

# Boulton Pumps

## ESK

Chemical Process  
Centrifugal Pumps



### Instructions for operation and maintenance

Instructions for Installation, Operation and Maintenance.

## **Boulton pumps**

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# 1. GENERAL

This manual is intended to be a reference guide for users of pumps providing information on:

- Pump installation and maintenance instructions,
- Pumps start-up, operation and shut - down procedures.

## 1.1. IDENTIFICATION OF SAFETY AND WARNING SYMBOLS



Safety instructions in this manual which could cause danger to life if not observed.



The presence of a dangerous electric current.



Non - observance to this warning could damage the machine or affect its functions.



Information to prevent explosion in the explosive atmosphere as per EC Directive 2014/34/UE (ATEX).

## 1.2. GENERAL INSTRUCTIONS



- This manual should be kept in a safe place and always be available to the qualified operating and maintenance personnel responsible for the safe operation and maintenance of the pumps.

- Qualified personnel should be experienced and knowledgeable of safety standards.

- To avoid faulty operation and malfunctioning of pumps the instructions in this manual are to be carefully studied and followed at all stages of the pump installation and operating life.

- The user is responsible for ensuring that authorized and qualified personnel who have studied this manual carefully carry out inspection and installation.

- The pump should be used only in the operating conditions given on the order for which the pump and materials of the construction have been selected and tested.

- If the pump is to be used for a different application please contact sales office or representative of the manufacturer. BOULTON PUMPS refuses to assume any responsibility if the pump used for different applications without prior written permission.

- If the pump is not to be installed and operated soon after arrival, it should be stored in a clean and dry place with moderate changes in ambient temperature. Extreme low or high temperatures may severely damage the pump unless suitable precautions are taken. The user is responsible for the verification of the ambient conditions where the pump will be stored or installed.

- BOULTON PUMPS does not guarantee repairs or alterations done by user or other unauthorized personnel. The use of original spare parts and accessories authorized by manufacturer will ensure safety.

- This manual does not take into account any site safety regulation, which may apply.

## 1.3. SAFETY INSTRUCTIONS



Strictly obey to the following instructions to prevent personal injuries and/or equipment damages:

- Pump should be used only in the specified operating conditions.
- Any weight, stress or strains on the piping system should not be transmitted to the pump.
- Electrical connections on the motor or accessories must always be carried out by authorized personnel and in accordance to the local codes.
- Any work on the pump should be only carried out when the unit has been brought to standstill.



- Always disconnect the power to the motor and make sure not be switched on accidentally before working on the pump or removing the pump from installation.

- Any work on the pump should be carried out by at least two persons.
- When approaching the pump always be properly dressed and/or wear safety equipment suitable for the work to be done.
- Do not work on the pump when it is hot.
- Do not touch the pump or piping with temperatures higher than 80 °C. User must take suitable precaution to warn the persons (e.g. using warning signs, barrier).
- Always be careful when working on pumps that handling dangerous liquids (e.g. acids or hazardous fluids).
- Do not work on the pump when the pump and piping connected to the pump are under pressure.
- After completion of the work always fix the safety guards back in places previously removed.
- Do not run the pump in the wrong direction of rotation.
- Do not insert hands or fingers into the pump openings or holes.
- Do not step on the pump and/or piping connected to the pump.

### 1.3.1. CE signs 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 the last page of this document.

### 1.3.2. Explosive atmosphere



This section should be read carefully for the pumps operating at explosive atmospheres.



Only the products certificated for the explosive atmospheres should be used at the explosive atmospheres.

Detailed information about the operating conditions at the explosive atmospheres are found in Directive on Equipment for Potentially Explosive Atmospheres 2014/34/UE (ATEX).

The pumps to be used at the explosive atmospheres should never be used at areas apart from the specified areas.

#### 1.3.2.1. Intended use - ATEX

The centrifugal pumps of the series ESN-EX or ESH-EX are Category 2 equipment according to the European Directive 2014/34/EU. They are designed to operate in Zone 1 (due to the presence of flammable gases or vapours of subgroups IIA and/or IIB) and in Zone 21 (due to the presence of combustible dust of dust subgroups IIIA, IIIB and IIIC).

The assembly is suitable for operation with flammable liquids of sub-group IIA or IIB (ZONE 1).

The user must verify that the equipment purchased is suitable for operation in his facilities, according to the existing zone classification and the characteristics of the products present.




The marking of these centrifugal pumps according to Directive 2014/34/EU is:

CE  II 2GD Ex h IIB IIIC TX Gb Db X

or also

CE  II 2G Ex h IIB T. Gb X

CE  II 2D Ex h IIIC T... °C Db X

 <b>Boulton Pumps</b>		Pol. Ind. . Santelices,7 48550, Muskiz Bizkaia +34 946 510 116	
TP: _____		MEI ≥ 0.4	
Y: _____	No: _____		
Q: _____	m <sup>3</sup> /h	H: _____	m
P: _____	kW	n: _____	rpm
Ø: _____	mm	II 2G Ex h IIB T. Gb X	
			

The "X" in the marking indicates "Special Conditions of Use":

**1)** It is a prerequisite for ensuring the safety of the equipment against the risk of explosion according to the requirements of Category 2 that **the centrifugal pump must at all times be operated in a primed condition with liquid inside**. The user who must ensure a sufficient liquid level to cover the impeller must observe this requirement.

**2)** The maximum surface temperature of the equipment depends on the pumped fluid:

Temperature class of the centrifugal pump	Maximum surface temperature	Maximum fluid temperature
T3	200°C	180°C
T4	135°C	110°C

Table 1

The user must check that the minimum ignition temperature of the flammable substances present or pumped is:

- For pumps marked T4: Higher than 135 °C for flammable gases and vapours or temperature class T4, T3, T2 or T1.
- For pump with T3 marking: Over 200 °C for flammable gases and vapours or temperature class T3, T2 or T1.

For ESN-EX or ESH-EX pumps with marking for areas with combustible dust, the user must observe the following safety margins, specified in EN 1127-1 and EN 60079-14, with regard to the minimum cloud (TMIN) and layer (TMIC) ignition temperatures of the substances that may be present:

- $(2/3 \times TMI_{Nube}) \geq$  Temperature marking in °C of the centrifugal pump.
- $(TMI_{Capa} - 75K) \geq$  Temperature marking in °C of the centrifugal pump.

Therefore, the powdery substances present must have a self-ignition temperature:

- For pumps marked **T4 or T135 °C**: greater than 203 °C in a cloud and 210 °C in a layer.
- For pumps with **T3 or T200 °C** markings: over 300 °C in a cloud and 270 °C in a layer.

The manufacturer does not guarantee the safety of the ESN-EX or ESH-EX centrifugal pump against the risk of an explosive atmosphere if the instructions given in this manual are not strictly observed.

### 1.3.2.2. Operation

The centrifugal pumps have been assessed and are ignition safe to operate in a zone classified as ZONE 1 and ZONE 2 for flammable gases/vapours (IIA and IIB) and as ZONE 21 and ZONE 22 for combustible dust (IIIA, IIIB and IIIC). Also to operate with flammable liquids (IIA or IIB) indoors, under the conditions defined for ZONE 1 in internal parts. (\*)

(\*) The following definitions apply (Directive 1999/92/EC):

- "ZONE 1" as "working area in which an explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas, vapour or mist is likely to occur in normal operation occasionally".
- "ZONE 2" means a "place in which an explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas, vapour or mist is not likely to occur in normal operation but, if it does occur, will persist for a short period only".
- "ZONE 21" as "working area in which an explosive atmosphere in the form of a cloud of combustible dust in air is likely to occur occasionally in normal operation".
- "ZONE 22" as a "place of work in which an explosive atmosphere in the form of a cloud of combustible dust in air is not likely to occur in normal operation or, if it does occur, will persist for a short period only".

Centrifugal pumps must always be primed, with liquid inside by submerging the impeller. The user must ensure this by the method he considers most appropriate.

The user of the pump must ensure that the pump does not operate against a closed outlet

The pump must be installed and operated in a horizontal position.

In the case of pumps with oil-lubricated bearings, the oil level in the bearing housing must be visible through the built-in sight glass.

The pump and its associated parts (motor, baseplate, pipes, etc.) must be equipotential and properly grounded.

#### **1.3.2.3. Equipment with ATEX marking**

The centrifugal pumps of the ESN-EX and ESH-EX series can be supplied with ATEX marked equipment from other manufacturers (motor, flexible coupling, mechanical seal). The installed electrical and/or mechanical equipment, with a given ATEX marking by third party manufacturers, must be checked and maintained according to the instructions given by the manufacturers of such equipment and with the frequency indicated in their corresponding manuals.

Inspections and maintenance of ATEX electrical equipment that may affect its ignition protection (according to its ATEX marking) must always be carried out in accordance with the EN 60079-17 standard.

The user must ensure that, after maintenance work, the installed electrical equipment has been connected in accordance with the instructions of the equipment manufacturer and in conformity with EN 60079-14.

