock gauge for rotation speeds lower than 1500 rpm
- 0.05 mm (0.002 inch.) on the clock gauge for rotation speeds higher than 1500 rpm

The clock gauge must be read while driving both half couplings at the same time and be done at four points (two on vertical centre line and two on horizontal centre line). Always take the radial clearances into account.
If both coupling plates cannot be driven at the same time, rotate them one after the other and read the misalignment at the same points.
In order to ensure the perfect alignment of the pump units during its tightening, distribute foils on either side of the wedges, if needed.

4.3.2 Pump Unit Grouting

The concrete block should be made of cement and fine sand. It is not advisable to use quick setting cement, as it cracks and breaks easily.

Once the alignment is correct, the foundation bolts must be tightened evenly but not fully. The pump unit can then be grouted to the foundation. Grout the cement between the foundation and the base plate. The base plate should be completely filled with grout keeping the metal wedges in place.

When construction provides for it, grout the cement inside the base plate.
Filling must be done carefully, right inside the angles (see fig 4.4).
Vibrate the cement if possible.

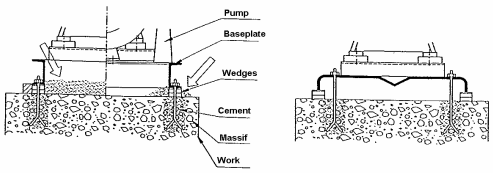


Figure 4.4 – Grouting –

For big industrial pump units, anchoring is facilitated by removing pump and motor and possibly the reduction gear. To avoid waiting for the cement drying, which fix the anchor bolts, the foundation block can be assembled as follow (see fig 4.5).

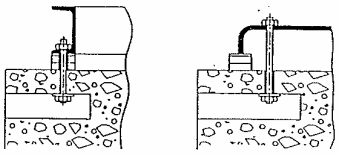


Figure 4.5 – Anchor Bolt Fixing -

Bedding the anchor bolts by means of the cement can be done at the same time as the grouting of the mortar in the base plate.

CAUTION Foundation bolts should not be fully tightened until the grout is hardened, usually about 48 hours after pouring.

4.4 Piping Assembly

CAUTION After the grout has set and the foundation bolts have been properly tightened, the pump unit must be checked for parallel and angular alignment and, if necessary, corrective action taken. After the piping of the unit has been connected and the system filled, the alignment must be checked again.

CAUTION The pump can perform properly only if it is supplied with a steady flow of liquid at the suction flange with sufficient pressure to provide adequate NPSH to the pump and with a uniform, non-swirling velocity profile. The failure of the suction piping to deliver the liquid to the pump in this condition can lead to noisy operation, random axial load oscillations, premature bearing failure, and cavitation damage to the impeller and inlet portions of the casing and occasionally damage due to liquid separation on the discharge side.

CAUTION Prevent uncontrolled external pipe load. It is recommended that all the piping connected to the equipment be supported independently of the pump.

4.4.1 Suction Piping

The suction piping must be selected in order to keep flow velocity lower than velocity in the pump suction nozzle (i.e. the suction piping diameter must be equal or bigger than the nominal pump suction size). Reduce pipe velocity to satisfy pump NPSH requirements and to control suction pipe losses.

Ensure a suction straight line of 5 - 10 pipe diameter minimum to ensure uniform flow to pump suction.

Pipe reducers

Reducers are installed just ahead of the pump suction nozzle when the pipe is larger than the pump nozzle. Suction reducers, if used, should be installed to avoid creation of air pockets. The reducers should be limited to one pipe diameter to avoid excessive turbulence and noise.

Elbow at pump suction

When a straight run of pipe at pump suction cannot be provided the Not Recommended arrangements must be avoided.

Elbow whose plane is parallel to the pump shaft should not be used. Only long radius elbow must be used and it must be installed with an arrangement in which the plane of the elbow is at right angles to the pump shaft.

Slope and flow restrictions

If the pump must operate with a suction lift, the suction line should slope constantly upwards toward the pump (figure 4.6). Any valves in the suction line should be installed to avoid collecting gas, air or vapor at high points.

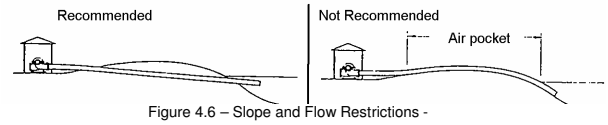
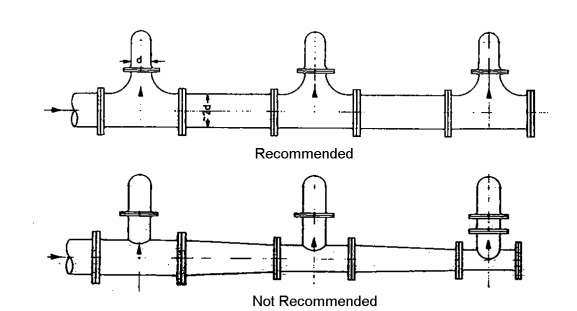


Figure 4.6 – Slope and Flow Restrictions -

Multiple fittings at pump suction

When several pumps must operate in parallel attached to the same suction pipe it must be designed to guarantee the same flow speed at every pump suction flange according to Figure 4.7.



The Flow speed into the suction pipe must be equal or lower than 2 m/s

4.4.2 Discharge Piping
Install a non-return and a shut-off valve in the discharge piping.
The check valve, placed between the pump and the shut-off valve, is to protect the pump from excessive back pressure and hence reverse rotation when the unit is stopped.
The shut-off valve is used in priming and starting or stopping the pump for maintenance.
Pipework reducers should have a maximum total angle of divergence of 15 degrees.

Fitting an isolation valve will allow easier maintenance

4.4.3 Forces and Moments
Steel and alloy steel DVMX pumps are designed to withstand external nozzle forces and moments according to API 610 limits, refer to API standard for values.

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

Recheck the coupling alignment, the reading must give the same values as those previously noted.
Ensure that the rotation direction is according to both motor and pump.

4.6 Electrical Connections
DANGER The motor must be wired up in accordance with the motor manufacturer's instructions.
DANGER Electrical connections must be made by a qualified Electrician in accordance with relevant local national and international regulations.
CAUTION Check the Direction of rotation before connecting the motor to the electrical supply (see also Section 5.3).

4.7 Protection Devices
The following protection systems are recommended for the pump installed according to ATEX Directive.

To avoid mechanical seal dry running or to check leakage product from the pump or its associated sealing system it is recommended to:
- provide a leakage detector for single seals
- provide pressure gauges on inlet mechanical seal flushing line or on the reservoir for double pressurized seals
- provide level gauges on the reservoir for double unpressurized mechanical seals

Provide a maintenance routine that include the bearing support vibration or temperature monitoring to prevent excessive surface temperature at bearings.

Install a protection device for high temperature prevention if is possible that the pump runs against a closed valve or below minimum continuous stable.

Install a power monitor to stop the pump or prevent it from being started If there are any circumstances in which the system can allow the pump to run dry, or start up empty.

5 OPERATION
Recommended Safety Measures
In the start as well as in the stop phase of the pump the operator should be adequately equipped for reasons of health preservation.
This means proper gloves and boots, anti-acid overalls, helmet with protective visor for the face and the indispensable equipment for each operator, which excludes the risk of physical damages. It is absolutely forbidden to introduce the fingers or other parts of the body into the orifices and the various openings. The pump is equipped with movable parts. The mentioned operations have to be performed by skilled staff.