#### **1.3.2.4. Equipotentiality and Grounding**

All metal parts of the assembly are equipotential. The equipotentiality is guaranteed by means of metal braids joining the different parts of the equipment or by means of the metal-metal joint. The equipotential connections must be checked periodically.

Special attention should be paid to the equipotential connection of the metal parts of the assembly, especially after maintenance work involving the disassembly of parts of the assembly. After such maintenance, the metal braids of the equipotential connection must be reconnected and it must be checked that there are no isolated metal parts.

The whole assembly must be properly grounded.

The user must ensure proper grounding of the installations. This grounding must be periodically checked as established in the Low Voltage Electrotechnical Regulations or equivalent national legislation.

#### **1.3.2.5. Chemical compatibility**

The user must ensure that the chemicals (gaseous or solid) that are or may be present in his premises are compatible with the construction materials of the pneumatic conveying system. These substances must not cause corrosion, exothermic reactions or physic-chemical alterations to the parts and components of the assembly (metal or non-metal parts, internal or external).

#### **1.3.2.6. Lubricants**

The lubricants used in the conveyor system must be chemically compatible and not generate exothermic reactions with the products that are or may be present inside the conveyor system or at its location.

These lubricants must have an ignition temperature of at least 185 °C (for T4 pumps) or 250 °C (for T3 pumps), which is 50K higher than the maximum surface temperature marked for the equipment.

#### **1.3.2.7. Maintenance**

The correct tightness of the pump parts and bolted elements must be checked periodically.

Special attention should be paid to the moving parts of such equipment: air gaps, seal bearings, shaft alignment, etc. Periodic checks should be made of:

- Condition of the bearings in order to detect possible wear or premature failure and to replace them if necessary. Special attention should be paid to signs such as abnormal noise, difficult rotation, loss of lubricant, discoloration, etc.
- Condition of seals, seals, etc., checking that they maintain protection against the entry of solid or liquid elements into the shafts.
- Correct alignment of shafts, verifying the absence of signs of friction between metallic elements.



#### 1.3.2.8. Cleaning

Periodic cleaning of the external parts of the equipment should be carried out to prevent the accumulation of dust deposits, in particular in the vicinity of moving parts. Accumulations of dust thicker than 5mm should be avoided.

#### 1.3.3. Monitoring

Pump and/or pumpset should be operated according to duty point and the limit described in nameplate.



The technical personnel should operate the pump within these limits and the status monitoring system should be used for the pump set.

Use of the monitoring system is important especially for the following areas of the pump:

- Temperature values on the pump casing.
- Temperature values in the sealing area.

In the systems where buffer liquid is supplied or double mechanical seal is available the buffer liquid should be observed.

- Temperature values in the bearing area.

For proper operation of the bearings, it would also be useful to monitor vibration and temperature values in the roller bearing.

- The pump should be operated according to ordered duty point.

#### 1.3.4. Constructional requirements

When explosive fluid is pumped, all parts under pressure should be made of ductile material.

Coupling protection housings should be made of non-sparking materials.

Mechanical seals should never be operated dry. The sealing area should be filled with liquid completely as long as the pump operates. If you are not sure that the sealing area is filled with liquid, then the buffer liquid may be applied.

Frame of the pump and/or pump set should always be earthed.

#### 1.3.5. 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 co-ordinate repair activity with operations and health and safety personnel, and follow all plant safety requirements and applicable safety and health laws and regulations.

### 1.4. RECYCLING

For products and parts, which will not be used and scraped, use the local or private waste collection services. If it is not possible, consult the nearest authorized service centre of Boulton Pumps.

# ESK PUMPS

## 2.1. GENERAL

### 2.1.1. Pump Description

ESK series pumps are horizontal, radially split volute casing, single stage, end suction centrifugal pumps with closed or semi-open impeller.

Dimensionally complies with EN 22858 / ISO 2858.

### 2.1.2. Applications

ESK series pumps are suitable for clean or slightly contaminated (max. 20 mg/dm<sup>3</sup>) liquids with low viscosities and temperatures up to 175 °C. The main application areas, among others, are:

- Chemical and Petrochemical Industry.
- Food and Beverage Industry
- Refineries and Loading Plants.
- Cooling and Heating Plants
- Paper and Cellulose Industry.
- Water Treatment Plants.
- Iron and Steel Industry.
- Power Plants.

### 2.1.3. Pump Designation

**ESK    X   -   150   -   250**




Pump Type \_\_\_\_\_


Impeller type \_\_\_\_\_

Discharge nozzle (DN in mm) \_\_\_\_\_

Nominal impeller diameter (mm) \_\_\_\_\_

### 2.1.4. Pump Nameplate

 <b>Boulton Pumps</b>		Pol. Ind. . . Santelices,7 48550, Muskiz Bizkaia +34 946 510 116	
TP: _____		MEI≥ 0.4	
Y: _____	No: _____		
Q: _____	m <sup>3</sup> /h	H: _____	m
P: _____	kW	n: _____	rpm
Ø: _____	mm		
 			

- TP: Pump Type and Size
- Y: Production Year
- No: Serial Number
- Q: Capacity
- H: Head
- P: motor Power
- n: Speed
- Ø: Impeller Diameter
-  Direction of Rotation

### 2.1.5. Technical Data

Speed	: up to 3600 rpm
Discharge Nozzle	: DN 32 up to 250 mm
Suction and Discharge Flanges	: DIN 2532 / PN16
Operating Temperature	: -10° C up to 175° C
Ambient Temperature (max)	: 40° C
Casing Pressure (max)	: 16 bar (25 bar*)

## 2.2. UNCRATING, TRANSPORT AND STORAGE

### 2.2.1. Uncrating

- Upon receipt, verify that the goods received are in exact compliance with that listed on the packing list.
- Check that no visible damage exists on the crate that could have occurred during transportation.
- Carefully remove the packaging material and check that pump and accessories (if any) are free from any markings, stretches and damages, which may have occurred during transportation.
- In the event of damage, report this immediately to BOULTON PUMPS service department and to the transport company.

### 2.2.2. Transport

#### 2.2.2.1. General recommendations



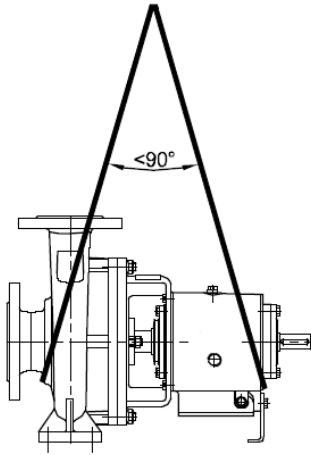
- Existing regulations for the prevention of accidents must be followed.
- Wearing of gloves, hard-toed boots and hard hats is obligatory for all transport works.

- Wooden cases, crates, pallets or boxes may be unloaded with fork-lift trucks or using hoisting slings, depending on their size, weight and construction.

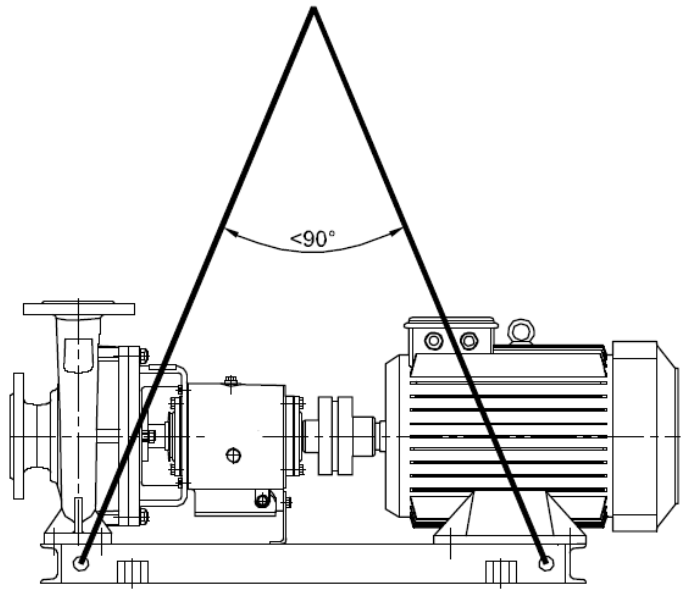
#### 2.2.2.2. Lifting

- Prior to lifting and moving the pump or pump and motor on a common base plate find out the following:
  - Total weight and center of gravity.
  - Maximum outside dimensions.
  - Lifting points location.
- The load-bearing capacity must be proper to the weight of the pump or the pump set.
- The pump or pump set must always be raised and transported in horizontal position.
- It is absolutely forbidden to stand beneath or nearby a raised load.
- A load should never remain in a raised position for longer than necessary.
- Accelerating and braking during the lifting process must be performed such that there is no danger to persons.

When lifting the pump or complete pump set lift them as shown in Fig.1a and Fig.1b respectively to avoid any distortion (especially do not use the motor eyebolt for carrying the complete unit).