5.1 Initial Procedures
At initial start up the following steps must be followed:
- check that the piping assembling has not altered the alignment,
- flush new and old systems to eliminate foreign matter,
- close all the drain valves,
- assure that the pump is vented and filled with liquid, the pump must not run unless it is completely filled,
- check that bearings and bearing support are free of dirt and foreign substances which may have entered during shipment or installation,
- fill the bearing support with the appropriate lubricant to the correct level (see also Section 5.2),
- check the tightness of the joints an the suction piping to avoid air intake,

- check that all cooling and flushing lines are well assembled and full of liquid with valves fully opened,
- before coupling installation start the motor and check the rotation, refer to electric motor manual and eventually change rotation (refer also to Section 5.3),
- assemble the coupling and check the alignment,
- install the coupling guard.

5.2 Lubrication

CAUTION always fill the bearing support with correct grade of oil (see table 5.1) to the correct level and quantity (see table 5.2) looking oil level regulator DENCO® OILER (see fig. 5.3).

Service Temperature in Bearing Zone °C	SAE grade	Viscosity		Point of	
		ISO VG	Minimum INDEX	Ignition Open P. °C min	Freezing °C max
-5 / 30	10	32	90	180	-9
30 / 70	20	68	90	200	-9
70 / 100	30	100	90	210	-9

Table 5.1 – Oil Table –

Max. Working Temperature		Oil 85 °C (185 °F)		Ball Bearings 90 °C (195 °F)	
Drain Periodicity		1st drain after 50 h 2nd drain after 500 h 3rd and after drain every 4000 h (*)			
Oil Quantity					
Pump type:	Line / Thrust	Thrust side [liters (pints)]		Line Side [liters (pints)]	
		first filling	year consumption	first filling	year consumption
3x4x9 3x6x9	LB/TB	0.4 (0.85)	1.8 (3.8)	0.4 (0.85)	1.8 (3.8)
	LJ/TB	0.7 (1.5)	2 (4.23)	0.4 (0.85)	1.8 (3.8)
4x6x10	LB/TB	0.7 (1.5)	2 (4.23)	0.7 (1.5)	2 (4.23)
	LJ/TB	1.2 (2.54)	2.5 (5.28)	0.7 (1.5)	2 (4.23)
6x8x11	LB/TB	1.4 2.9)	2.5 (5.28)	1.4 (2.9)	2.5 (5.28)
	LJ/TB	1.9 (4)	2.8 (5.9)	1.4 (2.9)	2.5 (5.28)
8x10x14½	LB/TB	1.6 (3.38)	2.6 (5.5)	1.6 (3.38)	2.6 (5.5)
	LJ/TB	2.7 (5.7)	5 (10.6)	1.6 (3.38)	2.6 (5.5)
10x12x14	LB/TB	1.6 (3.38)	2.6 (5.5)	1.6 (3.38)	2.6 (5.5)
	LJ/TB	2.7 (5.7)	5 (10.6)	1.6 (3.38)	2.6 (5.5)

(*) according to situation and conditions of service
Table 5.2– Oil Quantity -

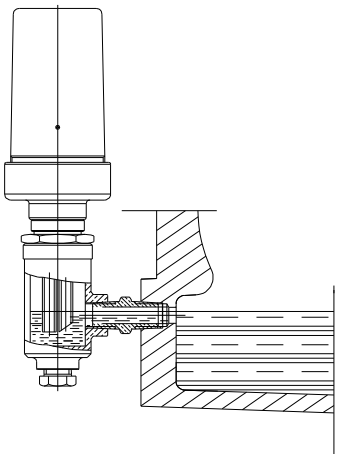


Figure 5.3 – Oil Level Regulator

5.2.1 Lubrication Schedule

The lubricating oil should be a high quality mineral oil having foam inhibitors.
Provide maintenance routine to control Oil level and Bearings temperature.
In case of sight oil level regulator option fill it backwards fill it up and close it (see fig. 5.3).

The bearing temperature may to rise to 50 ºC (122 ºF) above ambient temperature, but should not exceed 80 ºC (176 ºF) of absolute value.

- Drain the bearing support after approximately 50 hours running.
- Change the lubricant after at least 6 months for normal duty conditions. For hot application schedule a shorter time between oil changing.

5.3 Direction of Rotation

CAUTION Ensure the pump is given the same rotation as the pump direction stated on data sheet or according to the casing discharge nozzle position.

If an electric motor is used as a driver, the pump rotation must be checked the rotation should be checked with the coupling disconnected to avoid dry running.

5.4 Guarding

⚠ Guarding is supplied fitted to the pump unit. If guarding has been removed ensure that all the protective guards around the pump coupling and exposed parts of the shaft are securely fixed.

5.5 Priming and Auxiliary Supplies

CAUTION Ensure the inlet pipe and pump casing are completely full of liquid before starting duty operation. Open vent connection on top of the pump casing to allow the trapped air to escape.

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

5.6 Start and Run Procedure

After the activities indicated in Section 5.1 to 5.5 were performed proceed as follow.

5.6.1 Starting

- Ensure that the discharge valve is closed
- ensure that all inlet valves are opened
- provide to turn on all flushing, cooling, heating circuits before starting the pump
- ensure that pump is fully primed
- close all vent connections before start the pump
- start the motor checking the outlet pressure
- after the discharge pressure reaches the right value, slowly open the discharge valve
- check that motor current consumption doesn't exceed the values stated on motor nameplate
- CAUTION don't start the pump with discharge valve closed for more than 20 seconds
- if no pressure, or low pressure, stop the pump. (see Section 7).
- by the discharge valve regulate the flow until the requested capacity

5.6.2 Running

Once the pump unit is energised according to section 5.6.1, check:

- duty conditions
- vibration
- mechanical or packing seal status
- auxiliaries status
- gasketed joints status
- bearing temperature

5.6.2.1 Duty Condition Checking

Ensure that operating speed, capacity, suction pressure, discharge pressure and power input are according to the data sheet and pump/motor nameplates. If not see Section 7 and refer to Marelli Bombas

5.6.2.2 Vibrations Checking

Pumps are rigid support machines and fall under a classification within the international rotating machinery and the API standards where recommended maximum vibration levels are stated.

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

5.6.2.3 Packed gland status

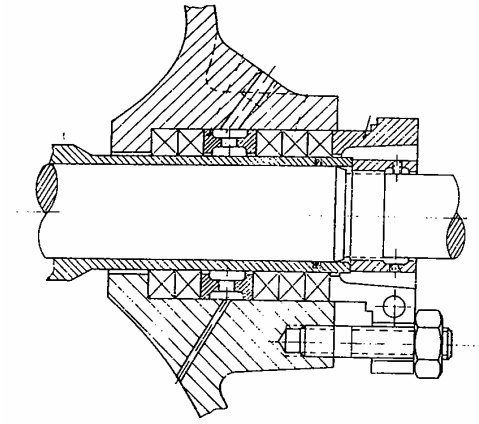


Figure 5.4 – Packing Seal

If packed gland is supplied it must be ensured that there must be some leakage from the gland. Initially Gland nuts should be finger-tight only. Leakage should take place soon after the stuffing box is pressurized. It is essential that the packing material is suitable to work with the pumped liquid. Care must be taken choosing the proper material according to the Pump Data Sheet.

Ex To avoid excess temperature the gland must be adjusted evenly to give visible leakage and concentric alignment of the gland ring. If no leakage takes place the packing will begin to overheat. In case of overheating the pump must be stopped and allowed to cool before re-started. When the pump is re-started, check that leakage is taking place at the packed gland.

The pump should be run for 30 minutes with steady leakage and the gland nuts tightened by 10 degrees at a time until leakage is reduced to an acceptable level, normally a minimum of 100 drops per minute is required. Bedding in of the packing may take another 30 minutes.

Care must be taken when adjusting the gland on an operating pump. Safety gloves are essential. Replace Shaft guards after the gland adjustment is complete.

CAUTION Never run gland packing dry, even for a short time.

5.6.2.4 Mechanical Seal Status

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

CAUTION Start external flush or quench before the pump is run and allow to flow for a period after the pump has stopped.

Refer to the Mechanical Seal Installation and Operating Manual for more detail.

5.6.2.5 Auxiliaries Status

Ensure that all auxiliaries required are connected, filled and fully operating. Check for flow control devices, any fitted instruments, sight glass and valves that must be set according to their function.

5.6.2.6 Gasketed Joints Status

Ensure that no leakage occur from gasketed joints. In case of leakage stop the pump units (in case of hot liquid wait till temperature is not dangerous) and fit the gaskets properly (see Section 6.9)

5.6.2.7 Bearing Temperature Checking

Ex If the pumps are working in a potentially explosive atmosphere temperature or vibration monitoring at the bearings is recommended.

The bearing temperature may to rise to 50 ºC (122 ºF) above ambient temperature, but should not exceed 80 ºC (176 ºF) of the absolute value.

If Bearing temperatures are to be monitored it is essential that a benchmark temperature is recorded at the commissioning stage and after the bearing temperature has stabilized. After start up the temperature rise should be gradual, reaching a maximum after approximately 1.5 to 2 hours. This temperature rise should then remain constant.

Set proper alarm and control devices taking into account the limits as previously stated.

5.7 Stop and Shut Down Procedure

Pump sets are normally suitable for the number of equally spaced stop/starts per hour. Check actual capability of the motor and control/starting system on the relevant operating manuals.

To Stop the pump proceed as follow:

- CAUTION Close the outlet valve, but ensure that the pump runs in this condition for no more than a few seconds.
- Turn off the driver.
- Switch off flushing, cooling, heating liquid supplies at a time appropriate to the process.
- CAUTION Drain the pump and any cooling and flushing arrangements in case of long shut-downs, especially when ambient temperatures are closer to liquid freezing point.

6 MAINTENANCE

The functionality of the pump depends on the number of working hours, the service conditions, the materials used for construction and the care with which the pump is treated during its operative life. A proper check during operation helps to avoid complications and assures an immediate intervention in case of damages.

6.1 General

Any work on the machine must be performed when it is disconnected an not operative. Follow the procedure for shutting down the machine, as in section 5.7 and take measures to prevent an uncontrolled start.

At the end of the maintenance work all guards and safety devices must be correctly re-installed.

Before restarting the machine perform follow the procedure listed on section 5.

Provide proper cleaning of maintenance area at the end of the maintenance work to avoid presence of lubricants on the floor or over the pump unit.

6.2 Maintenance Schedule

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

- ensure that the pump is working properly for the selected duty conditions (see relevant data sheet),
- check if vibrations, noise level and bearings temperature are within the normal values,
- check bearing lubricant level and record the time after the last lubricant change,
- ensure that the area around the pump unit is safe and clean, free from obstruction to the normal monitoring and maintenance operations,
- check the correct pump-motor alignment and re-align if necessary,

- check if any leakage from seal and gasket is present,
- check that any auxiliary systems installed is working properly.

If any problems are found follow these actions:

- refer to section 7 for fault diagnosis,
- ensure that the installation and the operation is according to this manual,
- contact Marelli Bombas if the problem persists.

6.2.1 Daily/Weekly Inspection

- Ensure noise, vibration and bearing temperatures are normal.
- Check that there are no fluid or lubricant leaks on static and dynamic seals and that any sealant systems are full and operating normally.
- Check any auxiliary supplies like heating/cooling are functioning correctly.
- Check the level and condition of oil lubricant and for greased bearings check running hours since last recharge.
- Refer to the manuals of any associated equipment for routine checks needed.

6.2.2 Six Monthly Inspection

- Check foundation bolts status.
- Check if bearing lubricant requires changing (change the oil after 4000 operating hours, se section 6.3).
- Check the correct coupling alignment.
- Refer to the manuals of any associated equipment for periodic checks needed.

6.3 Lubrication Issue

Lubricant and bearing temperature analysis can be useful in optimizing lubricant change intervals. In general the following is recommended.

6.3.1 Oil lubrication

For pump supplied with an oil level regulator the level will be automatically maintained and there is no need to refill as long as oil is visible in the regulator.

Refer to proper sections in this manual for methods of oil fill, oil grade recommendations and for the schedule and temperature limits.

6.4 Seal Maintenance

6.4.1 Mechanical seals

Perform these routines:

- Check the status after 4000 running hours
- Check the grain's friction sides
- Check the shaft sleeve's state, it must be perfectly smooth and grove less on the gasket bearing

After this check up, decide if the mechanical seal must be replaced.
Refer to Mechanical Seal Operating Manual.

6.4.2 Gland packing

The stuffing box split gland can be completely removed for re-packing or to enable the addition of extra rings of packing.

The stuffing box is supplied with a lantern ring to enable a clean or pressurised flush to the center of the packing.

Normally to lubricate and cool the packing is required a minimum leakage of 100 drops per minute to atmosphere.

6.5 Spare parts

When ordering spares the following information should be quoted:

1) Pump serial number
2) Pump type
3) Part name – according to sectional drawing
4) Part number – according to sectional drawing
5) Number of parts required

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

Spares must be stored in a clean dry area.

6.5.1 Recommended Spares

Refer to sectional drawings for Ref. identification.

For start-up operation:
1 - set of casing wear rings
1 - set of bearings (line and thrust)
1 - mechanical seal/packing
1 - shaft sleeves (if applicable)
1 - sets of gaskets, shims, O-rings and seals
1 - set of impeller wear rings (optional)

For normal maintenance operation (2 years):
1 - rotor made of all rotating parts attached to the shaft, except the half coupling
1 - shaft (with key)
1 - impeller for each type
1 - set of casing wear rings
1 - set of bearings (line and thrust)
1 - mechanical seal/packing
1 - shaft sleeves (if applicable)
1 - sets of gaskets, shims, O-rings and seals
1 - set of impeller wear rings (optional)

6.6 Fastener Torque Table

Bolt	Tightening Couple Nm (lbft)	
	1st tightening	2nd tightening
M 12 (½ in.)	16 (11.8)	25.5 (18.8)
M 16 (⅝ in.)	39 (28.8)	59 (43.5)
M 20 (¾ in.)	95 (70)	136.5 (100.7)
M 22 (⅞ in.)	149 (110)	186 (137)
M 24 (1 in.)	191 (141)	235 (173)
M 27 (1⅛ in.)	280 (207)	350 (258)
M 30 (1¼ in.)	380 (280)	475 (350)
M 33 (1⅜ in.)	485 (358)	600 (443)
M 39 (1½ in.)	625 (461)	775 (572)

Table 6.1 – Bolts Tightening Couple –

Always tighten the pressure casing bolts according to table 6.1.