**Fig. 1a.** Bare shaft pump



**Fig. 1b.** Pump and motor over a baseplate

### 2.2.3. Storage

- If the pump is not to be installed and operated soon after arrival, store the pump in a clean, dry and frost-free place with moderate changes in ambient temperature.
- If the pump has regreaseable bearings, pump extra grease on bearings to prevent moisture from entering around the shaft.
- To prevent the pump from moisture, dust, dirt and foreign materials suitable steps should be taken.
- The pump shaft should be revolved periodically (e.g. once a week) to prevent pitting of the bearing surfaces and the pump from seizing up.

### ATTENTION

## 2.3. INSTALLATION ON SITE

Installation has to be carried out in accordance with EN 60204-1.

The pump should only be installed, levelled up and aligned by skilled personnel. Incorrect installation or defective foundation could result in troubles. This would not be covered by the warranty.

### 2.3.1. Bare Shaft Pump

- If the pump has been supplied with bare shaft end it is required to prepare a proper base plate on which to mount the pump and motor assembly. The base plate must be properly designed and manufactured for enough rigidity to prevent vibrations and distortions.
- If the pump has been supplied without electric motor and coupling it is necessary to select a proper motor and coupling before proceeding to the installation of the unit.

The following considerations must be taken into account for selection of motor:

- Maximum power absorbed by the pump over the total operating range.
- Pump operating speed.
- Available power (frequency, voltage, etc.).
- Motor type (TEFC, exproof, etc.).

- Motor mounting position (foot mounted, flange mounted, horizontal, vertical, etc.).

When selecting the coupling, nominal motor power and operating speed must be taken into account.

### 2.3.2. Preparation for Installation

Before installing the pump:

- Clean the suction and discharge flanges thoroughly.
- Remove the protective coating from the pump shaft.
- If the pump has been in temporary storage remove all the grease from the bearings with grease lubricated or remove the oil from the bearing house if the pump is oil-lubricated, then clean the bearings with a suitable cleaning fluid and relubricate (NOTE: This is not necessary for the pumps with life time grease lubricated bearings).

### 2.3.3. Installation Site

**ATTENTION** The pump must be installed in a frost and dust-free, well-ventilated and non-explosive environment.

- The pump should be installed such that there is space for access, ventilation, maintenance and there is sufficient space above the pump for it to be lifted.
- The suction pipe should be kept as short as possible.

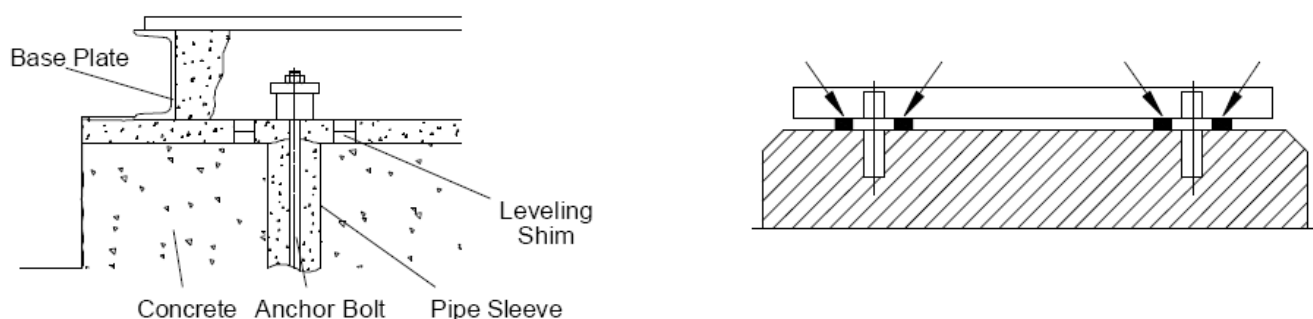
#### 2.3.3.1. Foundation

**ATTENTION** The greatest care must be taken in preparing the foundation and mounting the pump set. Incorrect installation will result in premature wear of pump components and break down of the pump.

The foundation should be heavy enough to reduce vibrations and rigid enough to avoid any twisting or misalignment. Make sure the concrete foundation has set firm and solid before mounting the pumpset. The surface of the foundation should be truly horizontal and perfectly flat.

#### 2.3.3.2. Installation

- Place the pumpset on the concrete and by adding or removing shims under the baseplate align the discharge flange horizontally by using a spirit level on it as shown on Fig.2. Make sure it is completely horizontal.
- Slightly tighten the anchor bolts.
- Check the coupling alignment as explained in section 2.3.4.



**Fig. 2.** Foundation, baseplate and fitting the shims

### 2.3.4. Coupling Alignment

#### ATTENTION

For a trouble free service life of the pumping unit the most important factor is aligning the coupling properly. The main reason for vibration, noisy operation, warming bearings and overloading is an unaligned or misaligned coupling. Therefore the coupling should be correctly aligned and be checked frequently.

A flexible coupling should never be expected to correct misalignment. A FLEXIBLE COUPLING IS NOT A CURE FOR MISALIGNMENT AT ALL AND IT DOES NOT COMPENSATE FOR EXCESSIVE MISALIGNMENT. A flexible coupling will only compensate for small amount of misalignment.

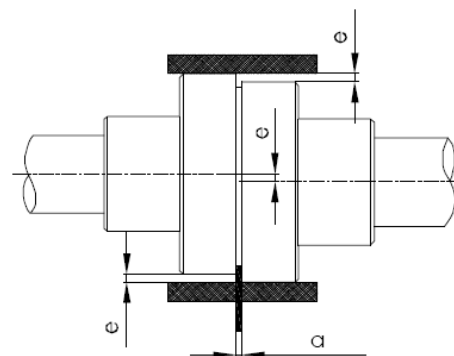
#### ATTENTION

“Coupling Alignment” means to secure the motor and pump rotation axes on the same straight line. ESK series pumps are dispatched from our factory after the coupling alignment is precisely secured if supplied with driver and baseplate. A certain amount of deformation of the baseplate is possible during handling and transit. For this reason, regardless of the excellent alignment made at factory, THE PUMP AND DRIVER HAVE TO BE REALIGNED DURING INSTALLATION.

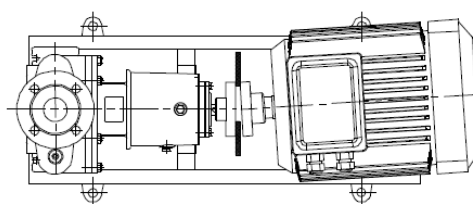
- Two pieces of minimum 100 mm long metal stripes with straight edge (steel ruler) and a precise calliper are needed to align the coupling (special instruments must be used for a very fine and precise alignment).
- There may be two forms of errors for coupling alignment:
  - a) Angular error.
  - b) Parallel sliding error.
- To check the angular error, the gap between the coupling halves must be the same at all points horizontally and vertically.
- To control parallel sliding error, straight edged steel ruler is pressed down on one half of the coupling in parallel to the axis. It is checked against the other half. Straight edge must touch to the both half couplings completely same at all points in each vertical and horizontal planes (Fig.3).
- Alignment errors can be either on vertical plane or horizontal plane. On vertical plane alignment is corrected by inserting shims under the pump or motor foot, and on horizontal plane alignment is corrected by sliding the pump and/or motor horizontally sideways by using the gaps at mounting holes. Fig. 4a, 4b, 4c, 4d show alignment of coupling step by step.

#### ATTENTION

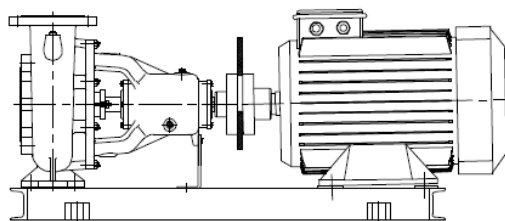
Following any alternation, each alignment should be rechecked because any movement due to an adjustment in one direction may cause misalignment in another.



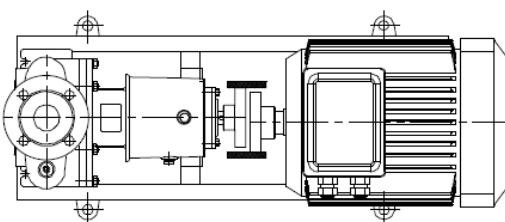
**Fig. 3.** Aligning a flexible coupling



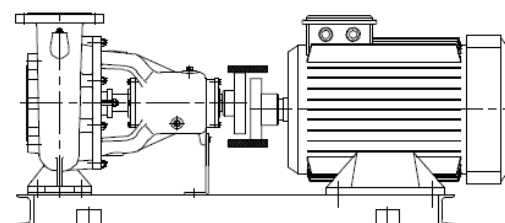
**Fig. 4a.** Angle error in horizontal plane and to settle



**Fig. 4b.** Angle error in vertical plane and to settle



**Fig. 4c.** Parallel sliding error in horizontal plane and to settle



**Fig. 4d.** Parallel sliding error in vertical plane and to settle

## 2.3.5. Connecting the Piping

### 2.3.5.1. General

#### ATTENTION

Never use the pump as an anchorage point or as a carrier for the piping.