6.7 Disassembly

⚠ Disassembly must be carried out only by qualified and trained personnel. Refer to sectional drawings on section 8.

Before start to disassemble anything close the isolating valves of the pump suction and discharge pipelines.

1. Unscrew the drain plug from the case and from both the bearing supports in order to accomplish the case and bearing support drain. Take care of hot oil/liquids.
2. Drain properly the mechanical seals, cooling/flushing and auxiliary pipes.
3. Disconnect the auxiliary pipes if necessary.
4. Remove the coupling guard, the coupling spacer the half coupling (pump side) and the key.
5. Loosing the nuts fixing the seal covers to free seals from spring pressure (if fitted with mechanical seal).
6. Loosing the gland cover of the packing seal (if applied).
7. Loosen all the fasten nuts on the upper half casing. Separate the two parts using pressure screws. Do not slide and wedge shaped tools between the two parts of the seal surface.

⚠ CAUTION the central sleeve bearing is in two parts. It's necessary to proceed as follow.

8. Lift up the upper half casing very carefully of 50 to 100 mm [2 to 4 inch].
9. Remove the central bearing.
10. Remove completely the upper half casing keeping it horizontal. At this point it's possible to have the access to all hydraulic parts and to check them without any further dismantling.
11. Drain properly the two bearing housings.
12. Remove the pump/motor coupling spacer.
13. Unscrew the bearing housings from the bottom half casing and remove the screws.
14. Remove the complete rotor, with the bearing housings attached to the shaft, from the bottom half casing. Ensure to lift it horizontally and place it in horizontal position on "V" wood blocks.
15. Using a proper extraction tool remove the half coupling.
16. Proceed dismantling the bearing housings following the procedure showed in the related section.

6.7.1 Dismantling of Bearings on Drive Side (Roller Bearings).

After unscrewing the nuts securing the bearing housing covers (internal and external):

1. Withdraw the external deflector, drive side held by one screw.
2. Remove the external cover, drive side, with the labyrinth ring.
3. Remove ring oiler.
4. Remove the Bearing nut and lock washer.
5. Remove the internal spacer.
6. Remove the bearing housing.
7. Remove the roller bearing.
8. Remove the internal cover with the labyrinth ring.
9. Remove the internal deflector.
10. Remove the mechanical seal or the packing seal. For a correct dismantling refer to any special instructions supplied with the mechanical seal.

6.7.2 Dismantling of Bearings on Thrust Bearing Side (Ball Bearing Housing).

After unscrewing the nuts securing the bearing housing covers (internal and external):

1. Remove the external cover.
2. Remove ring oiler.
3. Remove the Bearings nut and lock washer.
4. Remove the internal spacer.
5. Remove the bearing housing.
6. Remove the roller bearings.
7. Remove the internal cover with the labyrinth ring.
8. Remove the internal deflector.
9. Remove the mechanical seal or the packing seal. For a correct dismantling refer to any special instructions supplied with the mechanical seal.

6.7.3 Dismantling of Sleeve Bearing Housing (Drive Side).

After unscrewing the nuts securing the bearing housing covers (internal and external):

1. Withdraw the external deflector, drive side held by one screw.
2. Remove the external cover, drive side, with the labyrinth ring.
3. Remove the bearing housing.
4. Remove the sleeve bearing (pay attention to the ring oiler).
5. Remove the internal cover with the labyrinth ring.
6. Remove the internal deflector.
7. Remove the mechanical seal or the packing seal. For a correct dismantling refer to any special instructions supplied with the mechanical seal.

6.7.4 Dismantling of Sleeve/Ball Bearing Housing (Thrust Side).

After unscrewing the nuts securing the bearing housing covers (internal and external):

1. Remove the external cover.
2. Remove ring oiler.
3. Remove the Bearings nut and lock washer.
4. Remove the internal spacer.
5. Remove the Thrust Bearing carrier.
6. Remove the bearing housing.
7. Remove the roller bearings.
8. Remove the ring oiler.
9. Remove the internal bearing housing.
10. Remove the sleeve bearing (pay attention to the ring oiler).
8. Remove the internal cover with the labyrinth ring.
11. Remove the internal deflector.
12. Remove the mechanical seal or the packing seal. For a correct dismantling refer to any special instructions supplied with the mechanical seal.

6.7.5 Rotor Disassembly

CAUTION Never apply heat to remove the impeller, trapped oil or lubricant may cause an explosion.

1. Remove both the stuffing boxes.
2. Remove both the balancing sleeves.
3. Remove the impeller locating screw (drive end side).
4. Remove the spacer sleeve and the impeller (drive side).
5. Remove the impeller complete of casing and impeller wear rings.
6. Remove the impeller key.
7. Proceed with point 4,5,6 till the center sleeve is reached.
8. Remove the center sleeve and bush and key.
9. Remove the impeller complete of casing and impeller wear rings.
10. Remove the impeller key.
11. Remove the spacer sleeve.
12. Proceed with points 9,10,11 till the balancing sleeve is reached.
13. Remove the balancing sleeve and bushing.
14. Remove the key.
15. Remove the half locating rings.

6.8 Examination of parts

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

1. Inspect Casing, seal housing and impeller for excessive wear, pitting, corrosion, erosion or damage.
2. Replace as necessary.
3. Replace as necessary the case, impeller and stuffing box wear rings.
4. Mechanical seal stationary and rotating faces should be inspected for signs of wear or cracks and replaced as necessary.
5. Refer to manufacturers drawing for assembly of mechanical seal and details.
6. In case of Packing Seal replace the packing and inspect lantern ring for excessive wear, pitting, corrosion, erosion or damage.
7. Check the throat bush and replace if required.
8. Check the shaft between points or on two wee supports. The maximum loss of roundness must not exceed 0.03 mm.
9. After dismantling, discard and replace gaskets and O-rings.
10. Labyrinth seals and bearing isolators (if applicable) must be inspected for damage but are normally non-wearing parts and can be re-used.
11. It is recommended that bearings are not re-used after any removal from the shaft.

6.9 Assembly

All components should be cleaned thoroughly and all mounting surfaces should be checked for defects so that the original settings can be restored exactly without forcing.
Don't reuse bearings.
The assembly is carried out in inverse sequence to the dismantling operation.

6.9.1 Rotor Assembly

1. Fit the half locating rings on the shaft (not drive end side).
2. Place the balancing sleeve key.
3. Slide the balancing sleeve on the shaft and the balancing bushing not drive end side).
4. Slide the spacer sleeve on the shaft.
5. Place the impeller key into the slot.

6. Fit the impeller with impeller and casing wear rings fitted on it.
7. Proceed with points 4,5,6 till the center sleeve is required.
8. Place the center sleeve key.
9. Slide the center sleeve on the shaft and fit the center bushing.
10. Place the impeller key.
11. Fit the impeller with impeller and casing wear rings fitted on it.
12. Slide the spacer sleeve on the shaft.
13. Proceed with points 10,11,12 till the impeller locating nut is required.
14. Place the impeller locating nut.
15. Slide both the balancing sleeves (drive and not dive end).