- The pipes should be supported very near the pump (Fig. 5). It must be checked that any weight, stress or strains on the piping system should not be transmitted to the pump. Therefore after completing the piping installation, the bolt and connection on the suction and discharge nozzles must be loosened to ensure that there is not any stress on the piping system to the pump.
- The nominal sizes of the pump suction and discharge nozzles are no guide to the correct sizes of the suction and discharge piping. The nominal bores of the pipes should be same as or greater than those of the pump nozzles. Never use pipes or accessories which have smaller bore than the pump nozzles. Particularly foot valves, strainers, filters and non return valves must be preferred with larger free transition areas. In general the flow velocities should not exceed 2 m/s in the suction piping and 3 m/s in the discharge piping. Higher flow velocities will result in higher pressure drops, which could cause cavitation conditions in the suction piping and excessive friction losses in the discharge piping.
- Pipe joints should be by means of flanges with flange gaskets of proper size and material. Flange gasket must be centered between the flange bolts in a such way that there is no interference with the flow of the liquid.
- Thermal expansions of the pipework and excessive vibrations should be accommodated by suitable means so as not to impose any extra load on the pump.
- Prevent impurities such as welding beads, scale, sand and tow might be left in pipes while production of the piping system harms the pump. Seal the pump nozzles by means of blind gasket to stop impurities get in the pump. After assembling the system all the piping parts must be disassembled, thoroughly cleaned, painted and reassembled again. If a strainer is used on the suction side of the pump, it must be cleaned after several days of operation.

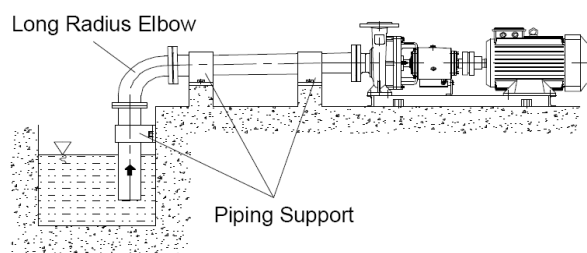


Fig. 5a. Suction Lift

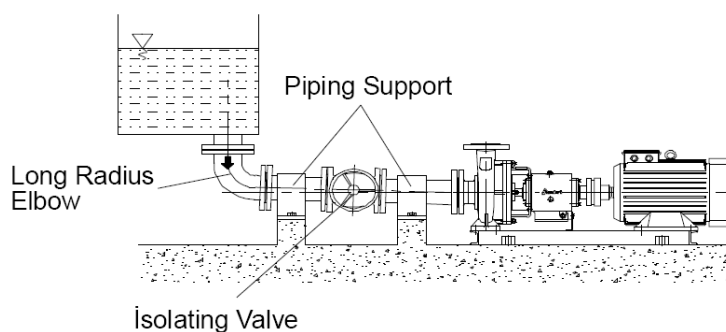


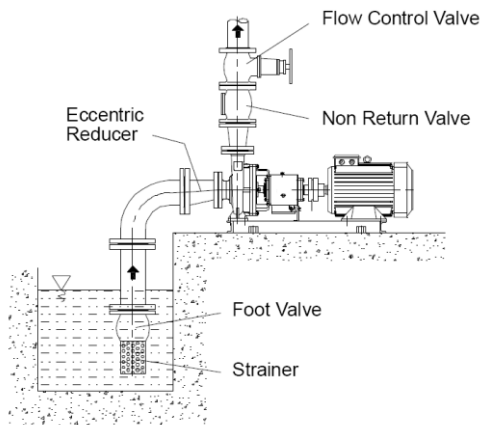
Fig. 5b. Suction Head

### 2.3.5.2. Suction piping (Fig. 5, 6)

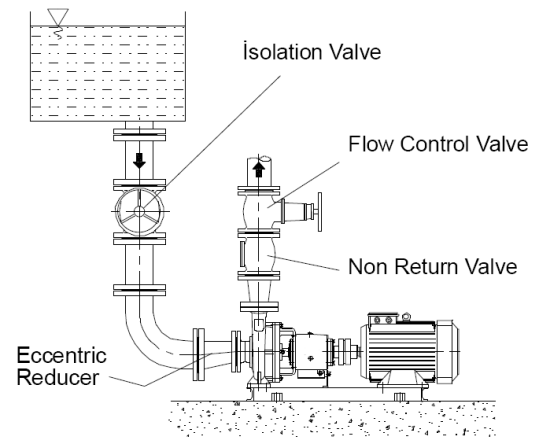
- The suction piping must be absolutely leak-tight and not present any features likely to promote the formation of air pockets. Suction piping therefore should have a slight downward slope towards the pump in the case of suction head installation (e.g. flooded suction) and slight upward slope towards the pump in the case of suction lift installation.
- In order to keep the pipe friction losses as low as possible it is essential to avoid any sharp bends and abrupt changes of direction or cross-section and the suction pipe should be kept as short as possible. If it is necessary to change the cross-section of a piping laid almost horizontal, an eccentric reducer, with top horizontal, should be used.
- A positive suction head piping should incorporate an isolating valve with the valve stem in the horizontal position. This valve should always remain fully open while the pump is running and must not be used to regulate the flow.

### 2.3.5.3. Discharge piping (Fig. 6)

- A control valve should be installed in the discharge pipe, as close to the pump as possible, to regulate the required flow and head.
- If the total head of the pump exceeds 10 meters or if discharge line is of appreciable length a non return valve should be installed between the pump and isolating valve on the discharge line to protect the pump against water hammer and reverse flow on shut down.



**Fig. 6a. Suction Lift**

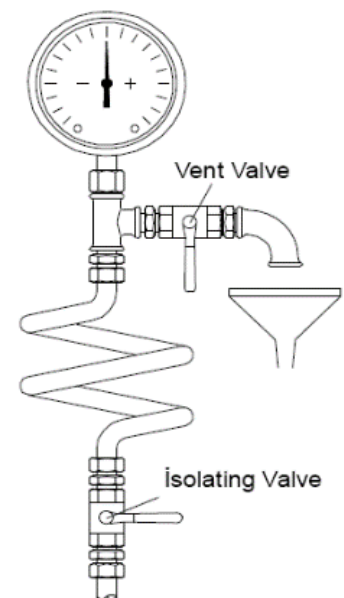


**Fig. 6b. Suction Head**

### 2.3.5.4. Auxiliary Connections

Depending on the application auxiliary pipe connection (drainage etc. necessary for the pumping system) and/or accessories to check the operating conditions (pressure gages, temperature gages etc.) may be made up and laid.

- Pressure and vacuum gauges must be properly anchored and connected at the measuring points located on the pipes approximately 2D close to the flanges with approximately 8 mm diameter tubing with pig tail configuration to lessen pressure fluctuation. For safety purposes isolating and vent valves should be fitted before the gauges (Fig. 7).
- Every pump is fitted with connection on the pump casing to drain the pump (Fig. 8). If required the pump drain can be piped to a suitable reservoir. The pump draining piping must be fitted with an isolating valve and both must be suitable for the maximum operating pressure of the pump.
- Cooling, sealing and flushing of seal piping must be connected only to the designated connections located on the pump (See Fig. 8 to 12).



**Fig.7**



**d1** : Pressure gauge (discharge).

**d2** : Pressure gauge (suction).

**d3** : Filling or vent.

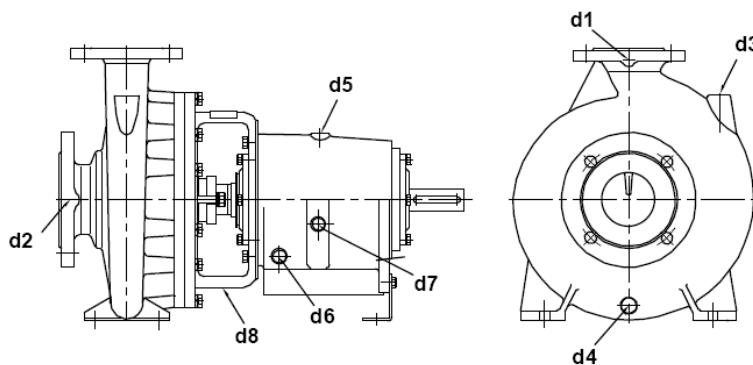
**d4** : Drain.

**d5** : Oil filling.

**d6** : Oil drain.

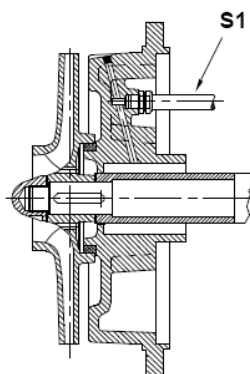
**d7** : Oil sight gauge.

**d8** : Seal leakage drain.



**Fig.8**

**S1** : Seal flushing liquid inlet from external source.



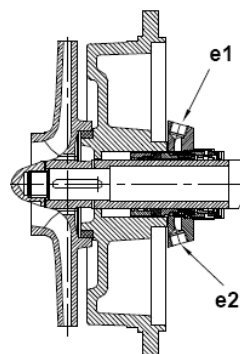
**Fig.9**

**e1**: Double mechanical seal buffer liquid inlet from external source.

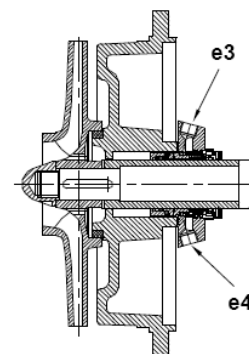
**e2**: Double mechanical seal liquid outlet.

**e3**: Single mechanical seal flushing liquid inlet from external source.

**e4**: Single mechanical seal flushing outlet.



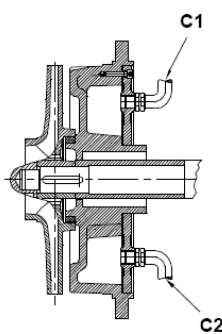
**Fig.10a**



**Fig.10b**

**C1**: Stuffing box cooling liquid inlet.

**C2**: Stuffing box cooling liquid outlet.



**Fig.11**

### 2.3.5.6. Electrical Connections



- The electrical motors have to be built in accordance with EN 60034-1.
- Enclosures of electrical motors and control systems on the pump unit shall as a minimum give protection in accordance with EN 60529 IP22. But in determining the degree of protection of enclosures of electrical motors and control systems on the pump unit the operating and environmental conditions must be taken into consideration.
- Electrical connection should be done by a qualified electrician. Current national regulation and motor manufacturer's instructions must be observed.
- Take all safety precautions listed in "Safety Instructions". Disconnect all power supplies prior to doing any work.
- The supply cable must be laid in such a way that it never touches the pipework, pump and motor casing.
- Check voltage, phase and frequency on motor nameplate with the mains.
- The electric motor must be protected against overloading by means of circuit breakers and/or fuses. Circuit breakers and fuses must be selected in accordance with full load amperage of the motor appearing on the motor rating plate.
- It is recommended to use PTC (Passive Thermal Control) on motor, but this is optional depending on customer requirement. In case of using PTC, these should be connected via corresponding terminals in the terminal box and the PTC should be connected to the thermal trip mechanism.
- Prior to connecting the electrical wiring rotate the pump shaft by hand to make sure rotor rotates easily.
- Connect the electrical wiring in accordance with local electrical codes and make sure to ground the motor.
- The connection diagram can be found in the terminal box of the motor or in the instruction manual.
- The mains connection on the tagboard depends on the nominal power of the motor, the power supply and the type of connection. The necessary connection of the bridges in the terminal box is shown in the following (Table 1. and Fig. 12a, 12b, 12c).

Type of switch	Motor Power $P_N \leq 4 \text{ kW}$	Motor Power $P_N > 4 \text{ kW}$
	Power supply $3 \approx 400 \text{ V}$	Power supply $3 \approx 400 \text{ V}$
Direct	Y – connection (10b)	$\Delta$ - connection (10a)
Y / $\Delta$ - start	Impossible	Remove connecting Bridges (10c)

Table 2

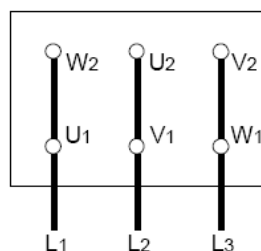


Fig. 12a.  $\Delta$  - connection

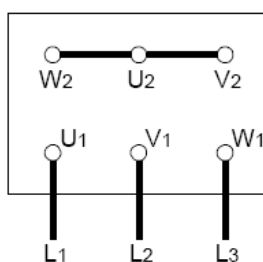


Fig. 12b. Y - connection

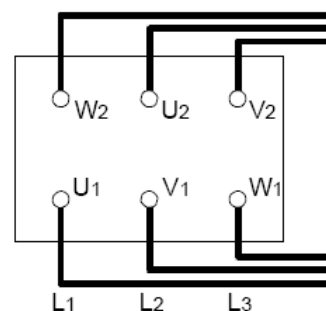


Fig. 12c. Y /  $\Delta$  connection

**ATTENTION**

In the case of three-phase induction motors with Y /  $\Delta$  – connection it must be ensured that the change-over points between star and delta follow on from one another very quickly. Longer change-over times may result in pump damage (Table 2).

Motor Power	Y –set time
$\leq 30$ kW > 30 kW	< 3 sec > 5 sec

Table 3

**2.3.5.7. Final check**

After completion all the above process check the coupling alignment once more as described in 2.3.4. Correct if there is a fault. Rotate the pump rotor several times by hand. Make sure rotor rotates easily. Fix the safety guards in places then run the unit until it warms up and normal operating conditions are reached. Now shut it down and make final alignment by shimming driver only. Final alignment should be made at operating temperature.



Fix the coupling guard back in place. Do not operate the pump before doing so. This is a necessity for security and job safety.

**2.4. START UP / SHUT DOWN****2.4.1. Preparation****2.4.1.1. Lubrication Control**

- Grease lubricated bearings are factory packed with grease enough for one year operation before dispatch. Before initial start up the pump it should be ascertained that no dirt has penetrated inside the bearing during transport or installation on site. Otherwise, the bearings should be cleaned out and repacked with fresh grease before start up.
- If the pump is stored for a long time before installation (more than 6 months) pump extra grease on bearings.
- Oil lubricated pumps are dispatched without oil and this is indicated with a warning label. Fill the bearings housing of this kind of pump with oil until the marked level on the gauge.
- See 2.5. for lubricating.

**2.4.1.2. Check the shaft seal (see 2.6.3)****2.4.1.3. Venting and Priming**

- Make sure that the pump and suction pipes are completely filled up with water. There is no problem for the pumps which have positive suction head. If there is a valve on suction line, it must be opened and air taps are loosened to enable the water replaces air in the pump, until it is completely full with water.
- If there is a foot valve for the pump, which has suction lift, pump is filled up with water through the filling tap at the highest point of the pump and the air is emptied out.
- If the system has a vacuum pump, water is brought up in the rising pipe and filled up the pump through this vacuum pump. When water is risen up to the highest point then the pump is started up.

**ATTENTION**

Make sure the pump never runs dry.

#### 2.4.1.4. Checking the direction of rotation

ESK type pumps rotate in clockwise when it is looked from coupling to the pump. This direction is already indicated on the pump nameplate by an arrow. Check this by switching the pump on, then off again immediately. Fit the coupling guard back in place if you took it out.

#### 2.4.2. Start Up the Pump

- Check if the shut off valve in the suction line is open and the shut off valve in discharge line is closed.
- Switch on the circuit breaker and run the motor.
- Wait until the motor reaches the full speed (on star-delta running motors wait until it switches on delta).
- Open the discharge valve slowly while watching the ampermeter on the control panel (if the discharge line is empty do not turn on the valve fully open on first start up. Turn it on slowly to maintain the value on the ampermeter is under the rated current value of the motor).
- When the valve is if fully open, check the pressure on the manometer and see it is the same with the duty point pressure. If the pressure on the pressure gauge is lower than duty point pressure brings them to the duty point value by slightly closing the valve. If it is higher value, check your installation, particularly head again.

#### ATTENTION

The pump should be shut down at once and the trouble should be corrected if the pump is running at it rated speed and found any of the following faults:

- Pump doesn't deliver any liquid.
- Pump doesn't deliver enough liquid.
- Flow is going down.
- Discharge pressure is not enough.
- Driver overloaded.
- Vibration on pump.
- High noise level.
- Bearing overheating.

#### 2.4.3. Shut Down the Pump

- Slowly close the shut-off valve in the discharge line.
- You may shut down the pump without closing the shut-off valve if there is a device for water hammer protection on the discharge line or the water hammer is not a considerable level.
- Switch off the driver. Ensure the pump set runs down smoothly and quietly to a standstill.
- Shut off external sealing liquid supply, if supplied, to relieve stuffing box pressure.
- If the set is to remain out of services for a long time close the shut-off valve in the suction pipe. Close off the auxiliary connections. In the event of frost and/or prolonged standstill, drain the pump or otherwise protect against freezing.

#### 2.4.4. Checks to be Made While The Pump is Running

- The pump must run smoothly, quietly and free from vibration at all times.
- The pump must never run dry.
- Never run the pump for along period against a closed discharge valve (at zero flow).
- The bearing temperature may exceed the ambient temperature by up to 50° C. But must never rise above 80° C.
- The valves in the auxiliary lines must remain open while the pump is running.

- If the pump has soft packing type stuffing boxes, these should drip during operation. The gland nuts should only be lightly tightened. In case of excessive leakage from the stuffing box tighten the gland nuts slowly and evenly until the leakage is reduced to the dripping state. Check the stuffing box for overheating by hand. If the gland nuts can not be tightened any further remove the old packing rings and clean the packing chamber and insert the new packing rings. Make sure that each packing ring is cut of correct size. The joint in successive ring should be offset to each other.
- If the pump has a mechanical seal, these will experience only minor leakage or no visible leakage during operation. It is maintenance free. If there is considerable leakage from the seal, that means the seal surfaces are worn-out and it needs to be replaced. The operation life of the mechanical seal highly depends on the purity of the water.
- The flexible coupling elements should be regularly checked and replaced as soon as they are shown signs of wear.
- Occasionally check the motor current. Stop motor if the amperage is higher than usual; there may be jamming or friction in the pump. Make the necessary mechanical and electrical checks.
- Stand-By pumps should be run for a short time at least once a week to ensure they are in constant readiness for operation. Check the integrity of auxiliary connections.