6.9.2 Casing Assembly

1. Ensure that the central bushing is placed with the proper pin.
2. Place the assembled rotor into the lower half casing.
3. Check that all the casing wear rings are installed.
4. Place a new casing gasket in the proper seat.
5. Assembly the upper half casing and tighten the pump casing screws according the torque values listed into table.6.1 .
6. Proceed with the assembly of the stuffing boxes.

For Mechanical Seals

- First check that contact faces of cup and fixed bush are clean, free from dust; falling to take care such precautions will cause rapid deterioration of packing during operation.
- Smear faces with a film of oil.
- Fit rotating parts of mechanical seal.
- Do not tighten fixing nuts.

For Packing Seals

- Select the proper packing according to the condition of service, Table.6.2 shows the most common packing type. Refer always to the packing manufacturer for details and proper selection.

Condition		Packing Type
Fluid	Temperature	
water or non aggressive	≤ 90°C (194 °F)	Algodon + Graphite
medium aggressive	> 90°C (194 °F)	asbestos free
aggressive	all	PTFE + Graphite

Table 6.2 – Packing seal Selection –

- If the pressure inside the stuffing box is lower than the atmospheric pressure it's necessary to flush the lantern ring with a barrier fluid with a pressure of 0.05 – 0.1 MPa (7.25-14.50 psi). If the pumping temperature is higher than 90°C (194°F) it is necessary to install a stuffing box forced cooling.

- Before placing another packing, carefully clean the chamber and gland; at the same time check the shaft sleeve condition that must be absolutely smooth, if not change it in order to avoid an early damage of the packing.

- To accomplish the cutting use a two slide board of same dimension as packing, in which it will be placed then chamfer it with a sharp tool.

- Form the rings and slide them one after the other without omitting to intercalate junctures and lantern ring (see figure 6.1).

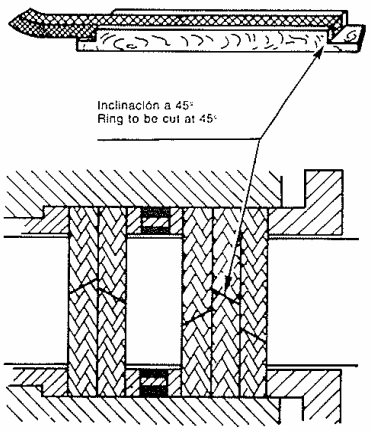


Figure 6.1 – Packing Setting –

- Progressively tighten the gland as mentioned above for the first running hour.

6.9.3 Bearings Assembly on Drive Side (roller Bearings).

1. Place the internal deflector and slide it till it will reach the shaft shoulder.
2. Slide the internal cover with the labyrinth ring and the O-Ring in place.
3. Install the roller bearing using the proper heater.
4. Slide the internal spacer on the shaft.
5. Secure the bearing in place by the proper lock washer and nut.
6. Slide the bearing housing and secure it with the internal cover tightening the proper screws.
7. Place the ring oiler.
8. Slide the external cover with the labyrinth ring and the O-Ring in place and secure it with the bearing housing tightening the proper screws.

9. Place the external deflector, drive side and secure it by one screw.

6.9.4 Bearings Assembly on Thrust Bearing Side (Ball Bearing Housing).

1. Place the internal deflector and slide it till it will reach the shaft shoulder.
2. Slide the internal cover with the labyrinth ring and the O-Ring in place.
3. Install the roller bearings using the proper heater.
4. Slide the internal spacer on the shaft.
5. Secure the bearing in place by the proper lock washer and nut.
6. Slide the bearing housing and secure it with the internal cover tightening the proper screws.
7. Place the ring oiler.
8. Slide the external cover with the O-Ring in place and secure it with the bearing housing tightening the proper screws.

6.9.5 Bearings Assembly on Drive Side (Sleeve Bearing).

1. Place the internal deflector and slide it till it will reach the shaft shoulder.
2. Slide the internal cover with the labyrinth ring and the O-Ring in place.
3. Install the sleeve bearing with the internal ring oiler in place.
4. Slide the bearing housing and secure it with the internal cover tightening the proper screws.
5. Place the external ring oiler.
6. Slide the external cover with the labyrinth ring and the O-Ring in place and secure it with the bearing housing tightening the proper screws.
7. Place the external deflector, drive side and secure it by one screw.

6.9.6 Bearings Assembly on Thrust Bearing Side (Ball Bearing Housing).

1. Place the internal deflector and slide it till it will reach the shaft shoulder.
2. Slide the internal cover with the labyrinth ring and the O-Ring in place.
3. Install the sleeve bearing with the internal ring oiler in place.
4. Slide the bearing housing and secure it with the internal cover tightening the proper screws.
5. Place the external ring oiler.
6. Slide the external bearing housing and secure it with the previous one using the proper screws.
7. Install the roller bearings using the proper heater.
8. Install the Thrust Bearing Carrier.
9. Slide the internal spacer on the shaft.
10. Secure the bearing in place by the proper lock washer and nut.
11. Slide the bearing housing and secure it with the internal cover tightening the proper screws.
12. Place the ring oiler.
13. Slide the external cover with the O-Ring in place and secure it with the bearing housing tightening the proper screws.

6.9.7 Completion

To complete the assembly proceed as follow:

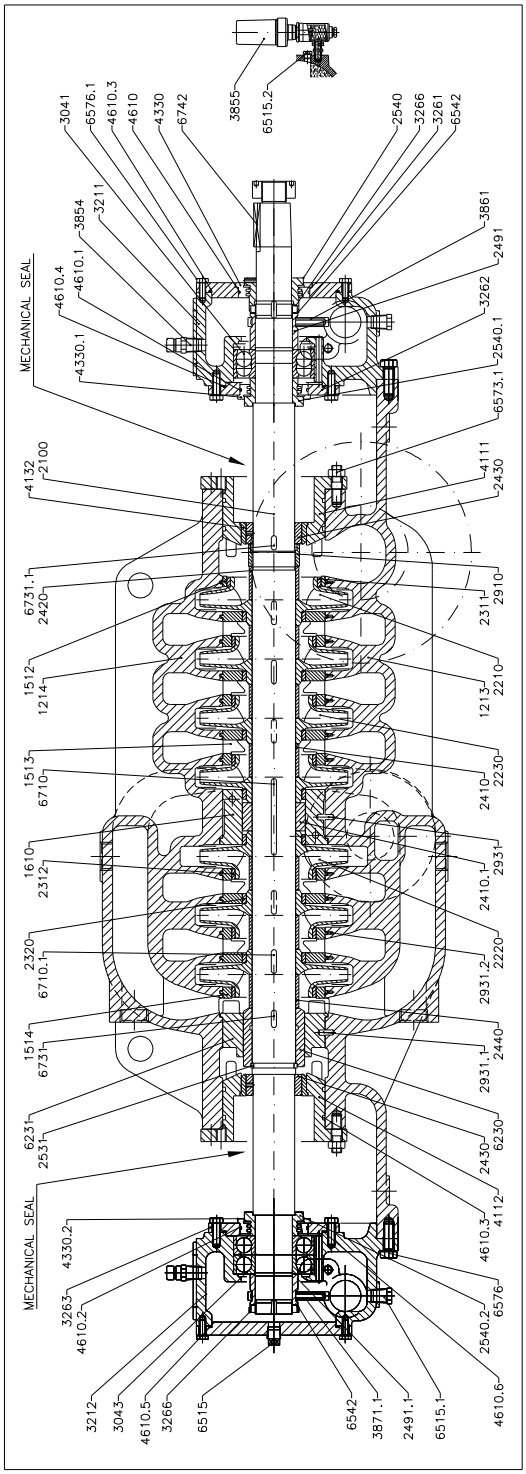
1. Position coupling key and fit the coupling.
2. Fill the bearing housing with the oil.
3. Couple the pump to the motor.
4. Connect wiring.