## 2.5. LUBRICATION

- Oil lubricated bearings are used in standard production.
- Depending on customer requirement pumps with regreaseable bearings are available.

### 2.5.1. Periods of Changing Oil

- Rated speed 2900 rpm: 1500 operating hours
- Rated speed 1450 rpm: 3000 operating hours
- The oil has to be changed at the end of these periods.
- Please use high quality suitable oil for lubrication. For example:

SHELL TELLUS 46 cst for 2900 rpm.

SHELL TELLUS 68 cst for 1450 rpm.

- See the attached Table 3 for required amount of oil according to the pump size.

Pump Dimension Group	Shaft End Diameter (Ø)	Bearing Type Number	Oil Fill (lt)
A	24	2 x 7307 – 1 x NU307 (6307)	0,75
B	32	2 x 7309 – 1 x NU309 (6309)	1,5
C	42	2 x 7311 – 1 x NU311 (6311)	1,75
D	48	2 x 7313 – 1 x NU313 (6313)	2,75
E	55	2 x 7312 – 1 x NU312 (6312)	2
F	70	2 x 7315 – 1 x NU315 (6315)	3

Table 3

- Check the oil levels on oil lubricated bearings frequently and fill up when shortened. Empty the old oil, clean the box and refill with new oil until the indicated level on the gage once a year maximum.
- The bearing temperature may exceed the ambient temperature by up to 50°C. But never rise above 80°C.
- Do not reuse the bearings following disassembly for maintenance purposes.

## 2.6. DISASSEMBLY, REPAIR AND REASSEMBLY



Before starting work on the pumpset, make sure it is disconnected from the mains and can not be switched on accidentally.



Follow the safety precaution measures outlined in “safety instructions”.

### 2.6.1. Disassembly

- Close all valves in the suctions and discharge lines, and drain the pump by opening the drain plug (230).
- Drain oil from the bearing bracket (030) if the pump is oil lubricated.
- Remove coupling guard and other safety guards.
- Detach pump suction and discharge flanges and all auxiliary supply lines, disconnect the pump from the piping system. No need for this operation for the pumps where SPACER TYPE COUPLING is being used (back pull out design). For this application pump rotor assembly can be pulled out without dismantling the volute casing (001).
- Disconnect pump from the driver and detach from the baseplate (no need to dismantle the motor for the pumps which have spacer types of couplings).
- Unscrew the bolts which mount casing cover (003) to the volute (001).
- Take out spacer part of coupling (if used) from where is mounted. Use the space available to pull out bearing housing and rotor assembly.
- Pull off the pump end coupling half from the shaft (060) using a pull-off device and remove the coupling key (211).
- Unscrew the end nuts (065) of the impeller and take out the impeller (050) and impeller key (210). Use rust remover solvent if necessary during dismantling.
- Dismantle bearing covers (034&035), casing cover (003), shaft (060) and bearings (202&203).
- Clean all the parts, replace damaged or worn-out ones.

### 2.6.2. Reassembly

- Reassembly proceeds in reverse sequence to disassembly as described in section 2.6.1. You may find the attached drawings useful.
- Coat the seats and screw connections with graphite, silicon or similar slippery substance before reassembly. If you can not find any of the above you may use oil instead (except the pumps for drinking water)
- Never use the old gaskets, make sure the new gaskets and o-rings are the same size as the old ones.
- Start mounting from the bearings. Place ball bearings on their places on the shaft by slightly heating or by using press. Put this part to the bearing housing from the coupling side put the bearing covers at both ends to their places. Place stuffing box and impeller and tighten the impeller nut.
- Mount rotor assembly to volute casing
- Make sure the gaskets and o-rings are evenly placed without sliding and not damaged or not squeezed at all.
- Place the pump on the baseplate, couple the motor. Connect suction and discharge pipes as well as auxiliary pipes. Take the unit into operation.

## 2.6.3. Shaft seal

### 2.6.3.1. Pump with soft packing gland

- While starting to change soft packing thoroughly clean the stuffing box and shaft sleeve.
- Cut enough number of pieces at the suitable length diagonally from suitable size of soft packing. Roll it up over the shaft sleeve and see the ends are in full contact. Insert the first packing ring as the joint will place up, and press home using the gland cover.
- Place the second ring as joint will place down. Insert all the packing rings in the same way. If there is a lantern ring put into place too.
- Place the gland and fully tighten, thus the packing rings will take the shape of stuffing box, then loosen it. Slightly tighten by turning the shaft and stop tightening when it slightly brakes the shaft.
- After starting operation, it is necessary that water drips from the packing. This dripping shouldn't be less than 10 cm<sup>3</sup>/min and more than 20 cm<sup>3</sup>/min. Adjust dripping by uniformly tightening and slackening the gland nuts slightly.
- Check the temperature of soft packing after two hours operation after gland adjustment to avoid overheating. Packing temperature must not exceed 80°C where pumping liquid temperature is the same as ambient temperature.

### 2.6.3.2. Pump with mechanical seal

- When operating properly the mechanical seal has no visible leakage. Usually mechanical seals do not require maintenance until leakage is visible but its tightness is to be checked regularly.
- Follow the instructions of mechanical seal manufacturers for the pumps having mechanical seals and NEVER RUN IT DRY!
- Mechanical seal diameters are given in Table 4.

Pump Dimension Group	Shaft End Diameter (Ø)	Mechanical Seal Diameter (Ø)
A	24	35
B	32	45
C	42	55
D	48	65
E	55	60
F	70	80

Table 4

## 2.7. SPARE PARTS

BOULTON PUMPS guarantees to supply the spare parts for ESK type pumps for 10 years. You can provide any spare parts easily.

Inform us about the following details on the name-plate, when you order spare parts.

Pump Type and Size : (ESK-125-315)  
 Motor Power and Speed : (30 kW - 1450 rpm)  
 Prod. Year and Serial Number : (2019 - 20503)  
 Capacity and Head : (200 m<sup>3</sup>/h - 30 m)

- If you prefer to have spare parts in your stock, we recommend you to have the following quantities for a two years operation depending on the number of same type of pumps (Table 5).

Part No.	Part Name	Number of pumps in the system						
		2	3	4	5	6-7	8-9	10+
060	Shaft (incl. keys)	1	1	2	2	2	3	30%
050	Impeller	1	1	1	2	2	3	30%
020 - 021	Wear rings (if any)	2	2	2	4	4	6	50%
022 - 023	Wear plates (if any)	1	2	2	3	3	4	50%
202 - 203	Bearings	2	2	4	4	6	8	50%
030	Bearing housing	-	-	-	-	-	1	2
422 ... 422	O-ring	4	6	8	8	9	12	150%
400	Soft Packing (set)	4	4	6	6	6	8	40%
070	Shaft Sleeve (if any)	1	1	1	2	2	2	20%

Table 5

## 2.8. FAULTS, CAUSES and REMEDIES

In this section you will find operating faults which may arise, their causes (Table 6) and suggested remedies (Table 7).

**ATTENTION** Before remedying operating faults, check all measuring instruments used for reliability and accuracy.

The pump must have cooled down to ambient temperature and its pressure must be released before attempting to remedy faults on parts.

FAULTS	POSSIBLE CAUSES
Pump does not deliver any water after start-up	1-5-7-10-11-13
Flow is going down or no flow at all	2-3-8-14
Driver overloaded	9-12-17-18-19-27-28
Bearing overheating	19-20-21-22-24
Vibration on pump	15-16-19-23-25
Noise level is high	4-6-26

Table 6



	POSSIBLE CAUSES	REMEDIES
1	There may be air existing in pump or piping.	Fill pump and piping completely with liquid and repeat the priming procedure.
2	Ingress of air through shaft seal, suction pipe or suction port. Pump lifts liquid with air.	Check for leaks in suction pipe joints and fittings. Check shaft seal if necessary increase the pressure of sealing liquid. Check the dept of suction pipe or foot valve in the liquid and if necessary increase the depth of them.
3	Air pocket in the suction pipe.	Check the slope of the suction line make sure that there is no reason for formation of air pockets.
4	There is air in liquid.	Suction pipe is not submerged enough creating vortex. Check liquid level in suction tank or increase the depth of suction pipe or foot valve in the liquid.
5	Too much suction lift.	If no obstruction at inlet check the friction losses of suction line, larger piping may correct condition. If static lift is too high, the liquid level in the suction tank must be raised or the pump lowered.
6	Pump is working at cavitation conditions.	NPSH available is too low. Check liquid level in suction tank, check suction line for excessive friction losses. Check isolating valve in suction line to make sure it is completely open. If necessary increase suction head on pump by lowering the pump.
7	Insufficient manometric head.	The actual total head is higher than that originally specified. Check the geodetic total head and friction losses in the discharge line. Larger piping may correct the condition. Check that valves are fully open.
8	Increase at total manometric head.	Check that valves are fully open. Check that there is any obstruction in piping.
9	Pump is operating at lower manometric head.	The actual total head is lower than that originally specified. Machine impeller outer diameter to size advised by supplier.
10	Reverse rotation.	Check motor rotation with directional arrow on pump casing or nameplate.
11	Speed is too low.	Check the supply voltage and frequency or motor may have open phase.
12	Speed is too high.	If possible decrease the pump rotational speed or turn down the impeller outer diameter to size advised by supplier.
13	Impeller or check valve or strainer is clogged.	Clean the impeller or check valve or strainer.
14	Impeller or strainer is clogged partially.	Clean the impeller or strainer.
15	Partially clogged impeller.	Clean the impeller.
16	Worn out and defected impeller.	Replace impeller.
17	Mechanical frictions inside the pumps.	Check pump rotor for any rotor obstruction or deflection.
18	Excess tightened soft packing.	Loosen the nuts of the packing gland.
19	Bad coupling alignment.	Check the coupling rubber and realign the coupling.
20	Bearing covers are too tight.	Check and make necessary modification on the cover.
21	The pumped flow is less than the minimum flow required.	Increase the flow. If necessary use by-pass recirculating valve or line.
22	Existence of excess grease.	Remove excess grease.
23	Oblique shaft.	Check the shaft and replace it if necessary.
24	Insufficient lubrication or lubricating grease dirty, contaminated.	Check the amount of grease. Clean the bearings and bearing housing and relubricate
25	Unbalanced rotating parts.	Check the balance of the rotating parts.
26	Pump runs out of duty range.	Check the values of operating point.
27	The density or viscosity of the liquid pumped is higher than that originally specified.	Use a more powerful motor.
28	Defects in motor.	Check any motor defects. The motor may not be ventilated properly due to a poor location.

Table 7

## 2.9. TIGHTENING TORQUES

TIGHTENING TORQUES		
Thread Diameter (Ø)	Tightening Torque max (Nm)	
	Property Classes	
	8.8	10.9
M4	3.0	4.4
M5	5.9	8.7
M6	10	15
M8	25	36
M10	49	72
M12	85	125
M14	135	200
M16	210	310
M18	300	430
M20	425	610
M22	580	820
M24	730	1050
M27	1100	1550
M30	1450	2100
M33	1970	2770
M36	2530	3560

Table 8

## 2.10. EXPECTED NOISE VALUES

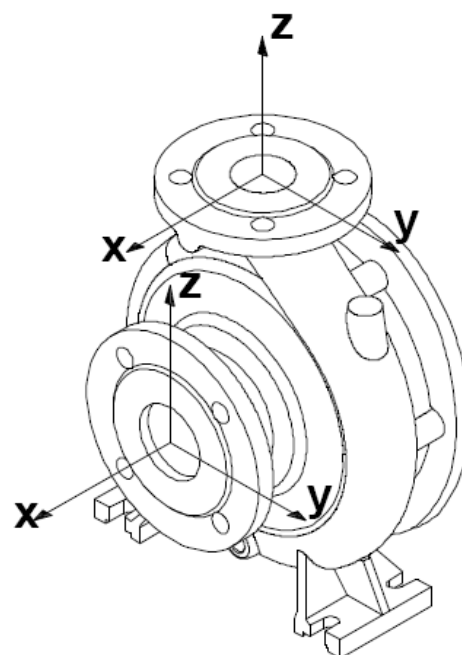
Power of motor $P_N$ (Kw)	Sound pressure level (dB) *	
	Pump with motor	
	1450 rpm	2900 rpm
< 0.55	60	64
0.75	60	66
1.1	62	66
1.5	63	68
2.2	64	69
3	65	70
4	66	71
5.5	67	73
7.5	69	74
11	70	76
15	72	77
18.5	73	78
22	74	79
30	75	81
37	75	82
45	76	82
55	77	84
75	78	85
90	79	85
110	80	86
132	80	86
160	80	86

Table 9

(\*) Without protective sound hood, measured at a distance of 1 m directly above the driven pump, in a free space above a sound reflecting surface.

## 2.11. PERMISSIBLE FORCES AND MOMENT AT THE PUMP FLANGES AND WEIGHTS

TYPE	$F_v$	$F_h$	$\sum F$	$\sum M_t$
32-160	1300	950	1600	180
32-200				
40-200	1400	1000	1700	200
40-250				
50-160	1500	1100	1800	280
50-200				
50-250				
50-315				
65-160	1800	1300	2200	450
65-200				
65-250				
65-315				
80-200	2300	1500	2700	630
80-250				
80-315				
80-400				
100-200	3100	1900	3600	930
100-250				
100-315				
100-400				
125-200	4200	2600	4900	1400
125-250				
125-315				
125-400				
150-200	5000	3300	6000	1800
150-250				
150-315				
150-400				
150-500				
200-260	5500	3500	6500	2000
200-315				
200-400				
200-500				
250-315	6500	4500	7800	3000
250-400				
250-500				



\* Forces in Newton [N], moments in Newton x Meter [N.m].

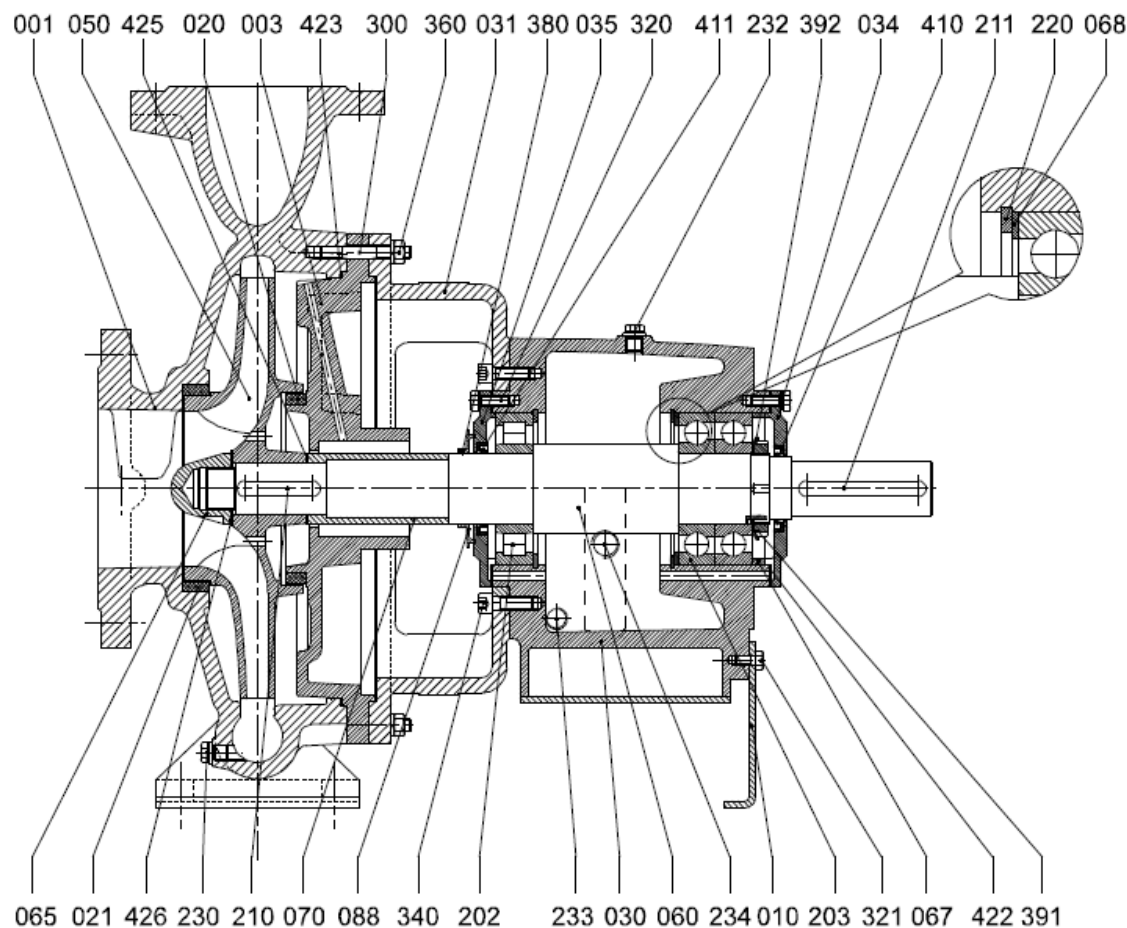
\* Values are applicable for casing material ``Grey Cast Iron (EN-JL-250 / GG25)``. Higher values are permissible for steel construction pumps.

## 2.12. PUMP DIMENSION GROUPS AND WEIGHTS

Pump Type	Dimension Group	Characteristics Dimensions Shaft Diameter / f (length)	Weight (kg)
32-160	A	Ø24 / 385	51
50-160			52
32-200			51
40-200			58
50-200			58
65-160	B	Ø32 / 500	56
65-200			63
80-200			75
100-200			108
125-200			140
40-250			95
50-250			97
65-250			102
80-250			125
50-315			130
150-200	C	Ø42 / 545	180
100-250		Ø42 / 530	139
125-250			150
150-250			180
65-315			143
80-315			145
100-315			158
125-315			180
80-400			175
100-400			182
125-400			205
150-315	D	Ø48 / 670	250
150-400		Ø48 / 684	277
200-260			310
200-315			330
150-500	E	Ø55 / 730	480
200-400		Ø55 / 725	360
250-315		Ø55 / 730	390
250-400		Ø55 / 750	460
200-500	F	Ø70 / 925	640
250-500		Ø70 / 940	660

## 2.13. SECTIONAL DRAWINGS

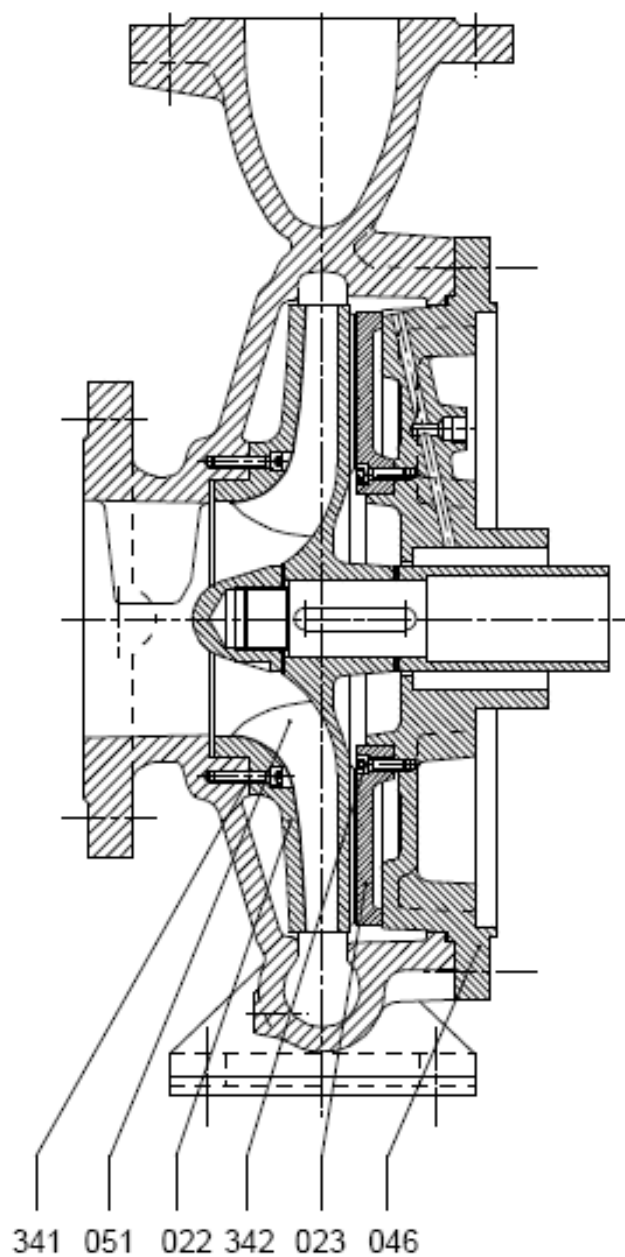
### M1 – STANDARD MOUNTING



#### PART LIST

001	Volute casing	211	Key (Coupling)
003	Casing cover	220	Circlip
010	Support foot	230	Grain plug
020	Wear ring (Casing)	232	Oil filling
021	Wear ring (Casing cover)	233	Oil drain
022	Wear ring (Front)	234	Oil level gauge
030	Bearing bracket	300	Stud
031	Bearing bracket lantern	320	Hex. head bolt
034	Bearing cover (Outboard)	321	Hex. head bolt
035	Bearing cover (Inboard)	340	Allen bolt
050	Impeller	360	Nut
060	Shaft	380	Set screw
065	Impeller Nut	391	Shaft end nut
067	Spacer ring (Bearing)	392	Lock washer
068	Spacer ring (Bearing)	410	Oil seal
070	Shaft sleeve	411	Oil seal
088	Thrower	422	Gasket
202	Cylindrical roller bearing	423	Gasket
203	Angular contact ball bearing	425	Gasket
210	Key (Impeller)	426	Gasket

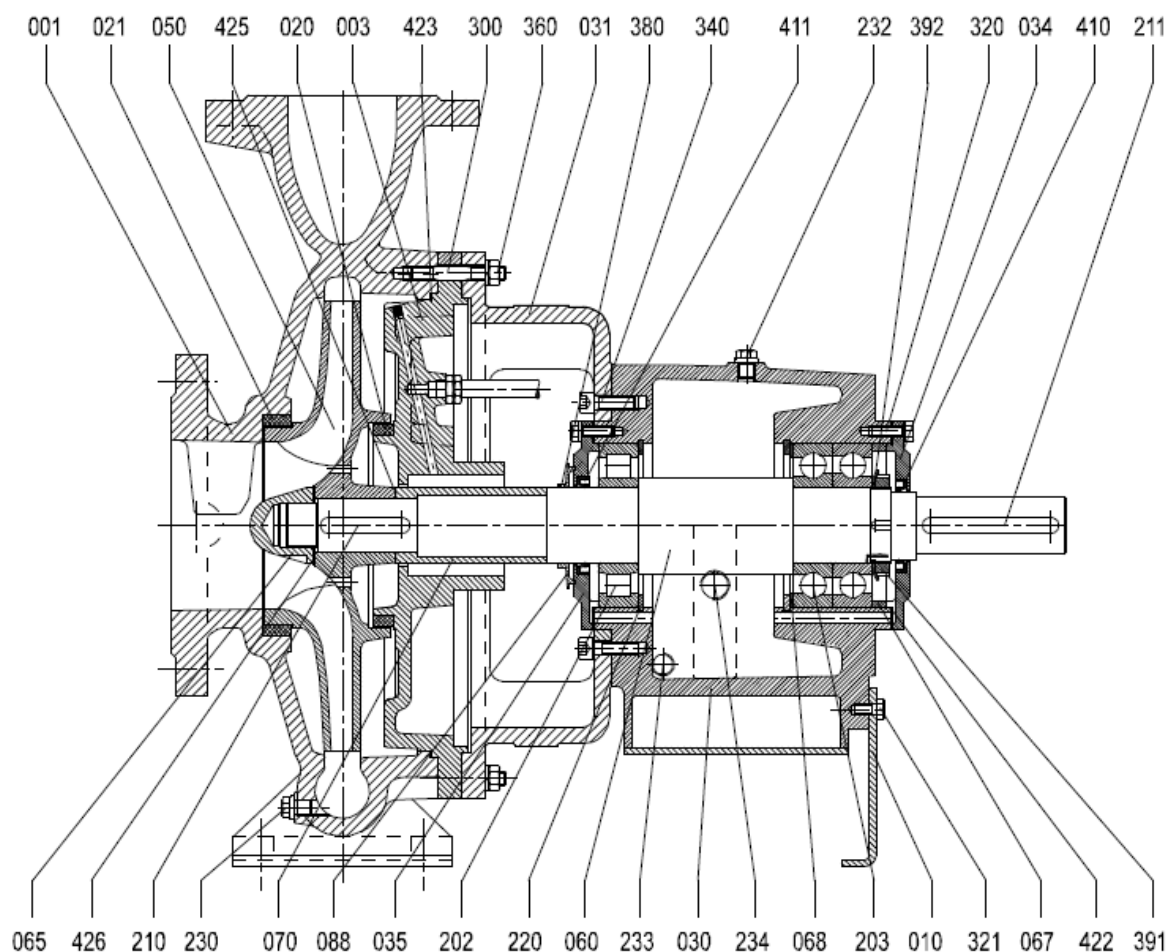
**M2 – SEMI-OPEN IMPELLER APPLICATION**



**PART LIST**

022	Wear plate (front)
023	Wear plate (back)
046	Casing cover (semi-open impeller)
051	Impeller (semi-open)
341	Allen bolt
342	Allen bolt

### M3 – FLUSHING FROM EXTERNAL SOURCE



#### PART LIST

001	Volute casing	220	Circlip
003	Casing cover	230	Grain plug
010	Support foot	232	Oil filling
020	Wear ring (Casing)	233	Oil drain
021	Wear ring (Casing cover)	234	Oil level gauge
030	Bearing bracket	300	Stud
031	Bearing bracket lantern	320	Hex. head bolt
034	Bearing cover (Outboard)	321	Hex. head bolt
035	Bearing cover (Inboard)	340	Allen bolt
050	Impeller	360	Nut
060	Shaft	380	Set screw
065	Impeller Nut	391	Shaft end nut
067	Spacer ring (Bearing)	392	Lock washer
068	Spacer ring (Bearing)	410	Oil seal
070	Shaft sleeve	411	Oil seal
088	Thrower	422	Gasket
202	Cylindrical roller bearing	423	Gasket
203	Angular contact ball bearing	425	Gasket
210	Key (Impeller)	426	Gasket
211	Key (Coupling)		



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# ESK

Instructions for  
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