7 TROUBLESHOOTING

Symptoms / Possible Causes	No output	Low output	Low Discharge Pressure	High Discharge Pressure	Wrong Discharge Pressure	Poor Efficiency	Shocks	Vibrations and Noise	Overheating Volute	Overheating Bearings	Overheating Motors	Leaky Seals	Damaged Bearings	Worn Bushing	Jammed Runner	Damaged Blades	General Erosion	Motor Tripped Out
Inadequate Equipment Control	X	X	X	X	X				X									X
Closed Suction or Delivery Valve	X		X					X	X									
Poor Suction Head	X	X	X					X										
Pump Unprimed	X							X							X			
Too Small Suction Pipe		X						X										
Partly Open Suction Valve		X						X										
Air Intake at Suction		X	X		X			X										
Too High Suction Head Loss		X	X					X										
Foot Valve too Heavy		X	X															
Back Slopes (air pockets)		X	X		X			X										
No Venting		X	X			X		X				X			X			
Suction Filter Clogged		X	X		X	X		X					X	X	X			
Internal Leaks due to Back Lash		X	X			X												
Turbulence at Suction		X	X		X		X	X					X					
Vortex		X	X		X	X	X	X					X	X		X		
Abnormal Leaks in the Plant		X																X
Too Much Flow Required		X																
Cavitation		X	X		X	X	X	X				X	X	X		X		
Wrong Rotation Direction		X	X			X		X										
Gas Laden Liquid		X	X		X			X				X		X		X	X	
Low Speed		X	X			X					X							
Delivery Valve Partially Open		X						X	X									
Delivery Head Loss (high)		X	X															X
Wrong Power Supply			X	X		X												
Too High Rotational Speed				X			X	X		X	X	X	X	X				
Too High Suction Head				X						X			X					
Wrong Bearing Assembly							X	X		X		X	X					
Resonant Components							X	X					X	X	X			
Coupling Wear							X	X		X		X	X	X				
Low Output Capacity							X	X	X	X			X		X	X		
High Output Capacity								X			X							X
Runner Unbalance								X				X	X					
Inadequate Foundation								X					X					
Pump Set Wedged or Anchored wrong								X					X					
Piping Unproperly Supported								X					X					
Pump and Motor Misalign								X		X		X	X					
Piping Straining the Pump								X					X		X			
Too High weight or viscosity				X		X					X							X
Poor Lubrication										X			X					
Poor Cooling efficiency										X		X	X					
Lubricant Quality										X			X					
Contaminated Lubricant										X			X					
Too Small Motor Size											X							X
Abnormally Low Voltage											X							X
Suspended Solid in Pumped Fluid												X		X	X		X	
Stuffing Braids Inadequate												X						
Too Close Internal Clearances						X									X			
Pump Jammed																		X

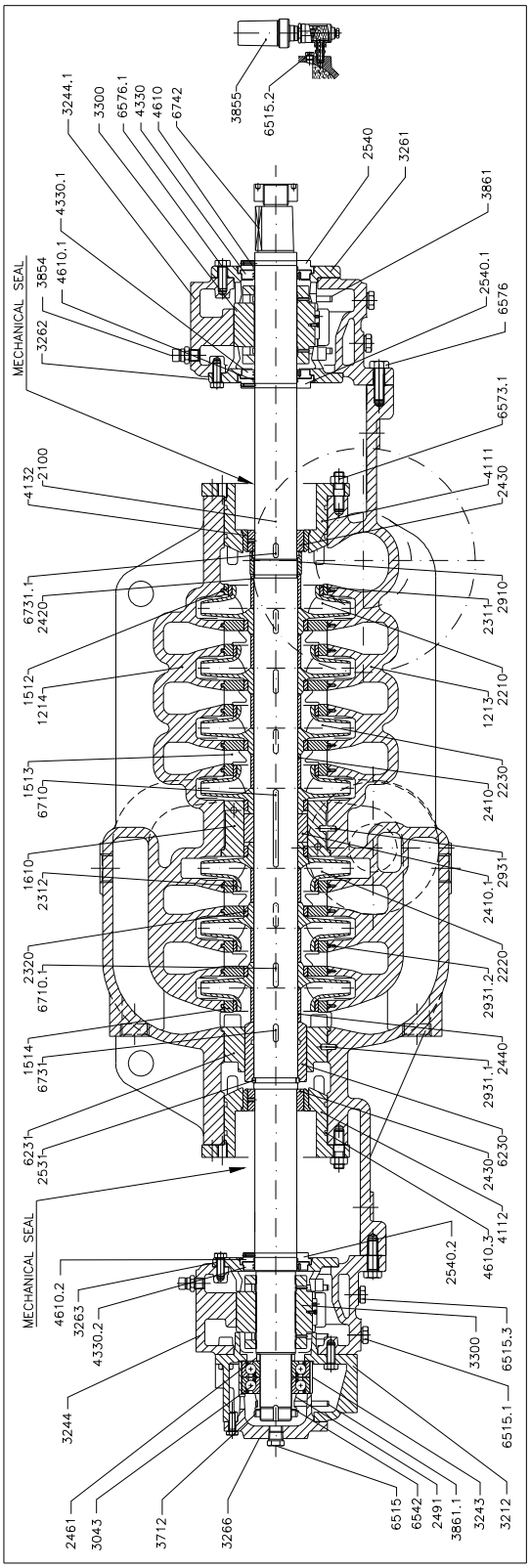
8 CROSS SECTIONAL AND DIMENSIONAL TABLES

8.1 DVMX with Ball Bearings



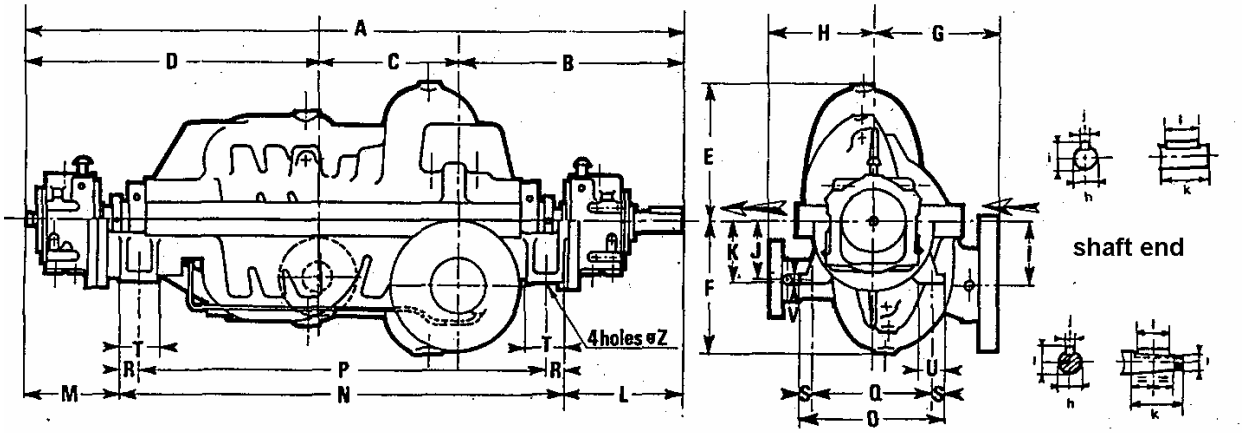
REF	DENOMINATION	SPARE	REF	DENOMINATION	SPARE	REF	DENOMINATION	SPARE	REF	DENOMINATION	SPARE
1213	LOWER HALF CASING		2430	NECH BUSH SLEEEVE O/DRIVE/S		3262	INTERNAL COVER DRIVE SIDE		4610.4	O-RING	X
1214	UPPER HALF CASING		2440	FINAL STAGES SLEEVE		3263	INTERNAL COVER OP. DRIVE SIDE		4610.5	O-RING	X
1512	CASING WEAR RING 1ª STG	X	2491	OIL RING LOCAT. COLLAR DRIVE S.		3266	EXTERNAL COVER OP. DRIVE SIDE		4610.6	O-RING	X
1513	CASING WEAR RING	X	2491.1	OIL RING LOCAT. COLLAR O/DR/S	X	3854	OIL FILLER PLUG		6230	BALANCING SLEEVE	
1514	CASING WEAR RING SIDE END	X	2531	RETAINING RING, SPLIT		3855	CONSTANT LEVEL OIL		6231	BALANCING BUSHING	
1610	CENTRAL BUSHING		2540	EXTERNAL THROWER DRIVE SIDE		3861	RING OILER	X	6515	TACHOMETER CONNECTION PLUG	
2100	SHAFT		2540.1	INTERNAL THROWER DRIVE SIDE		3871.1	RING OILER		6515.1	DRAIN PLUG	
2210	IMPELLER SUCTION FIRST STAGE		2540.2	INTERNAL THROWER O/DRIVE/SIDE		4111	STUFFING BOX, SUCTION SIDE		6515.2	OIL LEVEL PLUG	
2220	IMPELLER DELIVERY SIDE		2910	IMPELLER LOCKING NUT		4112	STUFFING BOX, DELIVERY SIDE		6542	BEARING NUT LOCKING WASHER	
2230	IMPELLER SUCTION SIDE		2931	RETAINING RIN CENTRAL BUSHING		4132	NECK BUSH		6573.1	STUD FOR STUFFING BOX	
2311	IMPELLER WEAR RING FIRST STG.	X	2931.1	RETAINING RIN BALANCING BUSHING		4330	LABYRINTH RING EXT. DRIVE SIDE		6576	BEARING HOUS. LOCKING SCREW	
2312	IMPELLER WEAR RING EYE SIDE	X	2931.2	RETAINING RIN CASING RING		4330.1	LABYRINTH RING INT. DRIVE SIDE		6576.1	COVER BEARING LOCKING SCREW	
2320	IMPELLER WEAR RING BACK SIDE	X	3041	RADIAL BALL BEARING DRIVE SIDE		4330.2	LABYRINTH RING INT. O/DRIVE/S.		6710	CENTRAL KEY	
2410	INTERSTAGE SLEEVE		3043	AXIAL BALL BEARING O/DRIVE/S.		4610	O-RING	X	6710.1	IMPELLER KEY	
2410.1	CENTRAL SEAL SLEEVE		3211	BEARING HOUSING DRIVE SIDE	X	4610.1	O-RING	X	6731	BALANCING BUSH KEY	
2420	SUCTION FIRST STAGE SLEEVE		3212	BEARING HOUSING O/DRIVE/SIDE	X	4610.2	O-RING	X	6731.1	LOCKING NUT KEY	
			3261	EXTERNAL COVER DRIVE SIDE		4610.3	O-RING	X	6742	COUPLING KEY	

8.2 DVMX with Sleeve Bearings



REF	DENOMINATION	SPARE	REF	DENOMINATION	SPARE	REF	DENOMINATION	SPARE	REF	DENOMINATION	SPARE
1213	LOWER HALF CASING		2461	BEARING SPACER SLEEVE		3266	EXTERNAL COVER OP. DRIVE SIDE		6230	BALANCING SLEEVE	
1214	UPPER HALF CASING		2491	OIL RING LOCAT. COLLAR		3300	SLEEVE BEARING		6231	BALANCING BUSHING	
1512	CASING WEAR RING 1° STG	X	2531	RETAINING RING, SPLIT		3712	BEARING NUT		6515	TACHOMETER CONNECTION PLUG	
1513	CASING WEAR RING	X	2540	EXTERNAL THROWER DRIVE SIDE		3854	OIL FILLER PLUG		6515.1	DRAIN PLUG	
1514	CASING WEAR RING SIDE END	X	2540.1	INTERNAL THROWER DRIVE SIDE		3855	CONSTANT LEVEL OIL	X	6515.2	OIL LEVEL PLUG	
1610	CENTRAL BUSHING		2540.2	INTERNAL THROWER O/DRIVE/SIDE		3861	RING OILER		6515.3	COOLING WATER CONNECTION PLUG	
2100	SHAFT		2910	IMPELLER LOCKING NUT		3861.1	RING OILER		6542	BEARING NUT LOCKING WASHER	
2210	IMPELLER SUCTION FIRST STAGE		2931	RETAINING RIN CENTRAL BUSHING		4111	STUFFING BOX, SUCTION SIDE		6573.1	STUD FOR STUFFING BOX	
2220	IMPELLER DELIVERY SIDE		2931.1	RETAINING RIN BALANCING BUSHING		4112	STUFFING BOX, DELIVERY SIDE		6576	BEARING HOUS. LOCKING SCREW	
2230	IMPELLER SUCTION SIDE		2931.2	RETAINING RIN CASING RING		4132	NECK BUSH		6576.1	COVER BEARING LOCKING SCREW	
2311	IMPELLER WEAR RING FIRST STG.	X	3043	AXIAL BALL BEARING O/DRIVE/S.	X	4330	LABYRINTH RING EXT. DRIVE SIDE		6710	CENTRAL KEY	
2312	IMPELLER WEAR RING EYE SIDE	X	3212	BEARING HOUSING O/DRIVE/SIDE		4330.1	LABYRINTH RING INT. DRIVE SIDE		6710.1	IMPELLER KEY	
2320	IMPELLER WEAR RING BACK SIDE	X	3243	BEARING CARRIER		4330.2	LABYRINTH RING INT. O/DRIVE/S.	X	6731	BALANCING BUSH KEY	
2410	INTERSTAGE SLEEVE		3244	BEARING HOUSING O/DRIVE/SIDE		4610	O-RING	X	6731.1	LOCKING NUT KEY	
2410.1	CENTRAL SEAL SLEEVE		3244.1	BEARING HOUSING DRIVE/SIDE		4610.1	O-RING	X	6742	COUPLING KEY	
2420	SUCTION FIRST STAGE SLEEVE		3261	EXTERNAL COVER DRIVE SIDE		4610.2	O-RING	X			
2430	NECH BUSH SLEEEVE O/DRIVE/S		3262	INTERNAL COVER DRIVE SIDE		4610.3	O-RING				
2440	FINAL STAGES SLEEVE		3263	INTERNAL COVER OP. DRIVE SIDE							

8.3 DVMX Dimensional Table



SIZE	PB-BB	PL-BB	PL-BL	OUTLINE DIMENSIONS										FASTENING								CYLINDRICAL END					CONICAL END					
				B	E	F	G	H	I	J	K	L	M	O	Q	R	S	T	U	V	Z	h	i	j	k	l	h	i	j	k	l	m
3x4x9	x			536	280	280	290	290	140	155	165	354	254	394	330	50	32	100	75	25	23	55	59	16	117	70						
3x4x9		x		536	280	280	290	290	140	155	165	354	402	394	330	50	32	100	75	25	23						55	54.4	14	102	65	40
3x4x9																																
3x6x9	x			543	280	280	320	280	140	155	165	347	255	394	330	50	32	100	75	25	23	65	69	18	136	100						
3x6x9		x		543	280	280	320	280	140	155	165	347	402	394	330	50	32	100	75	25	23						65	63.75	16	125	82	50
3x6x9																																
3x6x9 ED-HD	x			618	360	360	343	280	178	155	165	321	255	394	330	50	32	100	75	25	23	65	69	18	136	100						
3x6x9 ED-HD		x		618	360	360	343	280	178	155	165	321	402	394	330	50	32	100	75	25	23						65	63.75	16	125	82	50
3x6x9 ED-HD																																
4x6x10	x			709	400	400	360	360	190	190	215	398	271	445	380	64	32.5	128	100	32	30	75	79.5	20	140	120						
4x6x10		x		709	400	400	360	360	190	190	215	398	431	445	380	64	32.5	128	100	32	30						75	73.75	18	125	82	60
4x6x10			x	709	400	400	360	360	190	190	215	398	521	445	380	64	32.5	128	100	32	30						75	73.75	18	125	82	60
6x8x11	x			764	475	475	510	460	267	216	240	433	295	540	450	65	45	130	130	40	36	90	96.5	24	150	130						
6x8x11		x		764	475	475	510	460	267	216	240	433	455	540	450	65	45	130	130	40	36						90	88.5	22	147	100	70
6x8x11			x	764	475	475	510	460	267	216	240	433	547	540	450	65	45	130	130	40	36						90	88.5	22	147	100	70
8x10x14 ½	x			970	540	540	570	570	302	250	240	560	370	750	640	90	55	180	150	50	47	105	111	28	200	160						
8x10x14 ½		x		995	540	540	570	570	302	250	240	585	565	750	640	90	55	180	150	50	47						110	106.75	25	190	130	85
8x10x14 ½			x	995	540	540	570	570	302	250	240	585	620	750	640	90	55	180	150	50	47						110	106.75	25	190	130	85
10x12x14		x		965	635	630	650	650	290	290	145	570	535	850	720	60	65	200	185	85	62						110	106.75	25	190	130	85
10x12x14			x	965	635	630	650	650	290	290	145	570	570	850	720	60	65	200	185	85	62						110	106.75	25	190	130	85

Table 8.4 – Dimensional Table –

	3x4x9					3x6x9					3x6x9 ED-HD					4x6x10				
Nr. of Stages	A	C	D	N	P	A	C	D	N	P	A	C	D	N	P	A	C	D	N	P
4	1460	220	657	853	753	1507	266	690	985	825	1601	285	674	1025	925	1901	318	874	1232	1104
5	1556	323	657	940	848	1602	361	690	1000	888	1656	380	674	1120	1020	2034	451	874	1365	1237
6	1651	323	792	1043	949	1697	361	703	1085	995	1781	380	793	1215	1115	2167	451	1007	1498	1370
7	1748	410	792	1138	1038	1792	456	703	1100	1099	1886	475	793	1310	1210	2300	584	1007	1630	1503
8	1841	410	887	1233	1133	1887	456	888	1285	1185	1901	475	880	1485	1385	2433	584	1140	1764	1638
9	1836	513	887	1328	1228	1952	551	888	1300	1288	2078	570	5880	1500	1400	2500	717	1140	1857	1700
10	2031	513	982	1423	1323	2077	551	983	1475	1375	2071	570	883	1585	1495	2690	717	1273	2030	1802
11	2126	608	982	1518	1410	2172	848	983	1578	1470	2268	665	883	1690	1590					
12	2221	608	1077	1613	1513	2287	848	1070	1665	1545	2361	669	1070	1765	1685					
13	2316	703	1077	1708	1600															
14	2412	703	1172	1803	1703															
PL.BB. (*)	148		148			147		147			147		147			160				
PL.BL. (*)																250				

	6x8x11					8x10x14 1/2					10x12x14				
Nr. of Stages	A	C	D	N	P	A	C	D	N	P	A	C	D	N	P
4	2074	367	943	1348	1216	2560	405	1185	1630	1450	2973	610	1390	1868	1743
5	2228	519	943	1490	1368	2740	505	1185	1810	1630	3173	610	1588	2068	1340
6	2378	519	1085	1650	1520	2820	585	1365	1880	1810	3373	810	1790	2260	2148
7	2530	671	1085	1802	1672	3180	765	1365	2170	1990					
8	2582	671	1247	1954	1824	3280	765	1545	2350	2170					
9	2834	823	1247	2108	1976										
10	2986	823	1390	2250	2120										
11															
12															
13															
14															
PL.BB. (*)	160					220		195							
PL.BL. (*)	252					275		250			35		35		

(*) Length to add to the dimension A-D-M in case of sleeve bearings and thrust bearings
PB.BB. : Line Ball Bearing and Thrust Ball Bearing
PL.BB. : Line Sleeve Bearing and Thrust Ball Bearing
PL.BL. : Line Sleeve Bearing and Thrust Pad Bearing

9 CERTIFICATION

Certificates, determined from the contract requirements will be provided with this manual. Examples are certificates for CE marking and ATEX marking.

10 ATTACHMENTS

Supplementary instruction determined from the contract requirements for inclusion into User Instructions such as for a driver, instrumentation, controller, sub-driver, seals, sealing system, mounting component etc are part of job technical book.

11 NOTES AND INFORMATION

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

Marelli Bombas

Marelli Bombas S.R.L.
Headquarter and Manufacturing Plant
Ctra. Madrid-Toledo, km 30.8
Apartado, 32
45200 – ILLESCAS (TOLEDO)
ESPAÑA - SPAIN

Telephone: +34 925 51 12 00
Fax: +34 925 53 23 55
e-mail: marellipumps@marellipumps.com
web site: http://www.marellipumps.com

LEVANTE
Pintor Cabrera, 22 bajo 1ª
03003 – ALICANTE
SPAIN

Telephone: +34 96 522 86 48
Fax: +34 96 522 86 49
e-mail: marelli.alicante@marellipumps.com

CATALUÑA
Gran Via de les Corts Catalanes, 736
08013 – BARCELONA
SPAIN

Telephone: +34 93 232 72 61
Fax: +34 93 265 86 94
e-mail: marelli.cataluna@marellipumps.com

ANDALUCÍA
Monte Tabor, 6
41007 – SEVILLA
SPAIN

Telephone: +34 95 457 43 61
Fax: +34 95 457 76 06
e-mail: marelli.andalucia@marellipumps.com

ARAGÓN
New Direction
Unceta, 85
50010 – ZARAGOZA
SPAIN

Telephone: +34 976 46 01 82
Fax: +34 976 46 01 81
e-mail: marelli.aragon@marellipumps.com

Local Dealer: