xylem
Let's Solve Water

Installation, Operation, and Maintenance Manual

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N3531

FLYGT
a xylem brand

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1 Introduction and Safety

1.1 Introduction

Purpose of the manual

The retrofit manual is used for the installation of the MAS801 system when pumps are already installed and in operation. The installation can be required for different reasons.

For more information on the MAS801 system, see the System Installation and Operation manual and the Technical specification for the system. See also the specific documents for the Base Unit (BU), the Central Unit (CU), and the Human-machine interface (HMI).

Read and keep the manual

Save this manual for future reference, and keep it readily available at the location of the unit.

Intended use

WARNING:

Operating, installing, or maintaining the unit in any way that is not covered in this manual could cause death, serious personal injury, or damage to the equipment and the surroundings. This includes any modification to the equipment or use of parts not provided by Xylem. If there is a question regarding the intended use of the equipment, please contact a Xylem representative before proceeding.

Other manuals

See also the safety requirements and information in the original manufacturer's manuals for any other equipment furnished separately for use in this system.

1.2 Safety terminology and symbols

About safety messages

It is extremely important that you read, understand, and follow the safety messages and regulations carefully before handling the product. They are published to help prevent these hazards:

- Personal accidents and health problems
- Damage to the product and its surroundings
- Product malfunction

Hazard levels

Hazard level	Indication
 **DANGER:**	A hazardous situation which, if not avoided, will result in death or serious injury
 **WARNING:**	A hazardous situation which, if not avoided, could result in death or serious injury
 **CAUTION:**	A hazardous situation which, if not avoided, could result in minor or moderate injury

Hazard level	Indication
NOTICE:	Notices are used when there is a risk of equipment damage or decreased performance, but not personal injury.

Special symbols

Some hazard categories have specific symbols, as shown in the following table.

Electrical hazard		Magnetic fields hazard	
	Electrical Hazard:		CAUTION:

1.3 User safety

All regulations, codes, and health and safety directives must be observed.

The site

- Observe lockout and tagout procedures before starting work on the product, such as transportation, installation, maintenance, or service.
- Pay attention to the risks presented by gas and vapors in the work area.
- Always be aware of the area surrounding the equipment, and any hazards posed by the site or nearby equipment.

Qualified personnel

This product must be installed, operated, and maintained by qualified personnel only.

Protective equipment and safety devices

- Use personal protective equipment as needed. Examples of personal protective equipment include, but are not limited to, hard hats, safety goggles, protective gloves and shoes, and breathing equipment.
- Make sure that all safety features on the product are functioning and in use at all times when the unit is being operated.

1.4 Ex-approved products

Follow these special handling instructions if you have an Ex-approved unit.

Personnel requirements

These are the personnel requirements for Ex-approved products in potentially explosive atmospheres:

- All work on the product must be carried out by certified electricians and Xylem authorized mechanics. Special rules apply to installations in explosive atmospheres.
- All users must know about the risks of electric current and the chemical and physical characteristics of the gas, the vapor, or both present in hazardous areas.
- Any maintenance for Ex-approved products must conform to international and national standards (for example, IEC/EN 60079-17).

Xylem disclaims all responsibility for work done by untrained and unauthorized personnel.

Product and product handling requirements

These are the product and product handling requirements for Ex-approved products in potentially explosive atmospheres:

- Only use the product in accordance with the approved motor data.
- The equipment must never run dry during operation. The volute must be filled with liquid during operation. Dry running during service and inspection is only permitted outside the classified area.
- Before you start work on the product, make sure that the product and the control panel are isolated from the power supply and the control circuit, so they cannot be energized.
- Do not open the product while it is energized or in an explosive gas atmosphere.
- Intrinsically safe circuits are normally required for the automatic level-control system by the level regulator if mounted in zone 0.
- The yield stress of fasteners must be in accordance with the approval drawing and the product specification.
- Do not modify the equipment without approval from an Ex-approved Xylem representative.
- Only use original Xylem spare parts that are provided by an Ex-approved Xylem representative.
- The thermal contacts or thermistors that are fitted to the stator windings must be connected correctly to a separate motor control circuit and in use. The thermal contacts or thermistors shall be connected to a monitoring device, which disconnects the power supply immediately upon activation. This action prevents the rise of temperatures above the temperature value for the approval classification.
- The width of flameproof joints is more than the values specified in the tables of the EN/IEC 60079-1 standard. For information contact the manufacturer.
- The gap of flameproof joints is less than the values specified in Table 2 of the EN/IEC 60079-1 standard. For information contact the manufacturer.
- It is NOT allowed to repair the flameproof joints.

ATEX and IECEx

Drive Unit	Temperature Class	Minimum Ambient Temperature	Maximum Ambient Temperature
715, 716, 745, 746, 775, 776	T3/T4	–20°C	60°C
815, 816, 845, 846, 872, 873, 875, 876, 892, 893, 895, 896	T3	–20°C	60°C
915, 916, 945, 946, 975, 976	T4	–20°C	25°C
	T3	–20°C	60°C
960, 961, 995, 996, 997, 998	T3	–20°C	60°C

FM

Drive Unit	Temperature Class	Minimum Ambient Temperature	Maximum Ambient Temperature
715, 745, 775	T3A	–25°C	40°C
	T3	–25°C	60°C
716, 746, 776	T3A	–25°C	60°C
815, 816, 845, 846, 872, 873, 875, 876, 892, 893, 895, 896	T3	0°C	40°C
915, 916, 945, 946	T3A	–25°C	40°C
	T3	–25°C	60°C
960, 961, 975, 976, 995, 996, 997, 998	T3	–25°C	60°C

Guidelines for compliance

Compliance is fulfilled only when you operate the unit within its intended use. Do not change the conditions of the service without the approval of an Ex-approved Xylem representative. When you install or maintain explosion proof products, always comply with the directive and applicable standards (for example, IEC/EN 60079–14).

Minimum permitted liquid level

See the dimensional drawings of the product for the minimum permitted liquid level according to the approval for explosion proof products. If the information is missing on the dimensional drawing, the product must be fully submerged. Level-sensing equipment must be installed if the product can be operated at less than the minimum submersion depth.

Monitoring equipment

For additional safety, use condition-monitoring devices. Examples of condition-monitoring devices include, but are not limited to, the following:

- Level indicators
- Temperature detectors in addition to the stator thermal detectors

Any thermal detectors or thermal protection devices delivered with the pump must be installed and in use at all times.

The site owner is responsible for selection, installation, and proper maintenance of functional monitoring equipment for motor protection.

1.5 Special hazards

1.5.1 Biological hazards

The product is designed for use in liquids that can be hazardous to your health. Observe these rules when you work with the product:

- Make sure that all personnel who may come into contact with biological hazards are vaccinated against diseases to which they may be exposed.
- Observe strict personal cleanliness.

WARNING: Biological Hazard

Infection risk. Rinse the unit thoroughly with clean water before working on it.

1.5.2 Wash the skin and eyes

Follow these procedures for chemicals or hazardous fluids that have come into contact with your eyes or your skin:

Condition	Action
Chemicals or hazardous fluids in eyes	1. Hold your eyelids apart forcibly with your fingers. 2. Rinse the eyes with eyewash or running water for at least 15 minutes. 3. Seek medical attention.
Chemicals or hazardous fluids on skin	1. Remove contaminated clothing. 2. Wash the skin with soap and water for at least 1 minute. 3. Seek medical attention, if necessary.

1.6 Protecting the environment

Emissions and waste disposal

Observe the local regulations and codes regarding:

- Reporting of emissions to the appropriate authorities
- Sorting, recycling and disposal of solid or liquid waste
- Clean-up of spills

Exceptional sites

CAUTION: Radiation Hazard

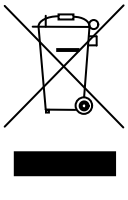
Do NOT send the product to Xylem if it has been exposed to nuclear radiation, unless Xylem has been informed and appropriate actions have been agreed upon.

1.7 End-of-life product disposal

Handle and dispose of all waste in compliance with local laws and regulations.

EU and UK only: Correct disposal of this product — waste electrical and electronic equipment

- EU: Directive 2012/19/EU on waste electrical and electronic equipment (WEEE)
- UK: SI 2013 No. 3113



This marking on the product, accessories or literature indicates that the product should not be disposed of with other waste at the end of its working life.

1.8 Spare parts

CAUTION:

Only use the manufacturer's original spare parts to replace any worn or faulty components. The use of unsuitable spare parts may cause malfunctions, damage, and injuries as well as void the warranty.

1.9 Warranty

For information about warranty, see the sales contract.

2 Transportation and Storage

2.1 Examine the delivery

2.1.1 Examine the package

1. Examine the package for damaged or missing items upon delivery.
2. Record any damaged or missing items on the receipt and freight bill.
3. If anything is out of order, then file a claim with the shipping company.

   If the product has been picked up at a distributor, make a claim directly to the distributor.

2.1.2 Examine the unit

1. Remove packing materials from the product.

   Dispose of all packing materials in accordance with local regulations.
2. To determine whether any parts have been damaged or are missing, examine the product.
3. If applicable, unfasten the product by removing any screws, bolts, or straps.

   Use care around nails and straps.
4. If there is any issue, then contact a sales representative.

2.2 Lifting guidelines

2.2.1 Precautions

DANGER: Crush Hazard

Moving parts can entangle or crush. Always disconnect and lock out power before servicing to prevent unexpected startup. Failure to do so could result in death or serious injury.

Position and fastening

The unit can be transported either horizontally or vertically. Make sure that the unit is correctly fastened during transportation, and cannot roll or fall over.

Horizontal position

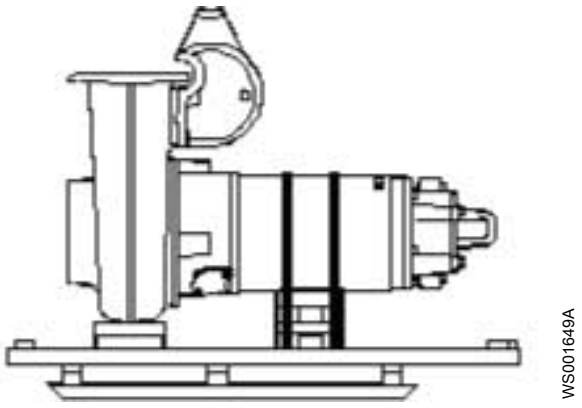


Figure 1: Horizontal position for transport

If the unit is transported in the horizontal position, then the impeller must be locked during transportation.

Vertical position

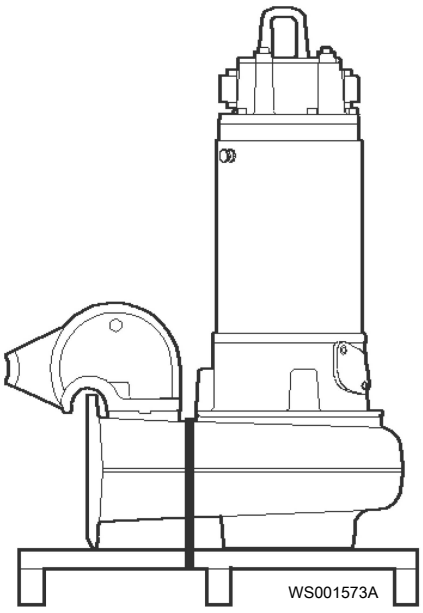


Figure 2: Vertical position for transport

2.2.2 Lifting

Always inspect the lifting equipment and tackle before starting any work.

WARNING: Crush Hazard

Always lift the unit by its designated lifting points.

Use suitable lifting equipment and ensure that the product is properly harnessed.

Wear personal protective equipment.

Stay clear of cables and suspended loads.

NOTICE:

Never lift the unit by its cables or hose.

Lifting equipment

Lifting equipment is always required to handle the unit. The lifting equipment must fulfill the following requirements:

- The minimum height between the lifting hook and the floor must be sufficient to lift the unit. Contact a Xylem representative for more information.
- The lifting equipment must be able to hoist the unit straight up and down, preferably without the need for resetting the lifting hook.
- The lifting equipment must be correctly anchored and in good condition.
- The lifting equipment must support the weight of the entire assembly. Only authorized personnel may use the lifting equipment.
- Two sets of lifting equipment must be used to lift the unit for repair work.
- The lifting equipment must be dimensioned to lift the unit with any remaining pumped media in it.
- The lifting equipment must not be oversized.

CAUTION: Crush Hazard

Improperly-dimensioned lifting equipment can lead to injury. A site-specific risk analysis must be done.

2.2.3 Lifting link placement for vertical lifting

Use the following lifting link configurations to lift the pump in the vertical position.

If only the drive unit is lifted, then the lifting cover must be turned 180°.

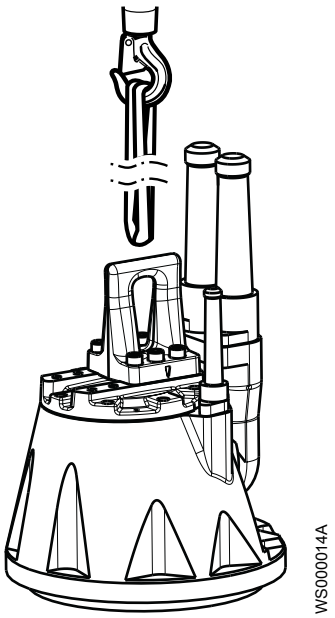


Figure 3: Drive units 705–998. 7XX with large connection housing.

705–998 drive units: The lifting link must be placed so that the complete unit hangs forward with an incline of 0–2° in relation to the vertical axis.

All the screws holding the lifting link in position must be tightened to 629 Nm (464 lbf·ft) before lifting the 705–998 drive units.

Placement for lifting the complete unit N3531, with 705–776 drive units:

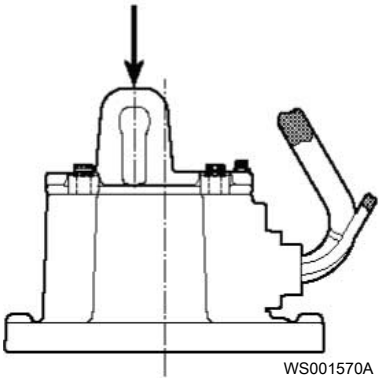
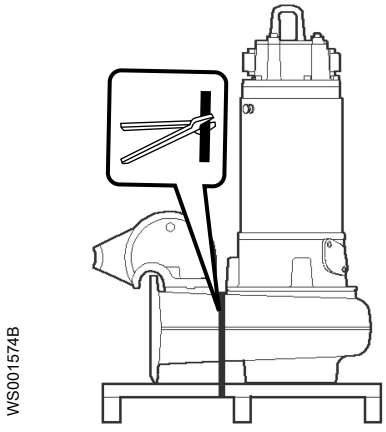


Figure 4: Drive units 705–776 with small connection housing

2.2.4 Lift pump from vertical position and remove transport pallet

1. Fit a lifting strap or sling to the lifting eye on the top of the drive unit.
2. Cut the transportation strap.

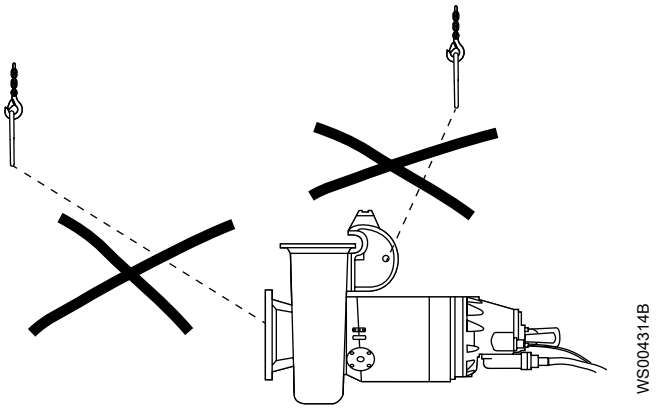


3. Lift the pump with correct lifting equipment.
4. Put the pump upright on a rigid horizontal surface so that it cannot fall over.

2.2.5 Lift pump from horizontal position and remove transport pallet

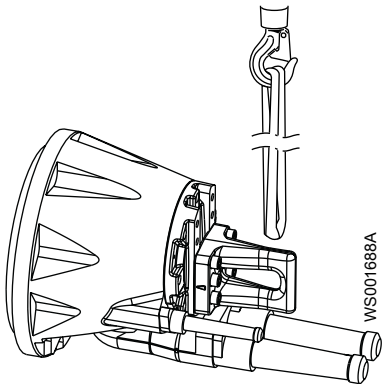
NOTICE:

An assembled pump must never be lifted by the holes in the hydraulic unit.



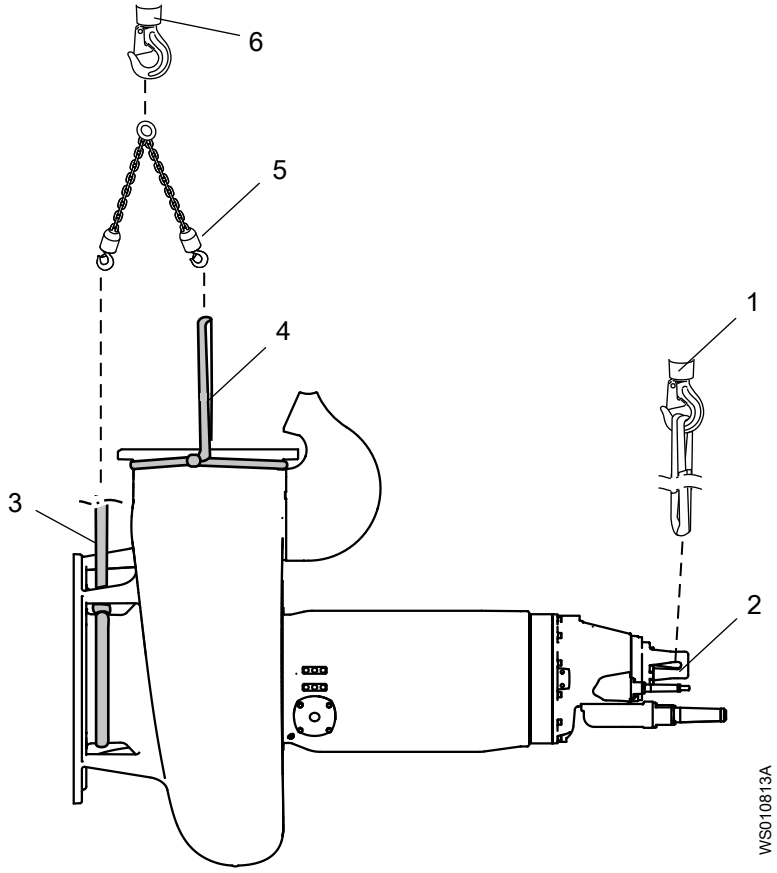
NOTICE:

When handling the unit to and from horizontal position, the unit should always be lifted by the lifting link. Use a suitable lifting sling/ strap.

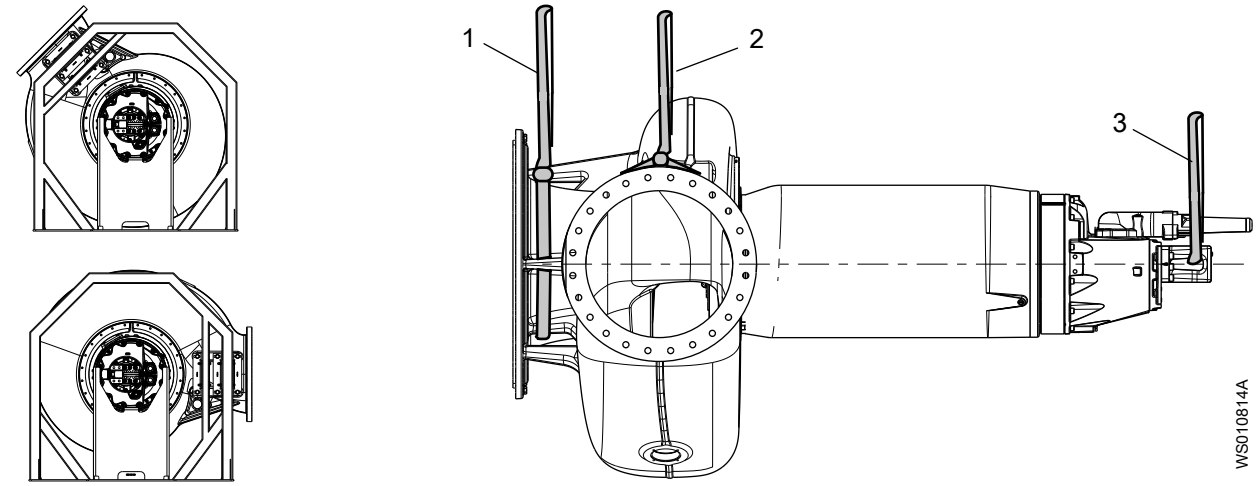


Lift with two lifting devices (recommended)

The illustrations are generic.



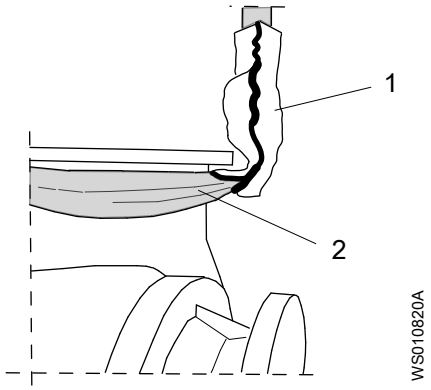
1. Hook on first lifting equipment
2. Lifting handle
3. Sling on inlet
4. Sling on outlet
5. Two-leg chain sling
6. Hook on second lifting equipment



1. Sling on inlet
2. Sling on outlet
3. Sling at lifting handle

1. Attach the first lifting sling or strap to the lifting handle on the top of the drive unit. Attach the other end of the sling to the hook on the first lifting device.
2. Attach a two-leg chain sling to the hook on the second lifting device.
3. Attach the second sling around the pump inlet. Attach the other end of the sling to the two-leg chain sling.
4. Attach the third sling around the pump outlet. Attach the other end of the sling to the other leg of the two-leg chain sling.

Use cut protection on the lifting sling.

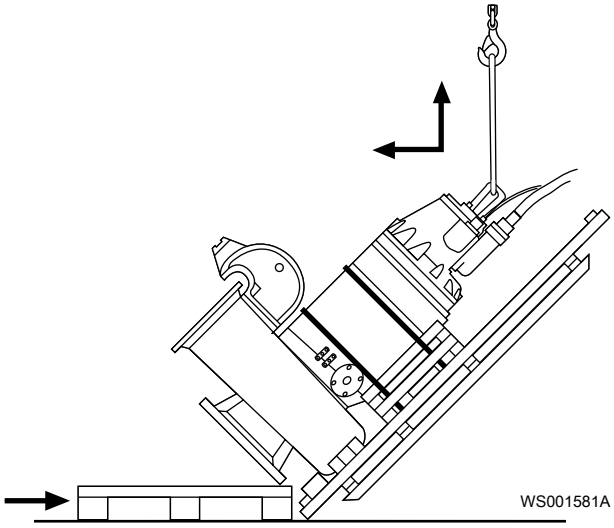


1. Cut protection on sling
2. Lifting sling

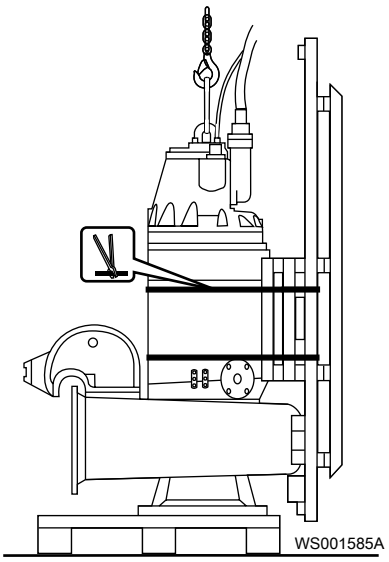
5. Adjust the straps and lifting tackle so that the pump cannot roll during the lift.
6. Remove the straps which secure the unit to the transport pallet.
   The transport pallet is custom-made for the pump and can be stored for future use.
7. Lift the unit.
8. Put the unit upright on a rigid horizontal surface so that it cannot fall over.

Lift with one lifting device

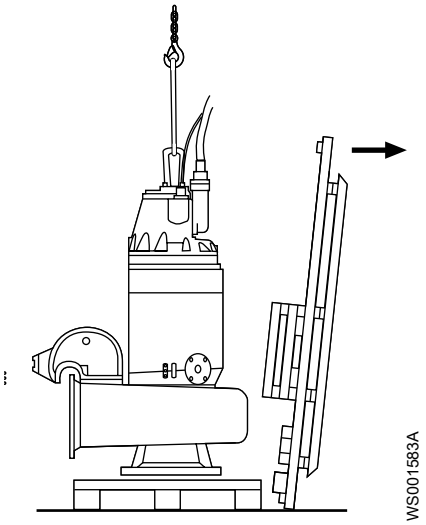
1. Attach a lifting sling or strap to the lifting eye on the top of the drive unit.
2. Lift the unit until it is halfway upright.
   The unit is attached to the transport pallet at this point.
3. Slide a pallet or similar object under the inlet section.
   The pallet minimizes the jolt which can occur later in the lifting, when the unit is almost fully upright.



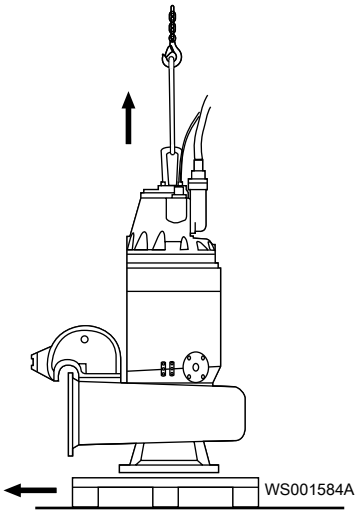
4. Continue raising the unit until it is upright.
   The unit can jolt or sway near the end of the lifting operation.
5. Remove the straps holding the unit to the transport pallet.



6. Remove the transport pallet.
   The transport pallet is custom-made for the pump and can be stored for future use.



7. Lift the unit and remove the support pallet.



8. Put the unit upright on a rigid horizontal surface so that it cannot fall over.

2.3 Temperature ranges for transportation, handling and storage

Handling at freezing temperature

At temperatures below freezing, the product and all installation equipment, including the lifting gear, must be handled with extreme care.

Make sure that the product is warmed up to a temperature above the freezing point before starting up. Avoid rotating the impeller/propeller by hand at temperatures below the freezing point. The recommended method to warm the unit up is to submerge it in the liquid which will be pumped or mixed.

NOTICE:

Never use a naked flame to thaw the unit.

Unit in as-delivered condition

If the unit is still in the condition in which it left the factory - all packing materials are undisturbed - then the acceptable temperature range during transportation, handling and storage is: –50°C (–58ºF) to +60°C (+140ºF).

If the unit has been exposed to freezing temperatures, then allow it to reach the ambient temperature of the sump before operating.

Lifting the unit out of liquid

The unit is normally protected from freezing while operating or immersed in liquid, but the impeller/propeller and the shaft seal may freeze if the unit is lifted out of the liquid into a surrounding temperature below freezing.

Follow these guidelines to avoid freezing damage:

1. Empty all pumped liquid, if applicable.
2. Check all liquids used for lubrication or cooling, both oil and water-glycol mixtures, for the presence of unacceptable amounts of water. Change if needed.

Water-glycol mixtures: Units equipped with an internal closed-loop cooling system are filled with a mixture of water and 30% glycol. This mixture remains a flowing liquid at temperatures down to –13°C (9°F). Below –13°C (9°F), the viscosity increases such that the glycol mixture will lose its flow properties. However, the glycol-water mixture will not solidify completely and thus cannot harm the product.

2.4 Storage guidelines

Storage location

The product must be stored in a covered and dry location free from heat, dirt, and vibrations.

NOTICE:

Protect the product against humidity, heat sources, and mechanical damage.

NOTICE:

Do not place heavy weights on the packed product.

Freezing precautions

The unit is frost-proof while operating or immersed in liquid, but the impeller/propeller and the shaft seal may freeze if the unit is lifted out of the liquid into a surrounding temperature below freezing.

Follow these guidelines to avoid freezing damage:

When	Guideline
Before storage	• The unit must be allowed to run for a short time after raising it to discharge remaining pumped liquid. This does not apply to impeller/propeller units. • The discharge opening must be covered in a suitable way, or placed facing down so that any still remaining pumped liquid runs out. • If present, the cooling jacket must be drained manually by opening the air vent screws at the top of the cooling jacket.
After storage	If the impeller/propeller is frozen, it must be thawed by immersing the unit in liquid before operating the unit. **NOTICE:** Never use a naked flame to thaw the unit.

Long-term storage

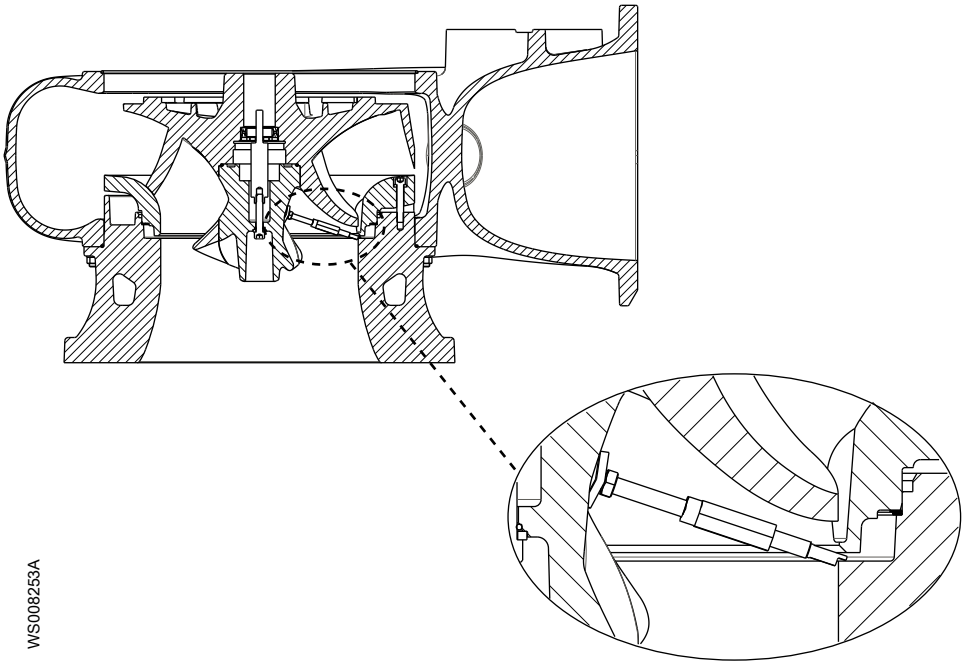
If the unit is stored for more than six months, then the following apply:

- Before operating the unit after storage, it must be inspected. Special attention must be given to the seals and the cable entry.
- The impeller or propeller must be rotated every other month to prevent the seals from sticking together.

2.4.1 Reinstall the locking device

If the unit is transported in the horizontal position, then the impeller or propeller must be locked with the locking device during the transport.

1. Reinstall the locking device.



2. Clamp the locking device in place by turning and locking it by hand as tightly as possible.
3. Tighten a further 1/8 to 1/3 of a turn according to the torque specified in the cross-sectional drawing in the Part List.

3 Product Description

3.1 Pump design

Intended Use

The product is intended for moving wastewater, sludge, raw and clean water. Always follow the limits that are given in *Application limits* on page 154. If there is a question regarding the intended use of the equipment, then contact a Xylem representative before proceeding.

DANGER: Explosion/Fire Hazard

Special rules apply to installations in explosive or flammable atmospheres. Do not install the product or any auxiliary equipment in an explosive zone unless it is rated explosion-proof or intrinsically-safe. If the product is rated explosion-proof or intrinsically-safe, then see the specific explosion-proof information in the safety chapter before taking any further actions.

NOTICE:

Do NOT use the unit in highly corrosive liquids.

3.1.1 Spare part requirements

The following applies when the unit is serviced or repaired:

- Modifications to the unit or installation must only be carried out after consulting with Xylem.
- Original spare parts and accessories that are authorized by Xylem are essential for compliance. The use of other parts can invalidate any claims for warranty or compensation. For more information, contact a Xylem representative.

3.2 Drive units

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Voltage range	Standard drive units	Ex-proof drive units	Maximum number of starts per hour
Up to 1 kV	705	715	15
	735	745	15
	765	775	15
Up to 1 kV	706	716	10
	736	746	10
	766	776	10
Up to 1 kV	805	815 (2)	15
	835	845 (2)	15
	865	875 (2)	15
Up to 1 kV	806	816 (2)	10
	836	846 (2)	10
	866	876 (2)	10
Up to 1 kV	905	915	10
	935	945	10
	965	975	10

Voltage range	Standard drive units	Ex-proof drive units	Maximum number of starts per hour
Up to 1 kV	906	916	10
	936	946	10
	966	976	10
1.2–6.6 kV	863	873 (1)	10
	883	893 (1)	10
1.2–6.6 kV	950	960	10
	985	995	10
	988	998	10
1.2–6.6 kV	951	961	10
	986	996	10
	987	997	10
(1) FM: 2.3–4.16 kV (2) FM: Up to 600 V			

3.3 The MAS 801 monitoring equipment

3.3.1 FLS: float switch sensor

The float switches are leakage sensors.

Drive units with direct, external or integrated cooling: The float switches are located in the lower part of the stator housing and in the junction box.

Drive units with internal closed-loop cooling: The float switches are leakage sensors located in the inspection chamber and in the junction box.

3.3.2 Vibration in three directions

A vibration sensor that is located in the PEM measures vibration speed in three directions.

Two adjustable alarm limits can be applied for each measurement direction:

- Early warning: “B”-alarm
- Pump stop: “A”-alarm

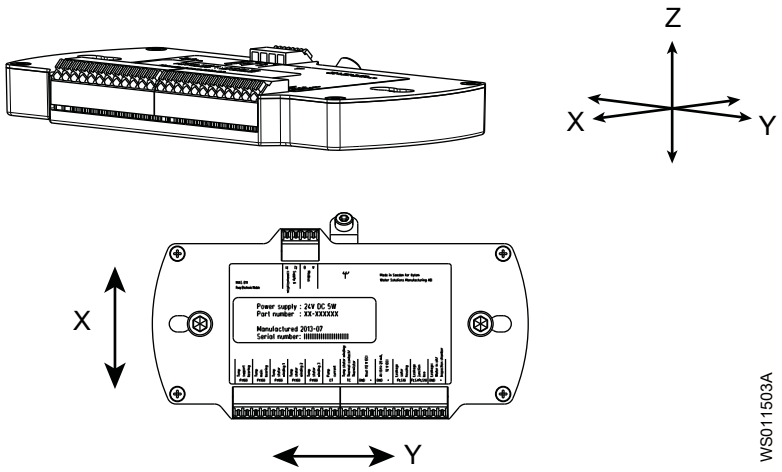


Figure 5: Vibration directions with reference to the PEM

The definitions of X, Y and Z are the same, whether or not the pump is in a vertical or horizontal position.

The Z-direction is parallel to the motor shaft. The X-direction points towards the cable entry.

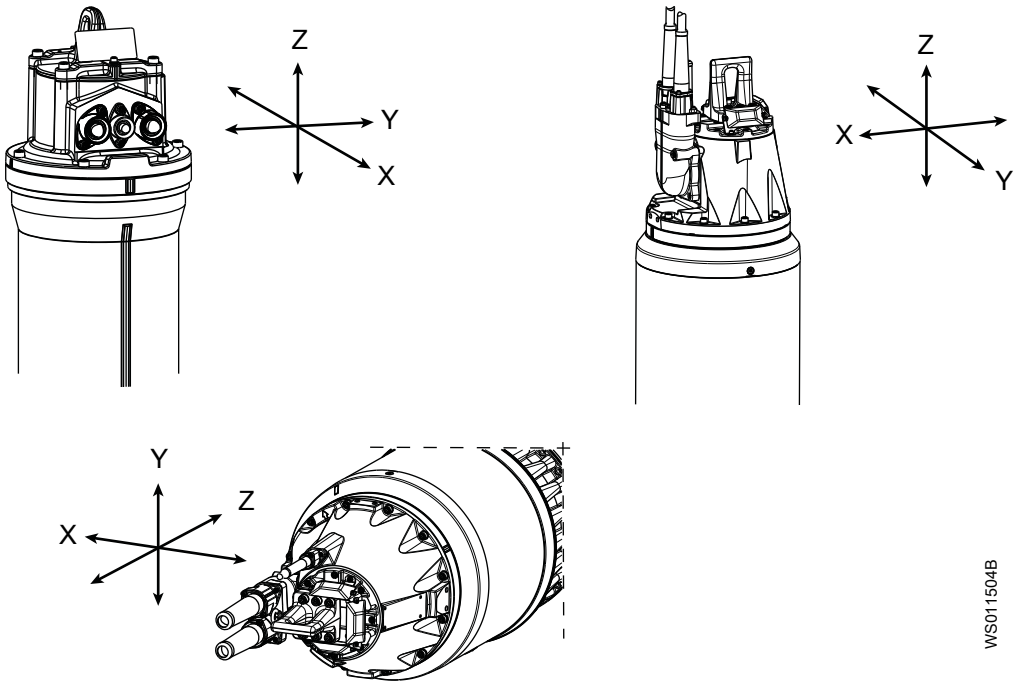


Figure 6: Vibration directions with reference to the pump

3.3.3 Bearing temperature measurement

Pt100 sensors monitor the bearing temperatures to protect the pump from the consequences of a bearing failure.

Main bearing

Main bearing temperature monitoring is standard in the MAS 711 and MAS 801. The Pt100 sensor is pressed by a spring against the outer ring of the ball bearing.

Support bearing

Support bearing temperature monitoring is an option in the MAS 711 and MAS 801. The Pt100 sensor is pressed by a spring against the outer ring of the roller bearing.

Alarms

Two adjustable alarm limits can be used:

- Early warning: “B”-alarm
- Pump stop: “A”-alarm

3.3.4 Stator temperature monitoring methods

The purpose of stator winding temperature monitoring is to make the motor shut off at high temperature. There are several monitoring methods, depending on the voltage of the motor, and types of thermal sensors chosen.

By using an analogue sensor, two adjustable alarm limits can be used, one for warning (“B”-alarm) and one for pump stop (“A”-alarm). The configurations which can be used for monitoring the stator winding temperature depend upon the voltage range of the drive unit. See *Drive units* on page 19 for the voltage range for each drive unit.

Up to 1 kV drive units

Table 1: Stator temperature monitoring configuration, up to 1 kV

Standard / Optional	Monitoring configuration description
Standard	• Three thermal contacts, connected in series, are incorporated in the coil ends of the stator winding. The contacts are normally closed, and open at 140°C (285°F). • One Pt100 sensor is incorporated in one of the windings.
	Or:
	• Three thermistors, PTC, connected in series, are incorporated in the coil ends of the stator windings. T_{Ref}=140°C (285°F). • One Pt100 sensor is incorporated in one of the windings.
Optional	• Three thermal contacts, connected in series, are incorporated in the coil ends of the stator winding. The contacts are normally closed, and open at 140°C (285°F). • Three Pt100 sensors, one for each phase, are incorporated in the windings.
	Or:
	• Three thermistors, PTC, connected in series, are incorporated in the coil ends of the stator windings. T_{Ref}=140°C (285°F). • Three Pt100 sensors, one for each phase, are incorporated in the windings.

1.2–6.6 kV drive units

Table 2: Stator temperature monitoring configuration, 1.2–6.6 kV

Standard / Optional	Monitoring configuration description
Standard	This configuration uses the following: • Three thermistors, PTC, connected in series, are incorporated in the coil ends of the stator windings. T_{Ref}=155°C (310°F) for medium-voltage drive units • Three Pt100 sensors, one for each phase, are incorporated in the windings. There are three extra thermistors, and three extra Pt100 sensors, already in position in the stator windings as reserves.

Stators used in the 1.2–6.6 kV drive units are equipped with three Pt100 sensors marked 19:20, 21:22, and 23:24. These sensors are connected at the plinth on the terminal plate. The stator is also equipped with a duplicate set of three Pt100 sensors, marked 19s:20s, 21s:22s, and 23s:24s. The duplicate set is not connected to the terminal plate as long as the first set of three Pt100 sensors function; it is kept in reserve as a back-up set. The ends of the reserve sensor leads are isolated, and leads bundled among the other cables, until the back-up Pt100 sensors are needed.

For pumps with drive units in voltage range 1.2–6.6 kV, the medium-voltage stator settings are shown in the following table.

Table 3: Stator alarm settings for 1.2–6.6 kV drive units

Stator Alarm	Setting
A	155°C
B	145°C

3.3.4.1 Temperature sensors

Table 4: Thermal contact

Description	Measured value	Fault values
The thermal contact is a normally closed contact.	0–3 ohm, unless the wires are long.	An infinite value (open circuit) indicates either high temperature or a fault. Examples of faults include a broken wire, or a bad contact in a connector.

Table 5: PTC thermistor

Description	Measured value	Fault values
The PTC thermistor is a semiconductor device.	Resistance at normal temperature: • 50–100 ohm (150–300 ohm for three in series).	• Above the tripping point, T_{Ref}, the resistance increases dramatically to several kilohm. • An infinite value (open circuit) indicates a fault. Examples of faults include a broken wire, or a bad contact in a connector. • A value close to zero indicates a short circuit in the wiring.

Table 6: Pt100 sensor

Description	Measured value	Fault values
The Pt100 sensor is a resistor changing value almost linearly with temperature.	Resistance: • 100 ohm at 0ºC (32ºF) • 107.79 ohm at room temperature (20ºC, 68ºF) • 138.5 ohm at 100ºC (212ºF) For resistance data between 0–160ºC (32–320ºF), see *Pt100 resistance* on page 155.	> 200 ohm (approximate) can indicate the following situations: • Broken sensor • Bad contact • Broken lead < 70 ohm (approximate) indicates: • Short circuit

NOTICE:

Never connect the Pt100 transducer to a voltage higher than 2.5 V.

For information on the various configurations of contacts, thermistors and sensors that are used to monitor stator winding temperature, see *Stator temperature monitoring methods* on page 27.

3.3.5 Pump current and power monitoring

Pump current

Pump current is an important parameter in itself, which the MAS 801 can also use to record running time, number of starts and other operating diagnostics. This information is fundamental for monitoring operation, maintenance planning, and fault diagnosis.

Pump current in one phase is standard with the MAS 801.

Pump current in three phases

Pump current in three phases is also possible with the MAS 801. To track pump current in three phases with the MAS 801, the following are needed:

- Three current transformers in the control cabinet
- The PAN 312 power analyzer

The current transformers are connected to the PAN 312. The PAN 312 transmits the data to the CU and the PEM in the MAS 801 system.

Power monitoring: PAN 312

The optional Flygt power analyzer PAN 312 allows the following parameters to be monitored:

- Three-phase power
- Power factor
- System voltage
- Voltage imbalance
- Pump current in three phases
- Current imbalance

3.3.6 CLS

This section applies to the following drive units:

- 605, 665
- 705, 735, 765
- 805, 835, 865, 885
- 905, 935, 965
- 950, 985, 988

Table 7: Water-in-oil sensor (CLS)

Description	Measured value	Fault values
Capacitive leakage sensor located in the oil housing. This sensor issues an alarm if the water content reaches a concentration of approximately 30% or more.	Standard drive unit only. CLS must be connected to 12 V DC with correct polarity (+/–).	See table below.

CLS alarm is not a cause for stopping the pump. It is merely an indicator to check the oil and outer seal at the next planned service.

Table 8: CLS current measurements

Measuring result	Explanation
0 mA	Can indicate one of the following conditions: • The sensor has the wrong polarity. Check by changing plus and minus. • The cable/lead is broken.
4.0 to 8.0 mA	OK
27 to 33 mA	Alarm current
> 33 mA	Short circuit

3.4 The MAS 711 monitoring equipment

The MAS 711 system

MAS 711 (Monitoring and Status) is a monitoring system for Flygt pumps. It monitors and stores measurements from a number of sensors (temperature, leakage, and vibration). These are used to:

- Protect the pump by raising an alarm when undesirable events occur.
- Track operational data.

Alarm levels can be set so that the operator is notified when an alarm event has occurred. Depending on the alarm/event configuration, the MAS 711 system may stop the pump.

The base unit stores all measurement data on its embedded server.

The system also includes a pump memory module, storing identity data of the pump.

The parameters that are tracked are chosen by the customer, and may include the following:

- Temperature:

  - Main bearing
  - Support bearing
  - Stator winding
- Vibration
- Leakage:
  - In the stator housing or inspection chamber
  - In the junction box
  - Water in the oil chamber (if applicable)
- Power monitoring

For more information, see the MAS 711 Installation and User Manual.

Pump current

Pump current is an important parameter in itself, which the MAS 711 can also use to record running time, number of starts and other operating diagnostics.

Pump current is not measured using the 12/24 lead monitoring cable. To measure it, the control cabinet must be equipped with a current transformer. Alternatively the Flygt power analyzer PAN 312 is used, requiring three transformers. The measurement results are transmitted to MAS 711 over a serial link (Modbus).

This information is fundamental for monitoring operation, maintenance planning, and fault diagnosis.

Signal cables

The pump is delivered with the signal cable (also known as “auxiliary,” “control” or “pilot” cable) mounted. The following SUBCAB signal cables are available:

- 12x1.5 mm^2 (unscreened, also known as unshielded). Conductors 1-12.
- 24x1.5 mm^2 (unscreened, also known as unshielded). Conductors 1-24.
- S12x1.5 mm^2 (screened, also known as shielded). Conductors 1-12.
- S24x1.5 mm^2 (screened, also known as shielded). Conductors 1-24.

The number of conductors that are required to connect the sensors to the monitoring system depends on the number and type of sensors being used. Medium-voltage (1.2–6.6 kV) drive units always have 24 signal cable leads.

Sensors, drive units up to 1 kV

The drive units in this voltage range are shown in *Drive units* on page 19.

Table 9: Sensors for pumps using drive units up to 1 kV

Parameter Monitored	Sensor	Signal Cable, Number of Leads Required	Standard or Optional
Vibration	VIS 10	24	Optional
Leakage in the junction box	Float switch leakage sensor (FLS)	12	Standard
Stator winding temperature in one phase	Pt100 analog temperature sensor in one stator winding	12	Standard
Stator winding temperature	Thermal contacts (3), or	12	Standard
	PTC-thermistors (3)	24	Optional
Stator winding temperature in phases 2 and 3	Pt100 analog temperature sensors in two additional stator windings	24	Optional
Main bearing temperature	Pt100 analog temperature sensor	12	Standard
Leakage in the stator housing or inspection chamber	Float switch leakage sensor (FLS)	12	Standard

Parameter Monitored	Sensor	Signal Cable, Number of Leads Required	Standard or Optional
Water in oil: standard drive units only. (Not applicable for drive units with internal closed-loop cooling.)	Capacitive leakage sensor (CLS)	24	Optional
Support bearing temperature	Pt100 analog temperature sensor	24	Optional
Pump memory	Printed circuit board for pump memory includes a temperature sensor.	12	Standard
Pump current	A current transformer in the control cabinet is required.		
Power monitoring	Separate electronic instrument using three current transformers.		Optional

For more information on the stator temperature monitoring, see *Stator temperature monitoring methods* on page 27.

Sensors, drive units 1.2 – 6.6 kV

The drive units in this voltage range are shown in *Drive units* on page 19.

Table 10: Sensors for pumps using 1.2 – 6.6 kV drive units

Description	Sensor	Signal Cable, Number of Leads Required	Standard or Optional
Vibration	VIS 10	24	Optional
Leakage in the junction box	Float switch leakage sensor (FLS)	24	Standard
Stator winding temperature	PTC-thermistors (3+3) [1]	24	Standard
Stator winding temperature in phases 1, 2 and 3	Pt100 analog temperature sensors in each stator winding (3+3) [1]	24	Standard
Main bearing temperature	Pt100 analog temperature sensor	24	Standard
Leakage in the stator housing	Float switch leakage sensor (FLS)	24	Standard
Water in oil: standard drive units only. (Not applicable for drive units with internal closed-loop cooling.)	Capacitive leakage sensor (CLS)	24	Optional
Support bearing temperature	Pt100 analog temperature sensor	24	Optional
Pump memory	Printed circuit board for pump memory includes a temperature sensor.	24	Standard
Pump current	A current transformer in the control cabinet is required.		
Power monitoring	Separate electronic instrument using three current transformers.		Optional

For more information on the stator temperature monitoring, see *Stator temperature monitoring methods* on page 27.

[1] 6 total: 3 sensors are connected and 3 are built-in spares.

3.4.1 FLS: float switch sensor

The float switches are leakage sensors.

Drive units with direct, external or integrated cooling: The float switches are located in the lower part of the stator housing and in the junction box.

Drive units with internal closed-loop cooling: The float switches are leakage sensors located in the inspection chamber and in the junction box.

3.4.2 Vibration sensor (VIS10)

Description	Measured value	Fault values
The vibration sensor located in the junction box measures vibrations in one direction. The output is a 4-20 mA signal proportional to the vibration level.	Current, 4-20 mA	• >> 20 mA indicates a short circuit. • << 4 mA indicates a fault. • A zero value indicates a broken wire or bad contact in a connector.

3.4.3 Bearing temperature measurement

Pt100 sensors monitor the bearing temperatures to protect the pump from the consequences of a bearing failure.

Main bearing

Main bearing temperature monitoring is standard in the MAS 711 and MAS 801. The Pt100 sensor is pressed by a spring against the outer ring of the ball bearing.

Support bearing

Support bearing temperature monitoring is an option in the MAS 711 and MAS 801. The Pt100 sensor is pressed by a spring against the outer ring of the roller bearing.

Alarms

Two adjustable alarm limits can be used:

- Early warning: “B”-alarm
- Pump stop: “A”-alarm

3.4.4 Stator temperature monitoring methods

The purpose of stator winding temperature monitoring is to make the motor shut off at high temperature. There are several monitoring methods, depending on the voltage of the motor, and types of thermal sensors chosen.

By using an analogue sensor, two adjustable alarm limits can be used, one for warning (“B”-alarm) and one for pump stop (“A”-alarm). The configurations which can be used for monitoring the stator winding temperature depend upon the voltage range of the drive unit. See *Drive units* on page 19 for the voltage range for each drive unit.

Up to 1 kV drive units

Table 11: Stator temperature monitoring configuration, up to 1 kV

Standard / Optional	Monitoring configuration description
Standard	• Three thermal contacts, which are connected in series, are incorporated in the coil ends of the stator winding. The contacts are normally closed, and open at 140°C (285°F). • One Pt100 sensor is incorporated in one of the windings.
	Or:
	• Three thermistors, PTC, connected in series, are incorporated in the coil ends of the stator windings. T_{Ref}=140°C (285°F). • One Pt100 sensor is incorporated in one of the windings.

Standard / Optional	Monitoring configuration description
Optional	• Three thermal contacts, which are connected in series, are incorporated in the coil ends of the stator winding. The contacts are normally closed, and open at 140°C (285°F). • Three Pt100 sensors, one for each phase, are incorporated in the windings.
	Or:
	• Three thermistors, PTC, connected in series, are incorporated in the coil ends of the stator windings. T_{Ref}=140°C (285°F) • Three Pt100 sensors, one for each phase, are incorporated in the windings.

1.2–6.6 kV drive units

Table 12: Stator temperature monitoring configuration, 1.2–6.6 kV

Standard / Optional	Monitoring configuration description
Standard	This configuration uses the following: • Three thermistors, PTC, connected in series, are incorporated in the coil ends of the stator windings. T_{Ref}=155°C (310°F) for medium-voltage drive units • Three Pt100 sensors, one for each phase, are incorporated in the windings. There are three extra thermistors, and three extra Pt100 sensors, already in position in the stator windings as reserves.

Stators that are used in the 1.2–6.6 kV drive units are equipped with three Pt100 sensors marked 19:20, 21:22, and 23:24. The sensors are connected at the plinth on the terminal plate. The stator is also equipped with a duplicate set of three Pt100 sensors, marked 19s:20s, 21s:22s, and 23s:24s. This duplicate set is not connected to the terminal plate as long as the first set of three Pt100 sensors function. The duplicate set is kept in reserve as a back-up set. The ends of the reserve sensor leads are isolated, and leads bundled among the other cables, until the back-up Pt100 sensors are needed.

The MAS 711 has preset stator alarm settings. For pumps with drive units in voltage range 1.2–6.6 kV, the settings must be changed upon installation. The medium-voltage stator settings are shown in the following table.

Table 13: Stator alarm settings for 1.2–6.6 kV drive units

Stator Alarm	Setting
A	155°C
B	145°C

3.4.4.1 Temperature sensors

Table 14: Thermal contact

Description	Measured value	Fault values
The thermal contact is a normally closed contact.	0–3 ohm, unless the wires are long.	An infinite value (open circuit) indicates either high temperature or a fault. Examples of faults include a broken wire, or a bad contact in a connector.

Table 15: PTC thermistor

Description	Measured value	Fault values
The PTC thermistor is a semiconductor device.	Resistance at normal temperature: • 50–100 ohm (150–300 ohm for three in series).	• Above the tripping point, T_{Ref}, the resistance increases dramatically to several kilohm. • An infinite value (open circuit) indicates a fault. Examples of faults include a broken wire, or a bad contact in a connector. • A value close to zero indicates a short circuit in the wiring.

Table 16: Pt100 sensor

Description	Measured value	Fault values
The Pt100 sensor is a resistor changing value almost linearly with temperature.	Resistance: • 100 ohm at 0ºC (32ºF) • 107.79 ohm at room temperature (20ºC, 68ºF) • 138.5 ohm at 100ºC (212ºF) For resistance data between 0–160ºC (32–320ºF), see *Pt100 resistance* on page 155.	> 200 ohm (approximate) can indicate the following situations: • Broken sensor • Bad contact • Broken lead < 70 ohm (approximate) indicates: • Short circuit

NOTICE:

Never connect the Pt100 transducer to a voltage higher than 2.5 V.

For information on the various configurations of contacts, thermistors and sensors that are used to monitor stator winding temperature, see *Stator temperature monitoring methods* on page 27.

3.4.5 CLS

This section applies to the following drive units:

- 605, 665
- 705, 735, 765
- 805, 835, 865, 885
- 905, 935, 965
- 950, 985, 988

Table 17: Water-in-oil sensor (CLS)

Description	Measured value	Fault values
Capacitive leakage sensor located in the oil housing. This sensor issues an alarm if the water content reaches a concentration of approximately 30% or more.	Standard drive unit only. CLS must be connected to 12 V DC with correct polarity (+/–).	See table below.

CLS alarm is not a cause for stopping the pump. It is merely an indicator to check the oil and outer seal at the next planned service.

Table 18: CLS current measurements

Measuring result	Explanation
0 mA	Can indicate one of the following conditions: • The sensor has the wrong polarity. Check by changing plus and minus. • The cable/lead is broken.
4.0 to 8.0 mA	OK
27 to 33 mA	Alarm current
> 33 mA	Short circuit

3.4.6 Pump memory

The pump memory is located inside the junction box of the pump. The memory is loaded with data from the factory, which is then uploaded to the MAS system at first start-up.

The data that is uploaded contains the following features:

- Data plate information
- Sensor types and alarm settings recommended by the manufacturer
- Operational data and data to support service:
  - Histograms of temperatures, vibrations, and cycle length
  - Start and stop registration
  - Service log with a maximum of 200 lines of text
  - Conditions to prompt for service based on for example, running time, number of starts and stops or specific dates

For more information, see the MAS 711 Installation and User Manual.

3.5 The cooling system

The cooling system removes the heat that is generated by the motor. Most of the heat is transferred to the surrounding media through the stator housing. The following table gives an overview of the various cooling systems.

Cooling system type	Cooling jacket	Description
Direct cooling	No	The pump is fully submerged and directly cooled by the surrounding water.
Integrated cooling	Yes	A portion of the pumped liquid is circulated from the pump housing through the cooling jacket. The pump can work continuously at output regardless of whether the pump is above or below the surface of the liquid.
External cooling	Yes	The cooling jacket is connected to a separate, external cooling system.
Internal closed-loop cooling	Yes	The motor is cooled by a closed-loop within the cooling jacket. An integrated coolant pump circulates the water-glycol coolant whenever the pump is operated.

For information about which cooling systems apply to a particular drive unit, see *Drive units overview* on page 154.

NOTICE:

Always operate the pump with the drive unit completely submerged in the pumped liquid, if the pump is delivered without the integral drive unit cooling jacket. When emptying the sump, the lowest liquid level must not be lower than the top of the pump housing. Contact your local Xylem representative for more information.

3.5.1 Direct cooling

In direct cooling, the pump is submerged in the liquid being pumped.

For direct cooling to be used, the pump must be completely submerged during normal operation.

On certain occasions, for example when emptying a sump, partial submersion is allowed. The allowable time for this is limited by several factors, such as ambient temperature, size of the sump, inflow, outflow, and so on.

For more information, please contact your local sales and service representative.

3.5.2 Internal closed-loop cooling

For information about which drive units use internal closed-loop cooling, see *Drive units overview* on page 154.

Overview

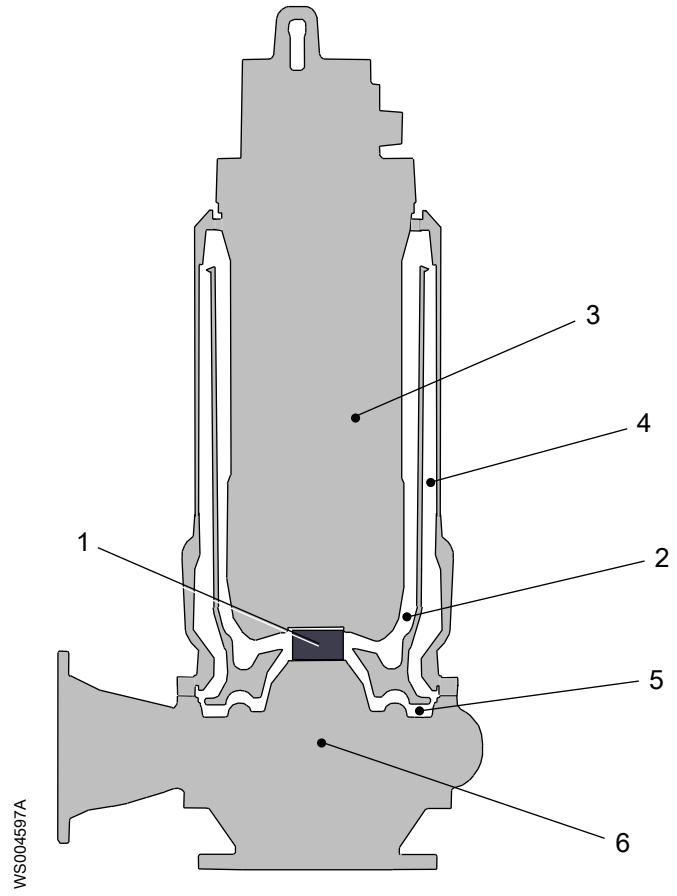
Internal closed-loop cooling removes heat from the motor by circulating coolant in a closed loop within the cooling jacket. The coolant circuit is self-contained within the drive unit; no external equipment is needed. The coolant is isolated from the pumped media.

Applications where internal closed-loop cooling can be used include the following:

- When extreme amounts of concentrated sewage where grease or fats are present, is combined with operating close to the limits of the cooling system.
- When the pumped media contains abrasive or corrosive components.

Principle

The following figure shows the principle of the internal closed-loop cooling system.



1. Internal pump to circulate coolant
2. Coolant channel between the stator house and the inner jacket
3. Stator housing
4. Return channel carrying coolant between inner and outer jackets
5. Channel between the hydraulic unit and the adapter ring
6. Hydraulic unit

Figure 7: Flow diagram

The drive unit is equipped with an inner and an outer cooling jacket. An internal pump (1 in the flow diagram) in the shaft seal unit pumps the coolant through the channel between the stator housing and the inner cooling jacket (2). In this channel, the coolant removes heat from the stator (3). The coolant then moves to the outer channel between the inner and outer cooling jackets (4), and flows back down to the bottom. It continues through the narrow slot (5) between the flow diffuser, which is mounted in the seal housing, and the seal housing cover, then back to the internal pump in the mechanical seal. The seal housing cover works as a heat exchanger, with the pumped fluid in the hydraulic unit cooling the water-glycol in the cooling system (6).

Combined lubrication and cooling

The purpose of the coolant is to cool and lubricate the seals, and to cool the motor.

Coolant

The coolant is a mixture of 70% water and 30% monopropylene glycol.

Z-installation orientation

Z-installations using internal closed-loop cooling require a specific orientation. The drive unit must be oriented such that the inspection chamber leakage sensor functions properly. The inspection plug on the adapter must be oriented downwards.

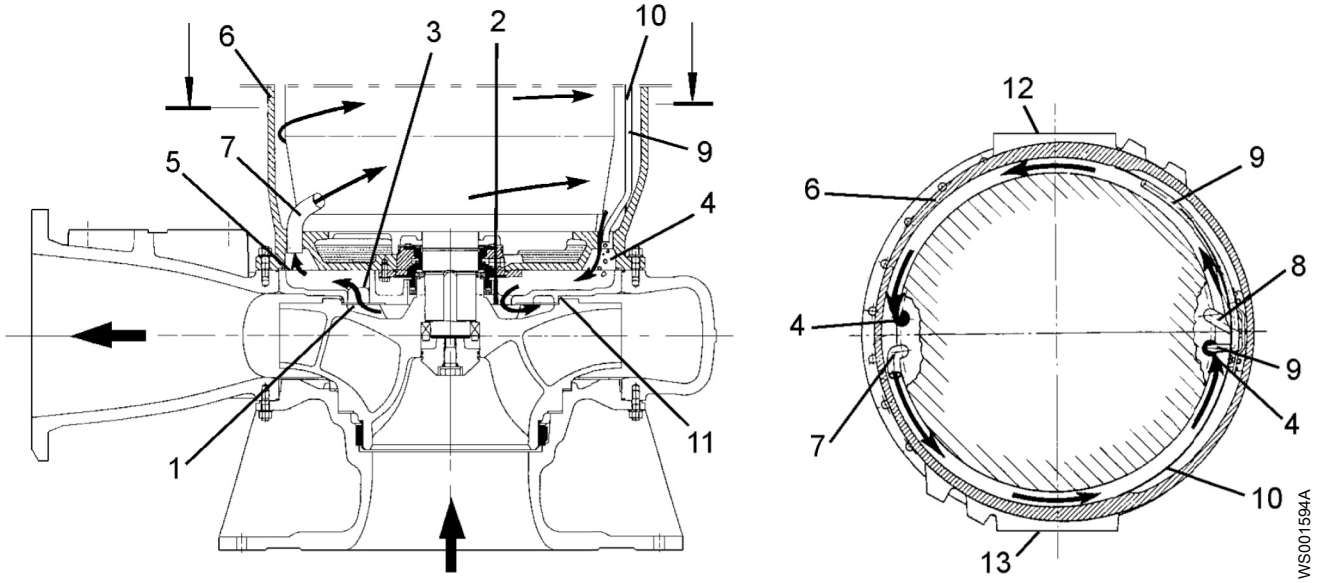
3.5.3 Integrated cooling

With integrated cooling, a portion of the pumped liquid is circulated from the pump housing through the cooling jacket. The pumped media removes the heat from the motor, and then returns to the pump housing, where it rejoins the main stream of liquid being pumped.

This cooling system is designed to tolerate a range of water qualities, up to and including municipal sewage. Larger particles and other contaminants in the pumped liquid are kept out of the cooling jacket by a narrow gap between the guide ring and the impeller.

System

The following figure shows the various parts of the integrated cooling system.



1. Back-vane on impeller
2. Coolant outlet, to pump housing
3. Coolant inlet, from pump housing
4. Air evacuation
5. Coolant entry
6. Cooling jacket
7. Coolant supply pipe, lower
8. Coolant supply pipe, upper
9. Air evacuation pipe
10. Metal shield
11. Anti-contamination gap

12. Inspection cover
13. Inspection cover

A separate circulation pump is not needed for integrated cooling. Circulation through the cooling jacket is provided by back-vanes on the impeller.

Ports and fittings

With integrated cooling, the cooling jacket is equipped with the following ports:

Port	Quantity	Description
Inlet pipes	2	Diametrically opposed one at bottom and one approximately 2/3 up. Not external ports – **no inlet connection required during pump installation.**
Outlet ports	2	Diametrically opposed at the bottom of jacket. Not external ports – **no outlet connection required during pump installation.**
Air vent	1	Automatic. At top of jacket.
Drain	1	At lower part of jacket. ISO G 3/4 threaded connection.

For information regarding the fittings required to drain the cooling jacket, see *Fittings needed to drain cooling jackets: drive units with external or integrated cooling systems* on page 36.

Filling and draining

With integrated cooling, the cooling jacket fills automatically at pump start-up.

For instructions on draining the cooling jacket, see *Empty the coolant (integrated cooling)* on page 110.

Z-installation orientation

Z-installations using integrated cooling require a specific orientation. The drive unit must be oriented such that the air evacuation system and the stator housing leakage sensor function properly. The cooling jacket inspection cover marked “SENSORS” must be oriented downwards.

3.5.4 External cooling

With external cooling, the drive unit is equipped with a cooling jacket. Water circulates through the jacket, cooling the motor. The cooling water circuit can be open or closed. In both cases, it is isolated from the pumped media.

This figure shows the principle of the external cooling system. The figure is only a representative sketch of the principle of external cooling.

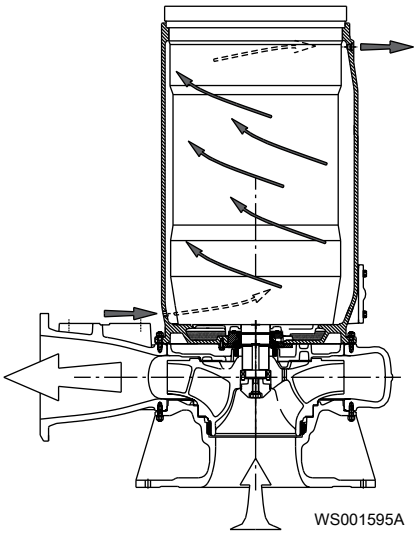


Figure 8: Representative image of the external cooling principle.

Applications where external cooling can be used include the following:

- When the temperature of the pumped media exceeds 40°.
- When extreme amounts of concentrated sewage where grease or fats are present, is combined with operating close to the limits of the cooling system.
- When the pumped media contains abrasive or corrosive components.
- In variable speed applications, where the lowest speed falls below the speed limit for the integrated cooling system during longer periods of operation.

Cooling jacket ports

With external cooling, the cooling jacket is equipped with the following ports:

Table 19: External cooling ports on 600–, 700–, 800– and 900–series drive units

Port		Quantity	Description
Inlet port		1	At the bottom of the jacket. Threaded ISO G 3/4.
Outlet port	600–series drive units	1	At the top of the jacket. Threaded ISO G 1/2. Also used to drain the jacket.
	700–, 800–, and 900–series drive units		At the top of the jacket. Threaded ISO G 3/4. Also used to drain the jacket.
Air vent		1	At the top of the jacket.

Drive units with internal closed-loop cooling may also be adapted for external cooling. The following table shows the fittings used.

Table 20: Adapting internal closed-loop cooling drive units for external cooling

Port	Quantity	Description
Drain plug	1	M16. At the bottom of the jacket. Used to drain the cooling jacket.
Fill plugs	2	M16. At the top of the jacket. Used as inlet and outlet plugs when externally cooled.
Air vent	—	No air vent on 700–series drive units with internal closed-loop cooling.

For information about which drive units use internal closed-loop cooling, see *Drive units overview* on page 154.

Draining the cooling jacket

For information regarding the fittings required to drain the cooling jacket, see *Fittings needed to drain cooling jackets: drive units with external or integrated cooling systems* on page 36.

For instructions on draining the cooling jacket, see *Empty the coolant (external cooling)* on page 110.

Supply water flow

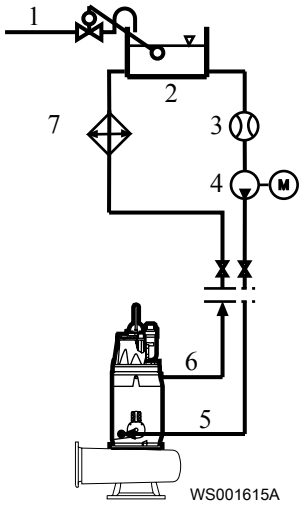
For information about dimensioning the water supply for external cooling, contact your local sales and service representative.

3.5.4.1 External cooling, closed loop

NOTICE:

It is extremely important that the cooling water flow is maintained at or above the desired minimum level while the pump is running.

For a closed loop system, the cooling water supply should be arranged as shown in the figure below.



1. Cooling water supply
2. Expansion tank
3. Flow meter
4. Circulation pump
5. Coolant in
6. Coolant out
7. Heat exchanger

Item	Notes
Cooling water supply	Incoming supply should be equipped with a vacuum valve. It should also be separated from the cooling circuit with a non-return (check) valve.
Expansion tank	Equipped with a level regulator. The tank is used to fill up the system at start-up, and then acts as an expansion tank.
Circulation pump	The pump must always be able to deliver **at least** the minimum required flow (including pressure drop in supply and return line) at all times.
Flow meter or flow switch	Used to monitor that the required flow of coolant is maintained during pump operation. The flow meter should have an electric output that can be wired into the pump power supply circuit in such a way, that the pump is stopped if the flow of coolant is interrupted.
Coolant in	Supply line (coolant in) and return line (coolant out) should both be fitted with valves so that the pump can be isolated from the cooling circuit during service.
	The supply line should also be fitted with a three-way connection and valving so that the cooling jacket can be drained before service work. See *Fittings needed to drain cooling jackets: drive units with external or integrated cooling systems* on page 36.

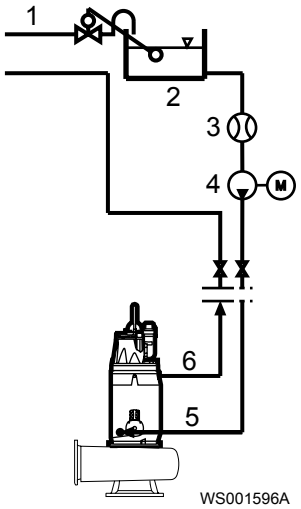
For P-installations, two 1-inch inner diameter reinforced water hoses are needed. To avoid movement in the sump, they should be fixed with cable ties to the cables.

For T- and Z-installation, pipes should be used instead of hoses to minimize the risk of accidental leakage. Flexible connections (for example, reinforced hose) from the pipe to the pump are advised, to avoid transmitting vibrations from the pump to the pipes.

3.5.4.2 External cooling, open loop

It is extremely important that the cooling water flow is maintained at or above the desired minimum level while the pump is running.

For an open loop system, the cooling water supply should be arranged as shown in the figure below.



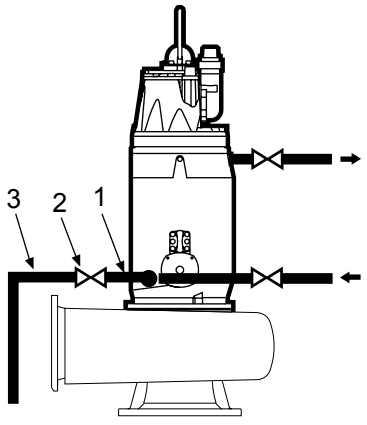
1. Cooling water supply
2. Supply tank
3. Flow meter
4. Circulation pump
5. Coolant in
6. Coolant out

Item	Notes
Cooling water supply	Incoming supply should be equipped with a vacuum valve. It should also be separated from the cooling circuit with a non-return (check) valve.
Supply tank	Local regulations may require that the supply line (especially in sewage applications) is totally separated from the cooling circuit.
Circulation pump	The pump must be able to deliver **at least** the minimum required flow (including pressure drop in supply and return line).
Flow meter or flow switch	Used to monitor that the required flow of coolant is maintained during pump operation. The flow meter should have an electric output that can be wired into the pump power supply circuit in such a way, that the pump is stopped if the flow of coolant is interrupted.

3.5.5 Fittings needed to drain cooling jackets: drive units with external or integrated cooling systems

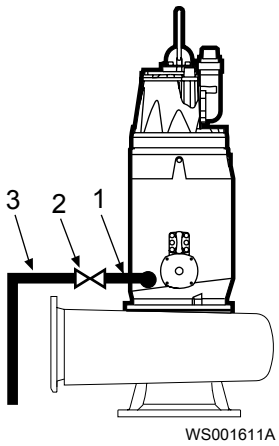
This section describes the fittings that are needed to drain the cooling jacket. It is applicable to both integrated cooling and external cooling systems.

The cooling jacket on T and Z installations with integrated cooling, and P, S, and T installations with external cooling, should be fitted with a nipple, a stop-cock, and a pipe or hose leading to a suitable sump. If external cooling is used, then a tee will be needed.



1. Tee, nipple (if needed)
2. Shutoff valve
3. Pipe to drain coolant

Figure 9: P, S, and T installations with external cooling



1. Nipple
2. Shutoff valve
3. Pipe to drain coolant

Figure 10: T and Z installations with integrated cooling

3.6 Seal flushing

Seal flushing is not available for drive units with internal closed-loop cooling.

External cooling required

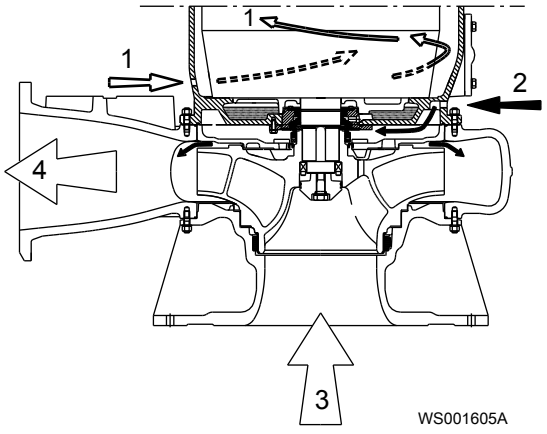
Seal flushing requires external cooling.

Description

Seal flushing is sometimes used when pumping demanding fluids which could cause fouling of the outer mechanical seal. The seal is continuously flushed with a supply of clean water. This keeps the mechanical shaft seal in clean water and isolated from the aggressive or abrasive fluid being pumped.

After circulating around the seal, the flush water continues out into the pump housing, where it combines with the fluid being pumped.

The following figure shows the flows of seal flush water, coolant, and fluid being pumped.



1. Coolant
2. Seal flushing, inlet
3. Pumped fluid, inlet
4. Pumped fluid and seal flush water, outlet

3.6.1 Applications for seal flushing

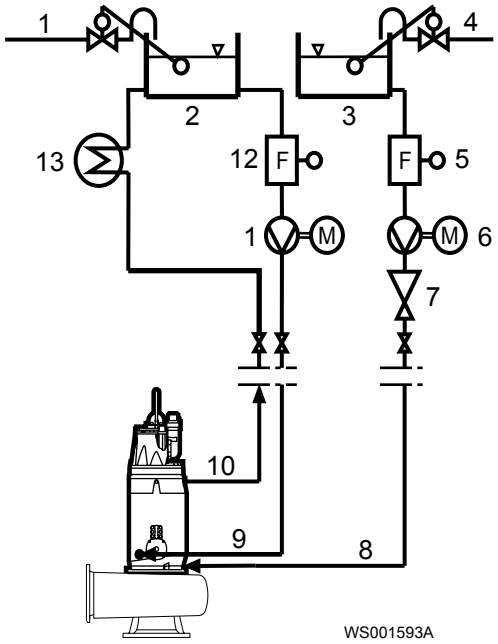
Examples of demanding applications where seal flushing might be used include the following:

- Corrosive liquids
- Water containing excessive amounts of sand, fine sediment, or other abrasive material
- Water containing calcium deposits
- Water containing excessive amounts of fibers or other materials with a tendency to clog together.

For more information, please contact your local sales and service representative.

3.6.2 Circuit diagram for seal flushing

The supply of incoming flushing water should be arranged as described in the circuit diagram below. As all slushing water is lost into the hydraulic end, this is always an open circuit solution.



1. Cooling water supply
2. Expansion tank
3. Supply tank
4. Seal flushing water supply
5. Flow meter
6. Booster pump
7. Constant flow valve
8. Seal flushing inlet to pump
9. Coolant inlet to motor
10. Coolant outlet
11. Circulation pump
12. Flow meter
13. Heat exchanger

It is recommended that a constant flow valve is installed in the supply line. This should be chosen to give a flow of at least 15 liters/min (4 US gal/min). If the valve is exposed to a sufficient pressure difference between its input and output connection, then the output flow will remain constant even if the pressure at the output connection varies. This feature is important if the pump operates at different duty points.

3.6.3 Connections for seal flushing

P-installations	T- and Z-installations
A 3/4” I.D. reinforced water hose is needed for the seal flushing. The supply line for the seal flushing water should be equipped with a stop-cock for service work. In order to avoid movement of the hose in the sump, it should be fixed to the cables with cable ties.	Pipes instead of hoses should be used to minimize risk of accidental leakage. However, flexible cables to the pump (for example, a piece of reinforced hose) are advised, to avoid transmitting vibrations from the pump to the pipes.

Inlet port and outlet control

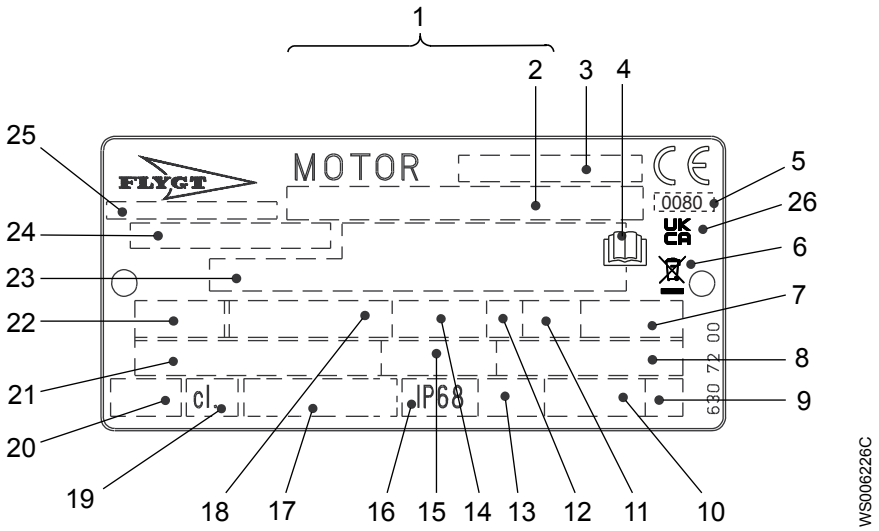
Table 21:

Item		Description
Flush water inlet	Location	At the lower part of the cooling jacket.
	Connection	Threaded ISO G 3/4.
Outlet control		Flushing water outlet is controlled by a lip seal, which acts as a check valve between the guide ring and the impeller hub to protect the mechanical seal.

3.7 The data plates

The data plates include key product specifications.

Drive unit

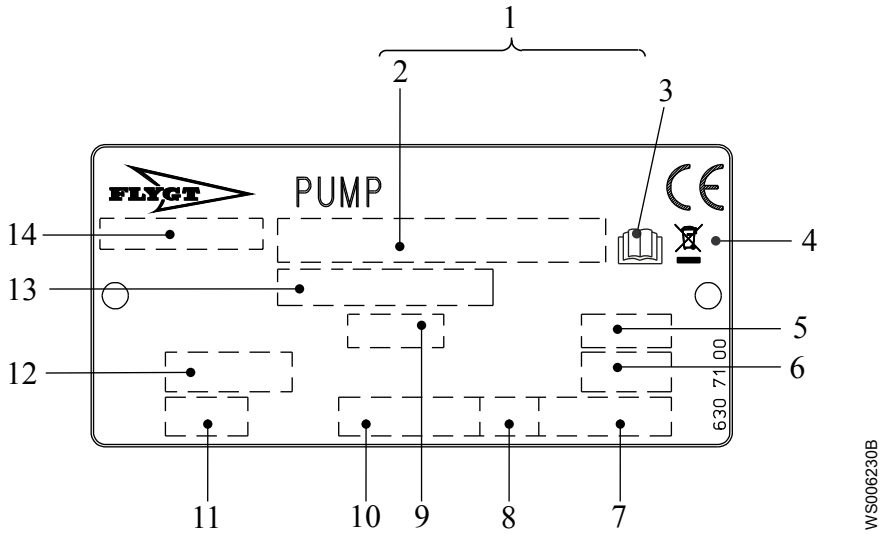


1. Serial number
2. Product code and number
3. Motor denomination
4. Read installation manual
5. Notified body, only for EN-approved Ex products
6. WEEE-Directive symbol
7. Maximum ambient temperature
8. Power factor
9. Locked rotor code letter
10. Product weight
11. Duty factor
12. Duty class
13. Maximum submergence
14. Rated speed
15. Rated current
16. Degree of protection
17. International standard
18. Rated shaft power
19. Thermal class
20. Thermal protection
21. Rated voltage
22. Phase; Type of current; Frequency
23. Additional information

24. Product number
25. Country of origin
26. UKCA marking

Figure 11: The drive unit plate

Hydraulic unit



1. Serial number
2. Product code and number
3. Read installation manual
4. WEEE-Directive symbol
5. Impeller diameter
6. Propeller blade angle
7. Product weight
8. Direction of rotation: L=left, R=right
9. Impeller or Propeller code
10. Rated speed
11. Pressure class
12. Column diameter or Inlet and outlet diameter
13. Product number
14. Country of origin

Figure 12: The hydraulic unit plate

3.8 Motor regulation

This product is submersible and therefore exempted from the motor efficiency requirement, in accordance with EU commission regulation 2019/1781 Article 2(2)(e).

3.9 Approvals

3.9.1 Product approvals for hazardous locations

7X5 drive units

This table shows product approvals for pumps with the following drive units:

- 715
- 745
- 775

Type	Approval
European Norm (EN)	• ATEX Directive • EN IEC 60079-0:2018, EN 60079-1:2014, EN ISO 80079-36:2016, EN ISO 80079-37:2016 • Ex II 2 G Ex db h IIB T3 Gb • Ex II 2 G Ex db h IIB T4 Gb

Type	Approval
IEC	• IECEx scheme • IEC 60079-0:2017, IEC 60079-1:2014-06, ISO 80079-36:2016, ISO 80079-37:2016 • Ex db h IIB T3 Gb • Ex db h IIB T4 Gb
FM (FM Approvals)	• Explosion proof for use in Class I, Div. 1, Group C and D • Dust ignition proof for use in Class II, Div. 1, Group E, F and G • Suitable for use in Class III, Div. 1, Hazardous Locations
CSA Ex	• Explosion proof for use in Class I, Div. 1, Group C and D
UKEx	• UK SI 2016 No. 1107 • EN IEC 60079-0:2018, EN 60079-1:2014, EN ISO 80079-36:2016, EN ISO 80079-37:2016 •  II 2 G Ex db h IIB T3 Gb •  II 2 G Ex db h IIB T4 Gb

7X6 drive units

This table shows product approvals for pumps with the following drive units:

- 716
- 746
- 776

Type	Approval
European Norm (EN)	• ATEX Directive • EN IEC 60079-0:2018, EN 60079-1:2014, EN ISO 80079-36:2016, EN ISO 80079-37:2016 •  II 2 G Ex db h IIB T3 Gb
IEC	• IECEx scheme • IEC 60079-0:2017, IEC 60079-1:2014-06, ISO 80079-36:2016, ISO 80079-37:2016 • Ex db h IIB T3 Gb
FM (FM Approvals)	• Explosion proof for use in Class I, Div. 1, Group C and D • Dust ignition proof for use in Class II, Div. 1, Group E, F and G • Suitable for use in Class III, Div. 1, Hazardous Locations
CSA Ex	• Explosion proof for use in Class I, Div. 1, Group C and D
UKEx	• UK SI 2016 No. 1107 • EN IEC 60079-0:2018, EN 60079-1:2014, EN ISO 80079-36:2016, EN ISO 80079-37:2016 •  II 2 G Ex db h IIB T3 Gb

8X5 drive units

This table shows product approvals for pumps with the following drive units:

- 815
- 845

- 875
- 895

Type	Approval
European Norm (EN)	• ATEX Directive • EN IEC 60079-0:2018, EN 60079-1:2014, EN ISO 80079-36:2016, EN ISO 80079-37:2016 • ⟨Ex⟩ II 2 G Ex db h IIB T3 Gb
IEC	• IECEx scheme • IEC 60079-0:2017, IEC 60079-1:2014-06, ISO 80079-36:2016, ISO 80079-37:2016 • Ex db h IIB T3 Gb
FM (FM Approvals)	• Explosion proof for use in Class I, Div. 1, Group C and D • Dust ignition proof for use in Class II, Div. 1, Group E, F and G • Suitable for use in Class III, Div. 1, Hazardous Locations
CSA Ex	• Explosion proof for use in Class I, Div. 1, Group C and D
UKEx	• UK SI 2016 No. 1107 • EN IEC 60079-0:2018, EN 60079-1:2014, EN ISO 80079-36:2016, EN ISO 80079-37:2016 • ⟨Ex⟩ II 2 G Ex db h IIB T3 Gb

8X6 drive units

This table shows product approvals for pumps with the following drive units:

- 816
- 846
- 873
- 876
- 893
- 896

Type	Approval
European Norm (EN)	• ATEX Directive • EN IEC 60079-0:2018, EN 60079-1:2014, EN ISO 80079-36:2016, EN ISO 80079-37:2016 • ⟨Ex⟩ II 2 G Ex db h IIB T3 Gb
IEC	• IECEx scheme • IEC 60079-0:2017, IEC 60079-1:2014-06, ISO 80079-36:2016, ISO 80079-37:2016 • Ex db h IIB T3 Gb
FM (FM Approvals)	• Explosion proof for use in Class I, Div. 1, Group C and D • Dust ignition proof for use in Class II, Div. 1, Group E, F and G • Suitable for use in Class III, Div. 1, Hazardous Locations
CSA Ex	• Explosion proof for use in Class I, Div. 1, Group C and D

Type	Approval
UKEx	• UK SI 2016 No. 1107 • EN IEC 60079-0:2018, EN 60079-1:2014, EN ISO 80079-36:2016, EN ISO 80079-37:2016 • II 2 G Ex db h IIB T3 Gb

9X5 drive units

This table shows product approvals for pumps with the following drive units:

- 915
- 945
- 960
- 975
- 995
- 998

Type	Approval
European Norm (EN)	• ATEX Directive • EN IEC 60079-0:2018, EN 60079-1:2014, EN ISO 80079-36:2016, EN ISO 80079-37:2016 • II 2 G Ex db h IIB T3 Gb • II 2 G Ex db h IIB T4 Gb
IEC	• IECEx scheme • IEC 60079-0:2017, IEC 60079-1:2014-06, ISO 80079-36:2016, ISO 80079-37:2016 • Ex db h IIB T3 Gb • Ex db h IIB T4 Gb
FM (FM Approvals)	• Explosion proof for use in Class I, Div. 1, Group C and D • Dust ignition proof for use in Class II, Div. 1, Group E, F and G • Suitable for use in Class III, Div. 1, Hazardous Locations
CSA Ex	• Explosion proof for use in Class I, Div. 1, Group C and D
UKEx	• UK SI 2016 No. 1107 • EN IEC 60079-0:2018, EN 60079-1:2014, EN ISO 80079-36:2016, EN ISO 80079-37:2016 • II 2 G Ex db h IIB T3 Gb • II 2 G Ex db h IIB T4 Gb

9X6 drive units

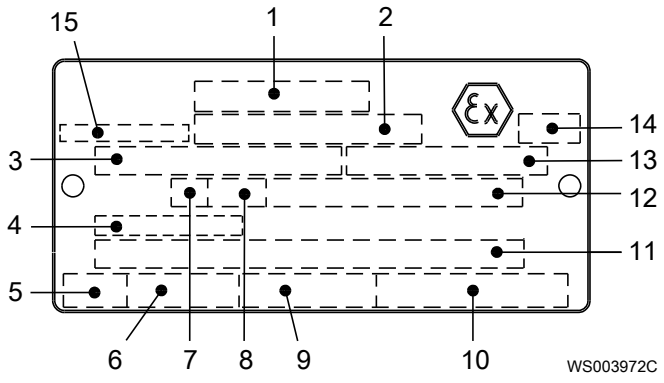
This table shows product approvals for pumps with the following drive units:

- 916
- 946
- 961
- 976
- 996
- 997

Type	Approval
European Norm (EN)	• ATEX Directive • EN IEC 60079-0:2018, EN 60079-1:2014, EN ISO 80079-36:2016, EN ISO 80079-37:2016 • Ⓔx II 2 G Ex db h IIB T3 Gb • Ⓔx II 2 G Ex db h IIB T4 Gb
IEC	• IECEx scheme • IEC 60079-0:2017, IEC 60079-1:2014-06, ISO 80079-36:2016, ISO 80079-37:2016 • Ex db h IIB T3 Gb • Ex db h IIB T4 Gb
FM (FM Approvals)	• Explosion proof for use in Class I, Div. 1, Group C and D • Dust ignition proof for use in Class II, Div. 1, Group E, F and G • Suitable for use in Class III, Div. 1, Hazardous Locations
CSA Ex	• Explosion proof for use in Class I, Div. 1, Group C and D
UKEx	• UK SI 2016 No. 1107 • EN IEC 60079-0:2018, EN 60079-1:2014, EN ISO 80079-36:2016, EN ISO 80079-37:2016 • Ⓔx II 2 G Ex db h IIB T3 Gb • Ⓔx II 2 G Ex db h IIB T4 Gb

EN approval plate

This illustration describes the EN approval plate and the information that is contained in its fields.

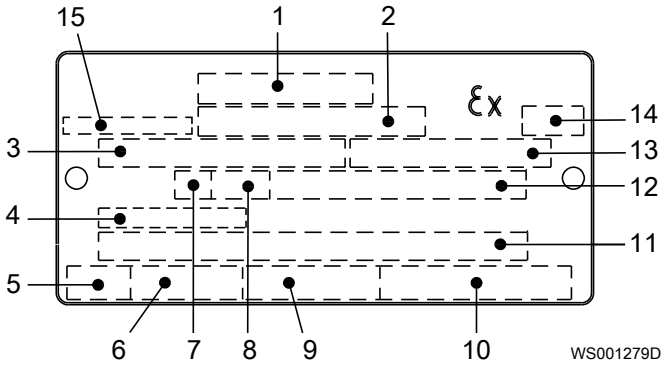


1. Approval
2. Approval authority and Approval number
3. Approved drive unit
4. Cable entry temperature
5. Stall time
6. Starting current or Rated current
7. Duty class
8. Duty factor
9. Input power
10. Rated speed
11. Additional information
12. Maximum ambient temperature
13. Serial number
14. ATEX marking
15. Country of origin

IEC approval plate

This illustration describes the IEC approval plate and the information that is contained in its fields.

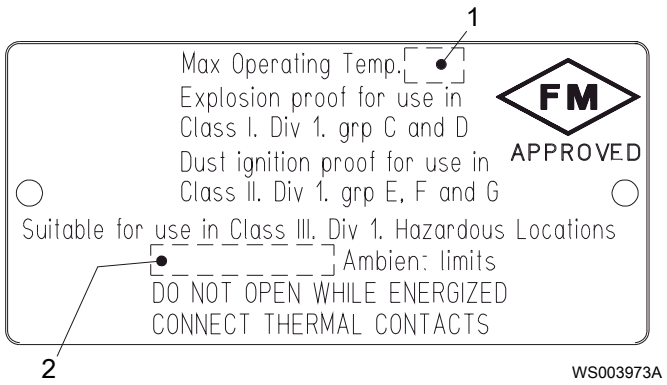
International Norm; not for EU member countries.



1. Approval
2. Approval authority and Approval number
3. Approved drive unit
4. Cable entry temperature
5. Stall time
6. Starting current or Rated current
7. Duty class
8. Duty factor
9. Input power
10. Rated speed
11. Additional information
12. Maximum ambient temperature
13. Serial number
14. ATEX marking
15. Country of origin

FM approval plate

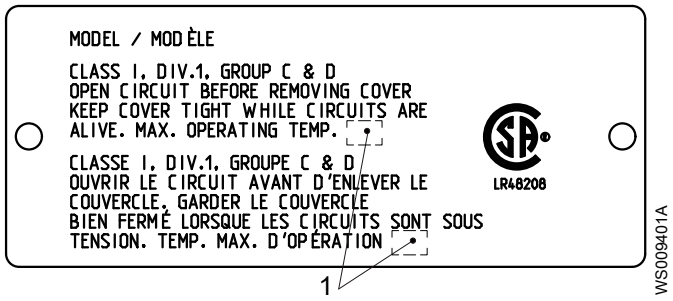
This illustration describes the FM approval plate and the information that is contained in its fields.



1. Temperature class
2. Maximum ambient temperature

CSA approval plate

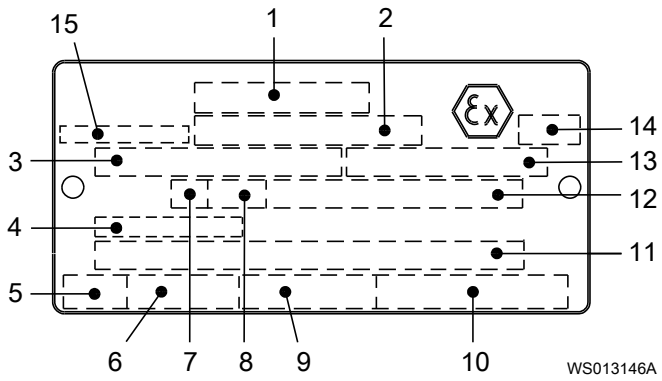
This illustration describes the CSA approval plate and the information that is contained in its fields.



1. Temperature class

United Kingdom: UKEx approval plate

This illustration describes the UKEx approval plate and the information that is contained in its fields.



1. Approval
2. Approval authority and Approval number
3. Approved drive unit
4. Cable entry temperature
5. Stall time
6. Starting current or Rated current
7. Duty class
8. Duty factor
9. Input power
10. Rated speed
11. Additional information
12. Maximum ambient temperature
13. Serial number
14. UKEx marking
15. Country of origin

3.10 Product denomination

Reading instruction

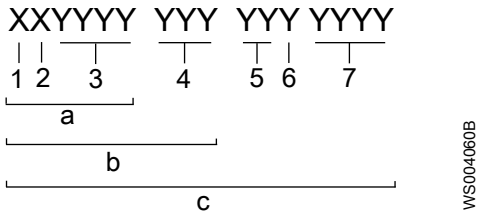
In this section, code characters are illustrated accordingly:

X = letter

Y = digit

The different types of codes are marked up with a, b, and c. Code parameters are marked up with numbers.

Codes and parameters



Type of Callout	Number	Indication
Type of code	a	Sales denomination
	b	Product code
	c	Serial number
Parameter	1	Hydraulic end
	2	Type of installation
	3	Sales code
	4	Drive unit
	5	Production year
	6	Production cycle
	7	Running number

4 Installation

4.1 Precautions

Before starting work, make sure that the safety instructions have been read and understood.

DANGER: Electrical Hazard

Before starting work on the unit, make sure that the unit and the control panel are isolated from the power supply and cannot be energized. This applies to the control circuit as well.

DANGER: Explosion/Fire Hazard

Special rules apply to installations in explosive or flammable atmospheres. Do not install the product or any auxiliary equipment in an explosive zone unless it is rated explosion-proof or intrinsically-safe. If the product is rated explosion-proof or intrinsically-safe, then see the specific explosion-proof information in the safety chapter before taking any further actions.

DANGER: Inhalation Hazard

Before entering the work area, make sure that the atmosphere contains sufficient oxygen and no toxic gases.

Before installing the pump, do the following:

- Provide a suitable barrier around the work area, for example, a guard rail.
- Make sure that equipment is in place so that the unit cannot roll or fall over during the installation process.
- Check the explosion risk before you weld or use electric hand tools.
- Check that the cable and cable entry have not been damaged during transport.
- Always remove all debris and waste material from the sump, inlet piping, and discharge connection, before you install the pump.

4.2 General requirements

- Use the pump dimensional drawing in order to ensure proper installation.
- Consult the nearest local sales and service representative regarding the following:
  - Sizing of the pump, piping station, and access frame
  - Choice of auxiliary equipment
  - Other aspects of installation

NOTICE:

Do not run the pump dry.

NOTICE:

Never force piping to make a connection with a pump.

Authority regulation

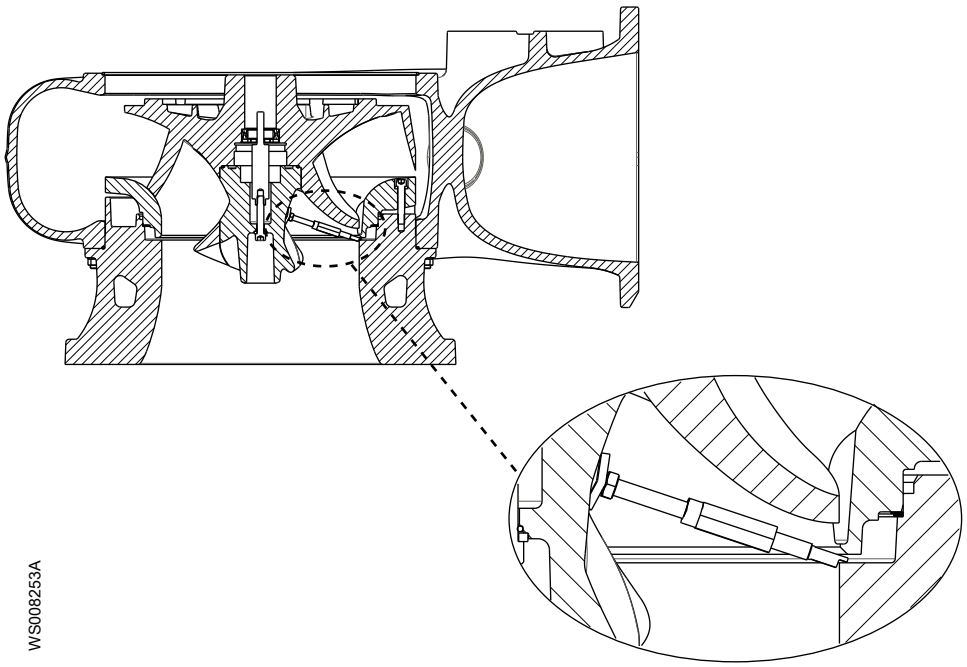
Vent the tank of a sewage station in accordance with local plumbing codes.

Fasteners

- Only use fasteners of the correct size and material.
- Replace all corroded or damaged fasteners.
- Make sure that all the fasteners are correctly tightened and that there are no missing fasteners.

The locking device

Pumps delivered in the horizontal position have a locking device for the impeller/propeller. Before you install the pump, you must remove this locking device.



4.3 Cables

General requirements

- The voltage drop in a long cable must be taken into account. Always follow the local regulations for voltage drop.
- If a Variable Frequency Drive (VFD) is used, then the screened cable must be used according to the European CE and EMC requirements. For more information, contact a sales or authorized service representative (VFD-supplier).
- All unused conductors must be insulated.
- The cable entry seal sleeve and washers must conform to the outside diameter of the cable.

Cable condition

- The cable must not have any sharp bends, and not be pinched.

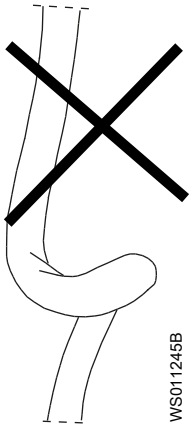


Figure 13: Kinked cable

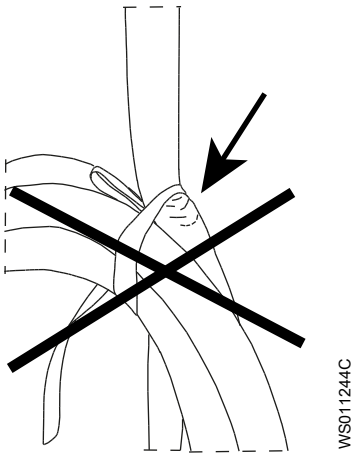


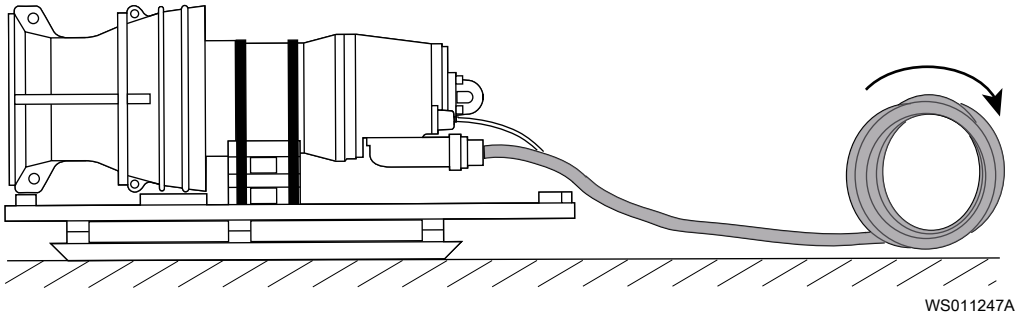
Figure 14: Pinched cable

- If the outer jacket of the cable is damaged, then replace the cable.
- The cable must not be damaged and must not have indentations or be embossed at the cable entry.
- If the cable has been used before, then a short piece must be peeled off when refitting it. This prevents the cable entry seal sleeve from closing around the cable at the same point.
- The cable must not be exposed for long periods to direct UV light. The cable ends must be protected from water during storage.

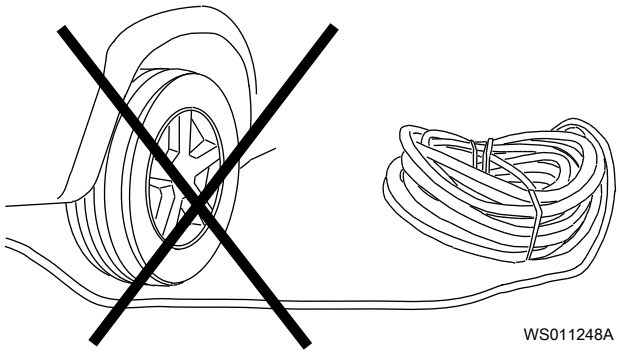
Cable handling

To install cables, follow these requirements:

- Start at the pump and carefully roll out the cable.



- When pulling the cable, do not exceed the maximum permissible tensile force.
- Do not bend the cable to a radius smaller than the recommended minimum bending radius.The recommended minimum bending radius is 10 times the diameter of the cable.
- Make sure that vehicles cannot run over the cable.



- All cables lose flexibility at lower temperatures. Use extra care when the cable is cold.Do not work with a cable whose temperature is below –30°C (–22°F).

4.4 Installing with P-installation

In the P-installation, the pump is installed on a stationary discharge connection, and operates either completely or partially submerged in the pumped liquid.

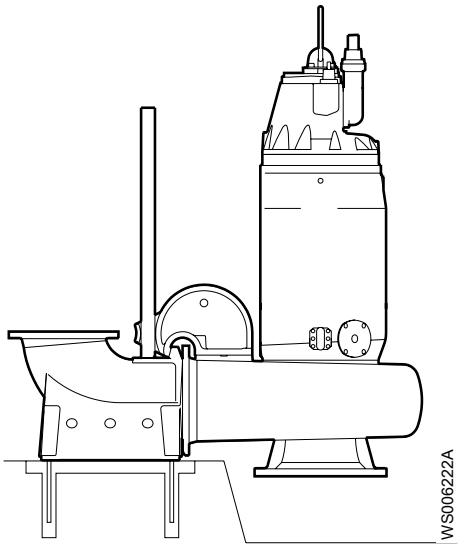


Figure 15: P-installation

Requirements

The following items are required:

- Guide bars
- Guide bar bracket to attach the guide equipment to the access frame or to the upper part of the sump
- Level regulators or other control equipment for start, stop, and alarm.
- Cable holder to hold the cable and regulating the height of the level regulators
- Access frame (with covers) to which the upper guide bar bracket and cable holder can be attached.
- Discharge connection to connect the pump to the discharge line. The discharge connection has a flange which fits the pump housing flange and a bracket to attach the guide equipment.
- Bushings for vibration damping between the guide bars and the discharge connection

Leveling the discharge connection

Alignment of the discharge connection is important to make sure a correct connection between it and the pump. The flange surface of the discharge connection must be vertically level. The discharge connection must be installed on a horizontal surface. If the surface beneath the discharge connection is not level and horizontal, then level it with shims.

4.4.1 Install with P-installation

1. Provide a barrier around the pump pit; for example, a guard rail.

   Make sure that the sump is dry.
2. Place the discharge connection in the correct position.
3. Mount the anchor bolts.
4. Level the discharge connection, using a leveler and if necessary, shims.
5. Place the discharge connection in position, and tighten the nuts.
6. Connect the discharge pipe to the discharge connection.
7. Install the guide bars:
   a) Secure the guide bars in the bracket.
   b) Check that the guide bars are placed vertical by using a level or a plumb line.

8. Lower the pump along the guide bars.

   On reaching the bottom position, the pump will automatically connect to the discharge connection.
9. Check that the pump is seated correctly at the discharge connection.
10. Secure the cables:
    a) Make sure that the cables cannot be sucked into the inlet of the pump. Support straps are required for deep installations.
    b) Run the cables up to the electrical panel or junction box and connect them according to the separate instructions.
11. Clean all debris from the sump, before filling the sump.

4.5 Installing with S-installation

In the S-installation, the pump is transportable and intended to operate either completely or partially submerged in the pumped liquid. The pump is equipped with a connection for hose or pipe and stands on a base stand. For more detailed information about the different installation types, see the Parts List document.

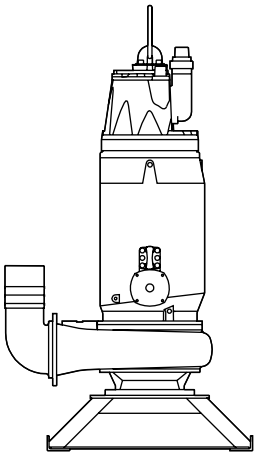
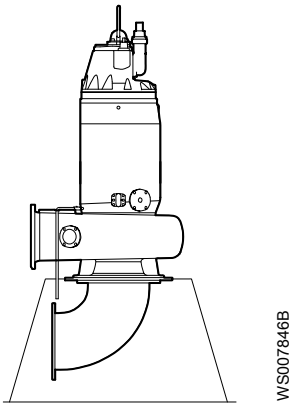


Figure 16: S-installation

4.6 Installing with T-installation

In the T-installation the pump is installed in a stationary vertical position in a dry well next to the wet sump.

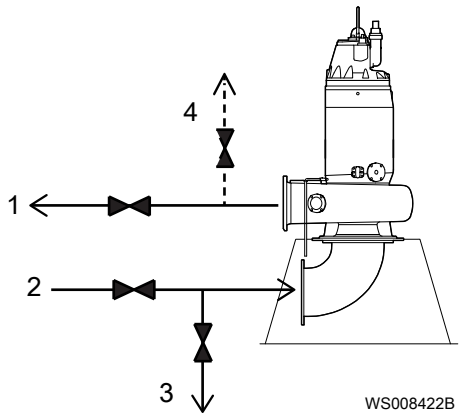


Requirements

The following items are required:

- Support stand for anchoring the pump to a base
- Plate or base stand with anchor bolts for anchoring the pump to a concrete base

- Inlet elbow for connecting the suction line and discharge line
- Shutoff valves to permit removal of the pump for service
- Air vent on the discharge side between the pump and the check valve



1. Outlet line
2. Inlet line
3. Line to drain
4. Air vent

De-energize the pump before removing the inspection cover

Never remove the inspection cover during service or internal cleaning of the pump housing until the pump has been de-energized and drained.

4.6.1 Install with T-installation

1. Fasten the pump:
   a) Use the anchor bolts to bolt the base stand to the concrete base.
   b) Bolt the pump to the base stand and the suction connection.
2. Make sure that the pump is vertical.
3. Connect the suction line and discharge line.
4. Run the cables up to the electrical panel or junction box and connect them according to the separate instructions.

   For information about electrical connections, see *Connect the cables: Pumps with MAS 711* on page 73.
5. Make sure that the weight of the pump does not put strain on the piping.

4.7 Installing with Z-installation

In the Z-installation, the pump is installed in a horizontal position on a support stand, and a bell mouth is connected to the inlet pipe.

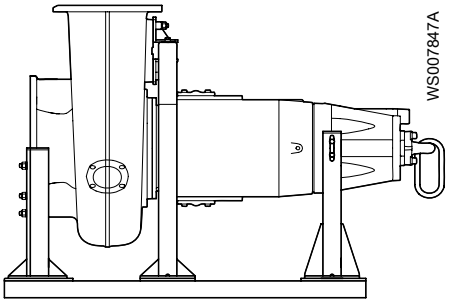


Figure 17: Z-installation. Generic Z-stand shown.

Orientation for Z-installations using integrated cooling

Z-installations using integrated cooling require a specific orientation. The drive unit must be oriented such that the air evacuation system and the stator housing leakage sensor function

correctly. The cooling jacket inspection cover marked “SENSORS” must be oriented downwards.

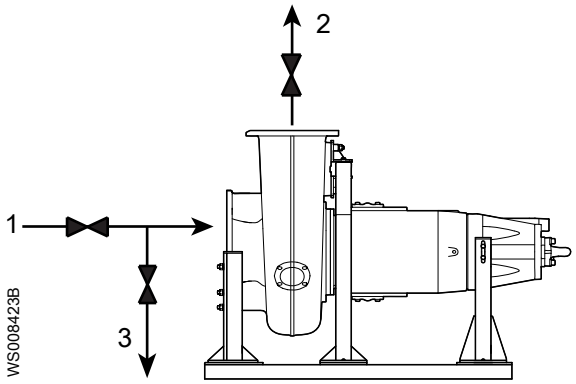
Orientation for Z-installations using internal closed-loop cooling

Only for drive units with internal closed-loop cooling: Z-installations using internal cooling require a specific orientation. The drive unit must be oriented such that the inspection chamber leakage sensor functions correctly. The inspection plug on the adapter must be oriented downwards.

Requirements

The following items are required:

- Support stand for anchoring the pump to a base
- Plate or base stand with anchor bolts for anchoring the pump to a concrete base
- Inlet elbow to connect the suction line and discharge line
- Shutoff valves to permit removal of the pump for service
- Air vent on the discharge side between the pump and the check valve



1. Inlet line
2. Outlet line
3. Line to drain

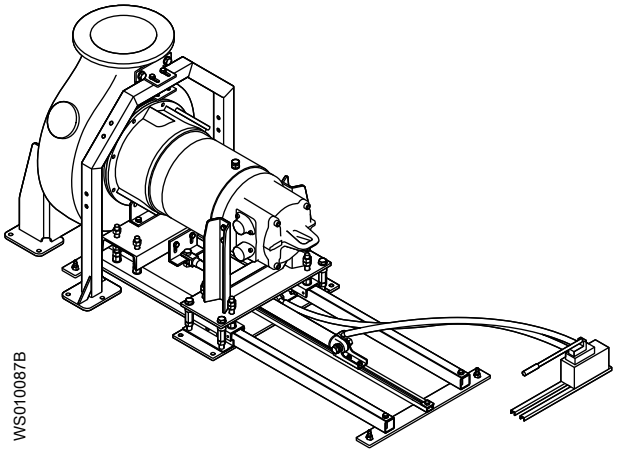
Figure 18: Valves on the inlet, outlet, and drain lines

De-energize the pump before removing the inspection cover

Never remove the inspection cover during service or internal cleaning of the pump housing until the pump has been de-energized and drained.

4.7.1 Install with Z-service sled

This section provides instructions for installing the Z-service sled with the pump in it.



Perform preliminary checks

1. Check that the surface of the floor where the pump is to be placed, is flat and horizontal.
2. Check that the external lifting equipment is correctly fastened to the correct lifting points.

Install the rails

1. Remove the four bolts near the connection house end. See the following figure.

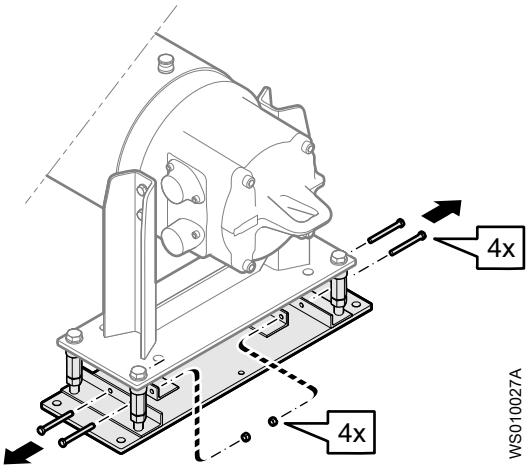


Figure 19: Removing the bolts

2. Slide the four rail pieces into position.
   The shorter pieces are nearest to the hydraulic unit.

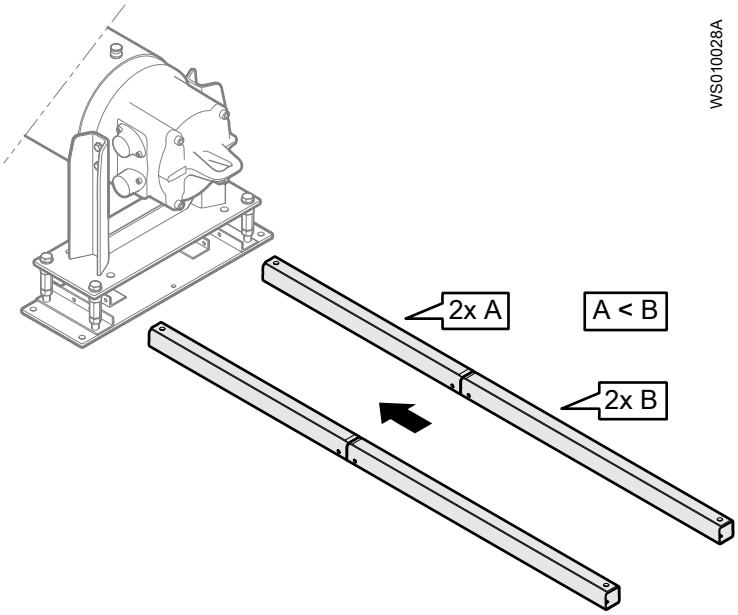


Figure 20: Sliding rail pieces into position

3. Put the two cross pieces under the rails at each end
4. Bolt the four rail pieces to the Z-service sled support near the connection house end. Attach the ends of the rails to the cross pieces.

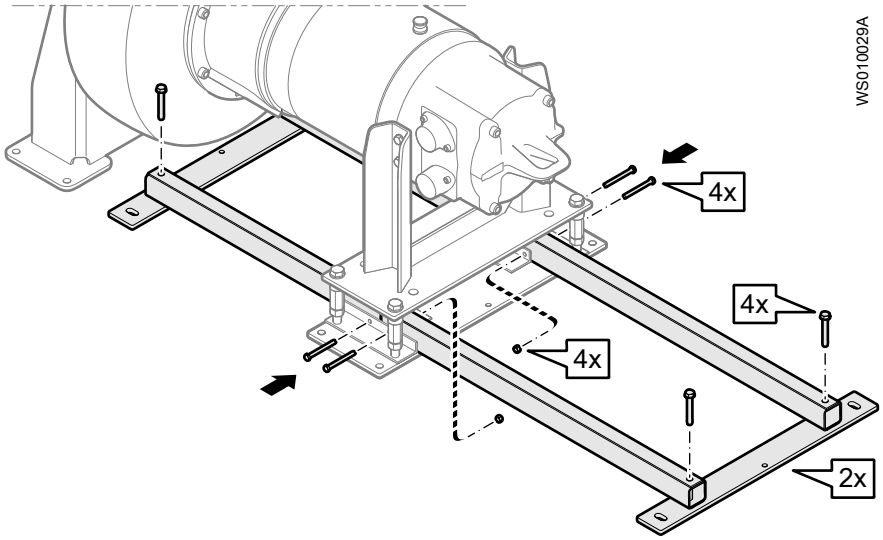


Figure 21: Fastening rails to cross pieces and Z-service sled support

Attach to the floor

1. Put the pump together with the Z-service sled on the floor in the correct location. Use the Z-service sled as a drill template and mark out the locations of the holes for the anchor bolts.

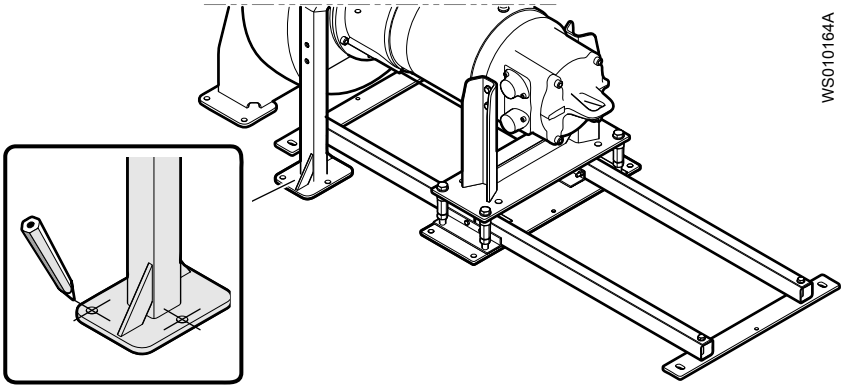


Figure 22: Marking locations of the holes

2. Remove the pump and Z-service sled from the floor.
3. Drill the holes to correct dimensions according to the instructions from the manufacturer.

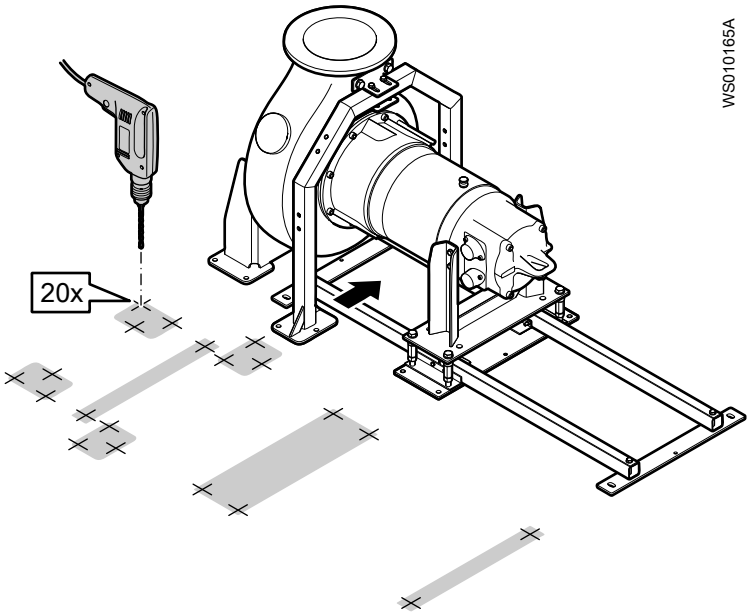


Figure 23: Drilling holes for anchor bolts

4. Put the pump and Z-service sled in place.
5. Use shim spacers to level the Z-service sled. Tighten nuts to the anchor bolts.

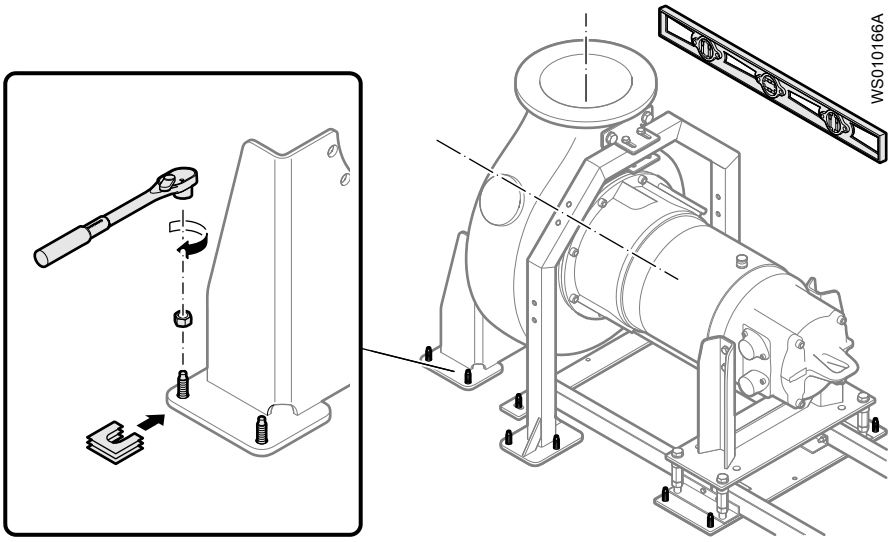


Figure 24: Leveling Z-service sled and tightening anchor bolt nuts

Attach the gliding shoes and supports

1. Fit the two gliding shoes on the rails. See the following figure.
   Do not tighten the fasteners.

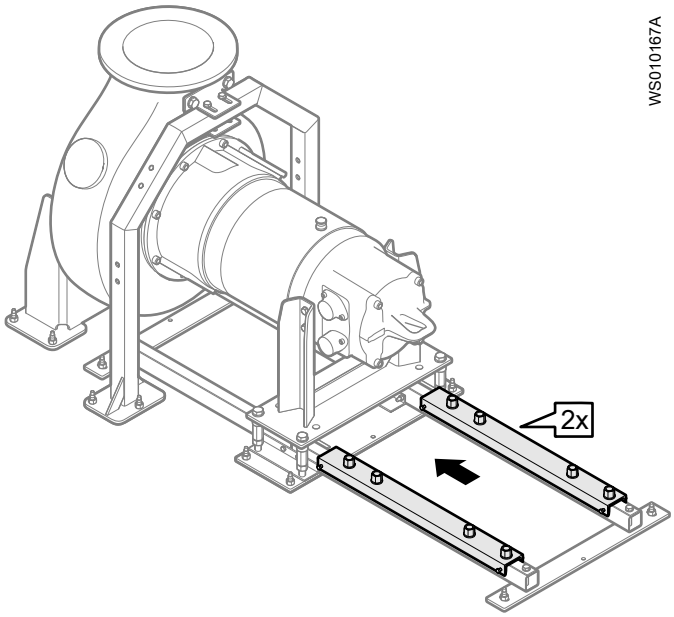
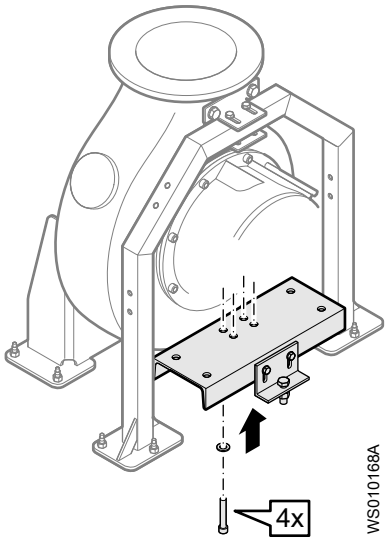


Figure 25: Fitting the gliding shoes on the rails

2. Attach the support plate to the drive unit, at the hydraulic end.

 Figure 26: 700-, 800-, and 900-series drive units	Attach the support plate to the drive unit with four bolts and washers.

3. Install the four support legs for the support plate near the hydraulic end:

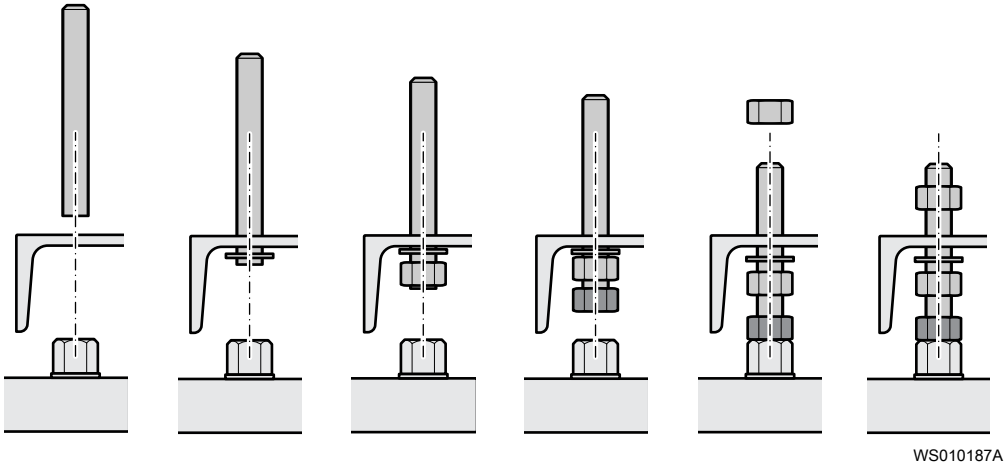


Figure 27: Installing support legs for the support plate near the hydraulic end

a) Insert the threaded bolt through the hole.
b) Under the support plate, fit a washer onto the threaded bolts.
c) Beneath the washer, fit a nut onto the threaded bolt.
d) Fit a second nut onto the threaded bolt.
e) Thread the bolt into the fastener on the gliding shoe.
f) Tighten the bottom nut. See the following figure.

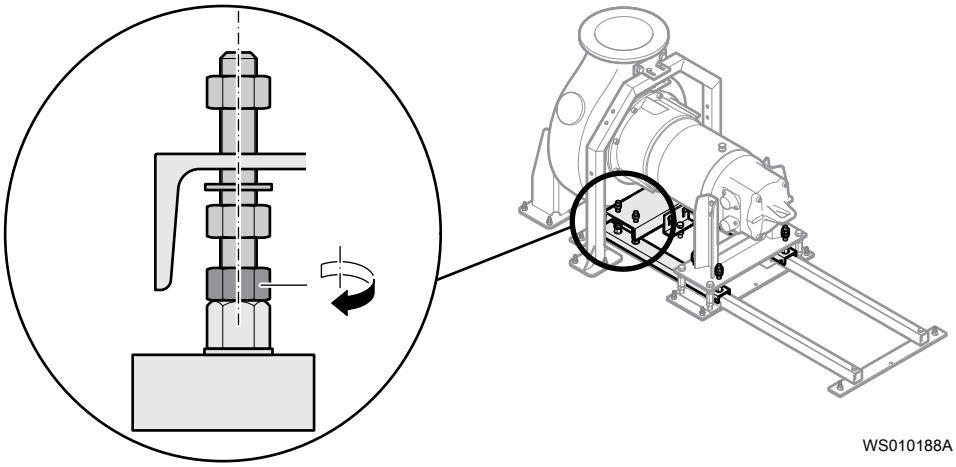


Figure 28: Tightening bottom nut at the support plate near the hydraulic end

4. Install the four support legs for the support plate near the connection house:

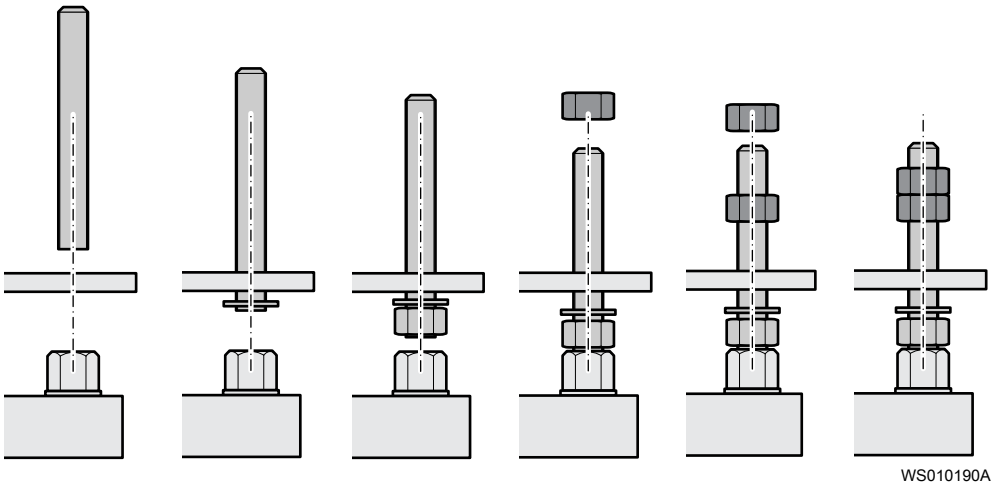


Figure 29: Installing support legs for the support plate near the connection house

a) Insert the threaded bolt through the hole.
b) Under the support plate, fit a washer onto the threaded bolt.
c) Beneath the washer, fit a nut onto the threaded bolt.
d) Thread the bolt into the fastener on the gliding shoe.
e) On the top side of the support plate, thread 2 nuts onto the bolt.
f) Tighten the top nuts. See the following figure.

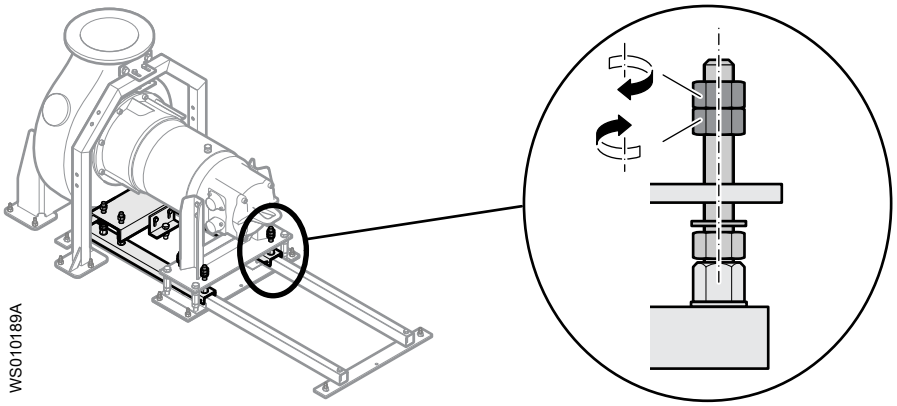


Figure 30: Tightening top nuts at support plate near the connection house

Mount the hand pump

1. Install the rail for the hand pump as shown in the following figure.

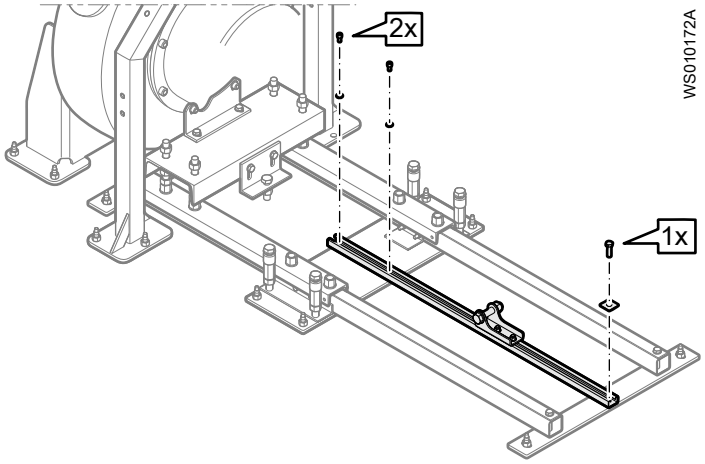


Figure 31: Mounting hand pump rails. (Pump not shown.)

2. Connect the piston to the rail, and connect the end of the piston arm to the support plate near the hydraulic end. See the following figure.

   The fastener connecting the arm to the support plate can be inserted from above or from below. Use the configuration which is best for the combination of hydraulic unit and drive unit.

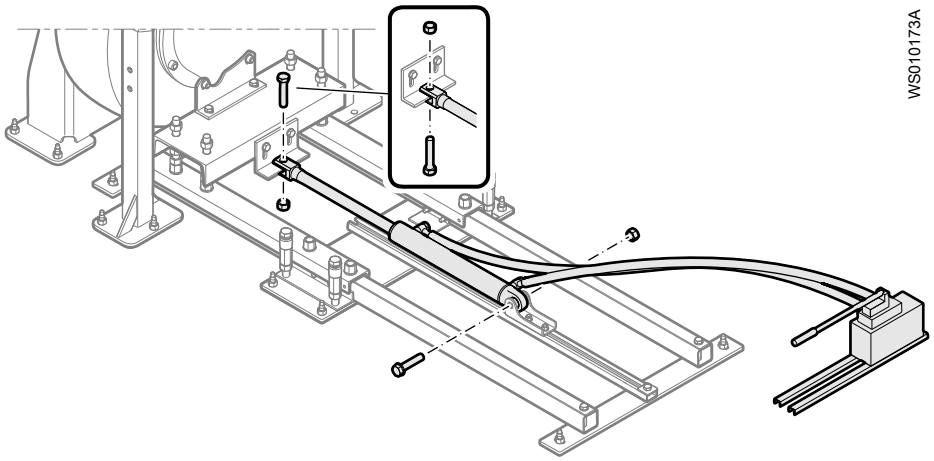


Figure 32: Installing hand pump. (Pump not shown.)

Complete the connections

1. Connect the suction line and discharge line.
2. Run the cables up to the electrical panel or junction box and connect them according to the separate instructions. For information about electrical connections, see *Connect the cables: Pumps with MAS 711* on page 73.
3. Make sure that the weight of the pump does not put strain on the piping.

4.7.2 Install with the Z-stand

This section provides instructions for installing the Z-stand with the pump in it.

These instructions are also applicable when the pump is equipped with the service lift.

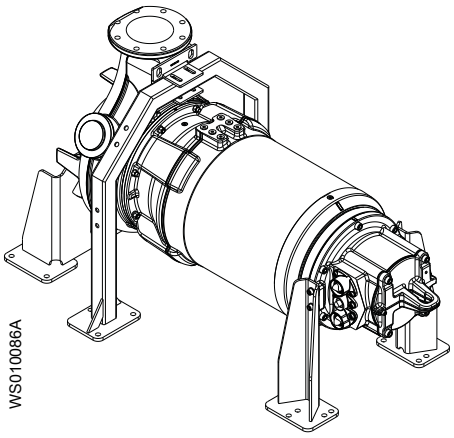


Figure 33: Pump in Z-stand

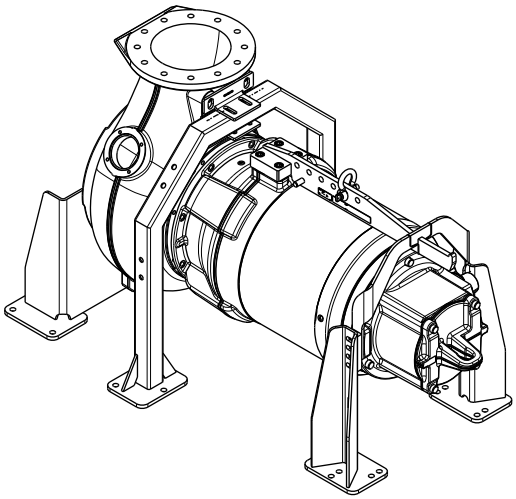


Figure 34: Pump in Z-stand and equipped with service lift

Do not use the service lift to lift the entire pump or the Z-stand. The service lift is designed to lift only the drive unit and impeller.

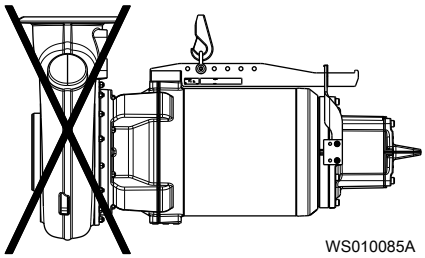


Figure 35: Do not lift the entire pump

1. Check that the surface of the floor where the pump is to be placed, is flat and horizontal.
2. Check that the external lifting equipment is correctly fastened to the correct lifting points.
3. Install the pump:
   a) Put the pump together with the stand on the floor in the correct position. Use the stand as a drill template and mark out the positions of the holes for the anchor bolts.

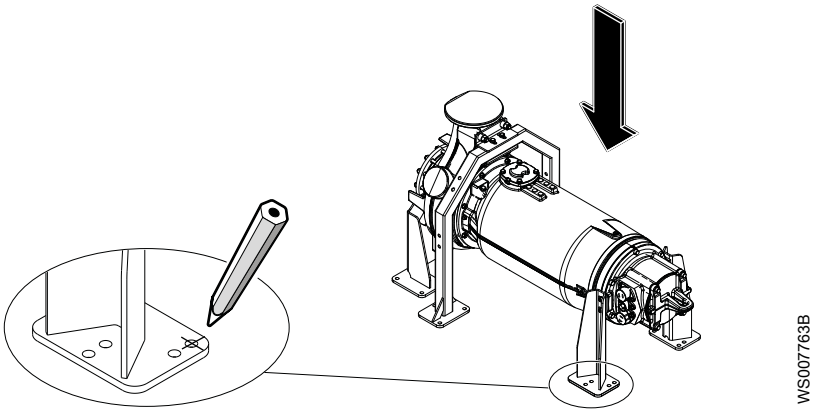
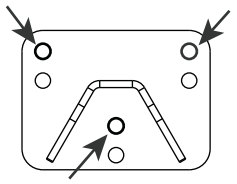
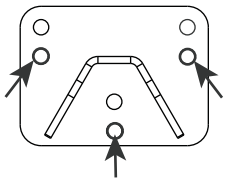


Figure 36: Marking hole locations for anchor bolts

Table 22: Anchor bolt holes for front legs

With the service lift	Without the service lift
	

b) Remove the pump and stand from the floor.

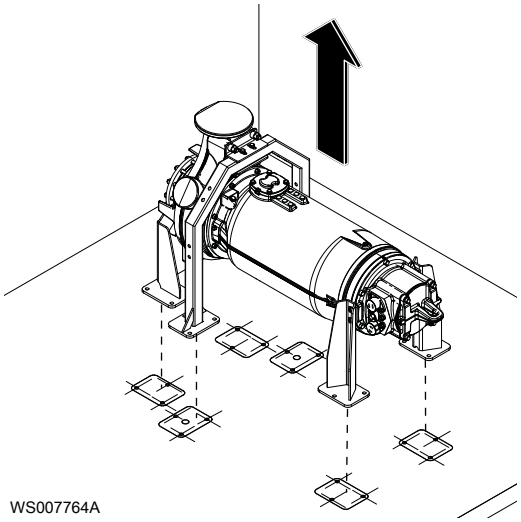


Figure 37: Removing pump and stand after marking holes

c) Drill the holes to correct dimensions according to the instructions from the manufacturer.

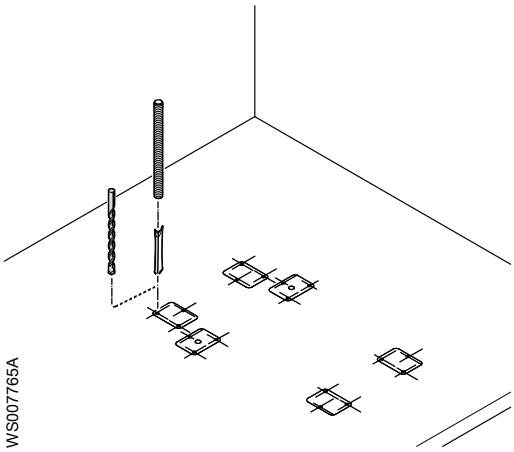


Figure 38: Drilling holes for anchor bolts

d) Clean the holes from drill cuttings.
e) Insert the chemical anchor ampoules and fit the anchor bolts into the holes, using the correct tools according to the instructions from the manufacturer.
f) Put the pump and stand in place.
g) Use shim spacers to level the Z-stand. Tighten nuts to the anchor bolts.

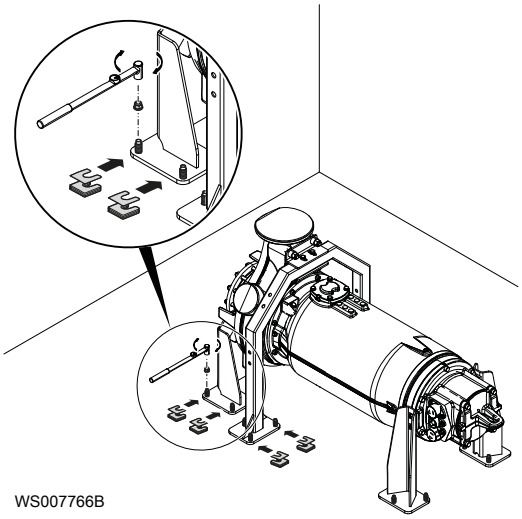
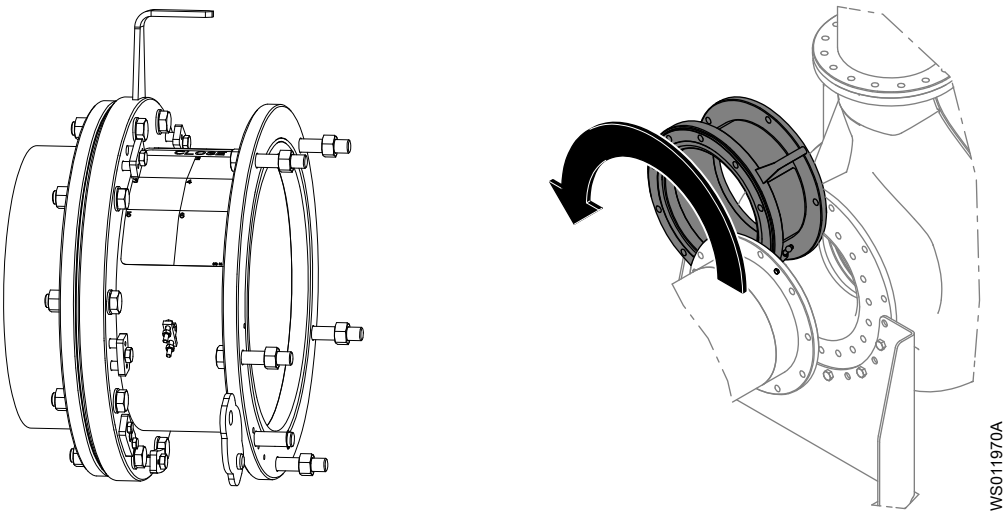


Figure 39: Leveling Z-stand and tightening anchor bolt nuts

4. Connect the suction line and discharge line.
5. Run the cables up to the electrical panel or junction box and connect them according to the separate instructions. For information about electrical connections, see *Connect the cables: Pumps with MAS 711* on page 73.
6. Make sure that the weight of the pump does not put strain on the piping.

4.7.3 Service inlet



For operating instructions, see the Mounting Instruction 850472.

4.7.4 Service lift

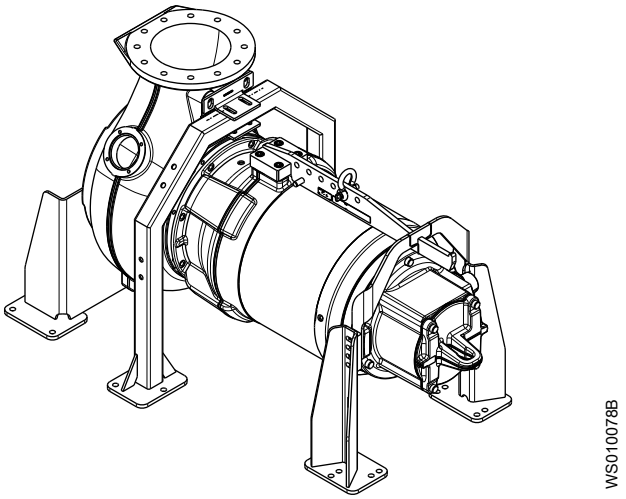


Figure 40: Service lift. Generic 700-series drive unit is shown.

The service lift is an optional lifting system to lift drive units from the horizontal position. It can be used with the 700-series, 800-series, and 900-series drive units.

For installation or operation instructions, see the following:

- Drive units 7XX: Mounting Instruction 850070
- Drive units 8XX and 9XX: Mounting Instruction 850358
- Service and Repair, Operating Part for the drive unit

Do not use to lift the entire pump

The service lift option can be used to lift the drive unit plus impeller. It cannot be used to lift the entire pump.

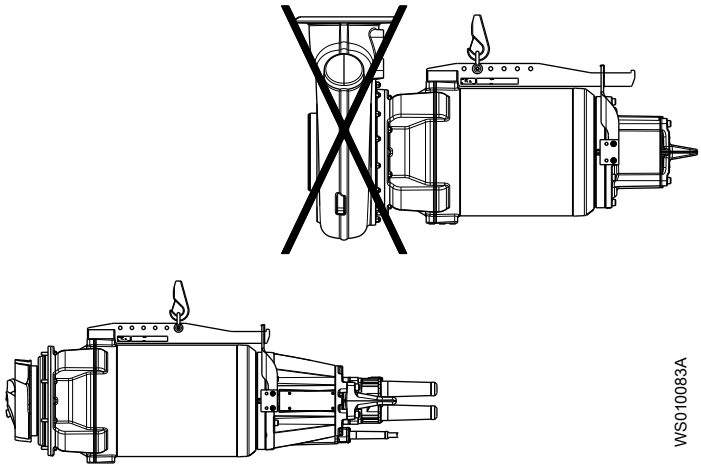


Figure 41: Do not lift the entire pump with the service lift

4.8 Make the electrical connections

4.8.1 General precautions

DANGER: Electrical Hazard

Before starting work on the unit, make sure that the unit and the control panel are isolated from the power supply and cannot be energized. This applies to the control circuit as well.

WARNING: Electrical Hazard

Risk of electrical shock or burn. A certified electrician must supervise all electrical work. Comply with all local codes and regulations.

WARNING: Electrical Hazard

There is a risk of electrical shock or explosion if the electrical connections are not correctly carried out, or if there is fault or damage on the product. Visually inspect equipment for damaged cables, cracked casings or other signs of damage. Make sure that electrical connections have been correctly made.

WARNING: Crush Hazard

Risk of automatic restart.

CAUTION: Electrical Hazard

Prevent cables from becoming sharply bent or damaged.

NOTICE:

Leakage into the electrical parts can cause damaged equipment or a blown fuse. Keep the cable ends dry at all times.

Requirements

These general requirements apply for the electrical installation:

- If the pump will be connected to the public mains, then the supply authority must be notified before installing the pump. When the pump is connected to the public power supply, it can cause flickering of incandescent lamps when started.
- The mains voltage and frequency must agree with the specifications on the data plate. If the pump can be connected to different voltages, then follow the specified voltage on the yellow sticker close to the cable entry.
- If the operation can be intermittent, such as S3 periodic duty, then the pump must be supplied with monitoring equipment supporting such operation.
- The thermal contacts must be connected to a protection circuit in accordance with the product approvals.
- The thermal contacts or thermistors must be in use.
- The environment must be appropriate for medium-voltage (1.2–10 kV) cables and electrical work.

- For FM-approved pumps, a leakage sensor must be connected and in use to meet approval requirements.
- Specially approved pumps must be earthed (grounded) at the external grounding (earthing) site on the outside of the drive unit, to meet approval requirements.

Motor and short-circuit protection

NOTICE:

A qualified electrician must select the size of motor protection breakers and fuses. The size must be chosen for the specific motor data such as rated current and starting current.

It is important that the short-circuit protection is not over-dimensioned. Over-dimensioned fuses or motor protection breakers decrease the protection for the motor.

- The fuse rating and the cables must be in accordance with the local rules and regulations.
- The fuses and circuit breakers must have the correct rating.
- The pump overload protection must be connected and set to the rated current.

The starting current in direct-on-line start can be up to six times higher than the rated current.

For more information, see the data plate and if applicable, the cable chart for the rated current.

4.8.2 Grounding (earthing)

Grounding (earthing) must be done in compliance with all local codes and regulations.

DANGER: Electrical Hazard

All electrical equipment must be grounded (earthed). Test the ground (earth) lead to verify that it is connected correctly and that the path to ground is continuous.

WARNING: Electrical Hazard

Risk of electrical shock. The ground (earth) lead must be sufficiently longer than the phase leads to make sure that the ground lead is the last to become disconnected if the cable is jerked loose.

WARNING: Electrical Hazard

Risk of electrical shock or burn. You must connect an additional ground- (earth-) fault protection device to the grounded (earthed) connectors if persons are likely to come into contact with liquids that are also in contact with the pump or pumped liquid.

4.8.3 Connect the ground at the outside of the drive unit

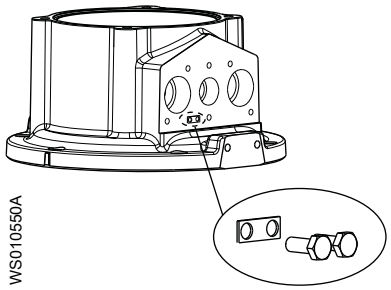
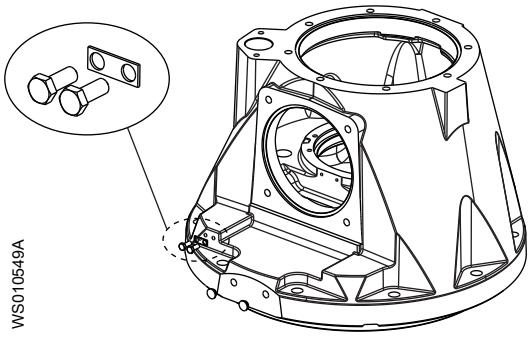
This section gives instructions for connecting the external earthing to the outside of the drive unit.

This procedure must be followed for:

- Pumps that are installed in an EX environment
- Medium voltage pumps.

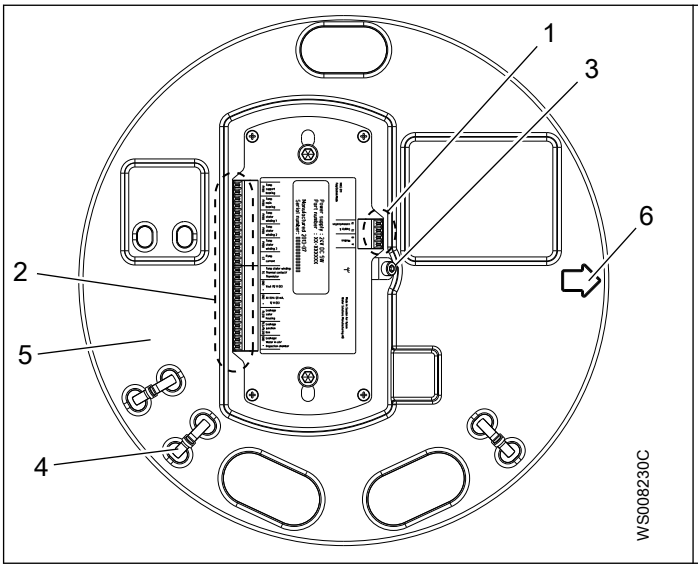
Other circumstances can also make this procedure applicable.

Connect the ground (earth) at the external grounding (earthing) site on the outside of the drive unit. See the following figures.

Small connection house	Large connection house
	

4.8.4 Connect the cables: Standard pumps with MAS 801

This procedure must not be used for Ex-proof applications. If the pump is Ex-proof, then use the procedure that is described in *Connect the cables: Ex-proof pumps with MAS 801* on page 70.



1. PEM communication terminals
2. PEM control terminals
3. Functional ground
4. Cable tie
5. Terminal plate
6. Index arrow. The index arrow on the terminal plate is aligned with the cable inlet.

1. Install the monitoring equipment. See the System Installation and Operation (SIO) Manual for the MAS 801 monitoring equipment.
2. Connect the two signal leads that are integrated in the SUBCAB® cable, T1 and T2, to the MAS BU.

   See the chapter “Installation” in the SIO Manual for the MAS 801 monitoring equipment.
3. If they are not already connected, then connect the T1 and T2 leads integrated in the SUBCAB cable to the PEM. See the illustration and table in *Terminals used in standard applications* on page 69.
4. If they are not already connected, then connect the power leads:
   a) Check the data plate to determine which connection is valid for the voltage supply.
   b) For 4-cable configurations: Fit the protective sleeve on each cable, where it connects to the terminal board. See the following figure.

      Protective sleeve: 94 05 89. Length: approximately 33 cm (13 in).

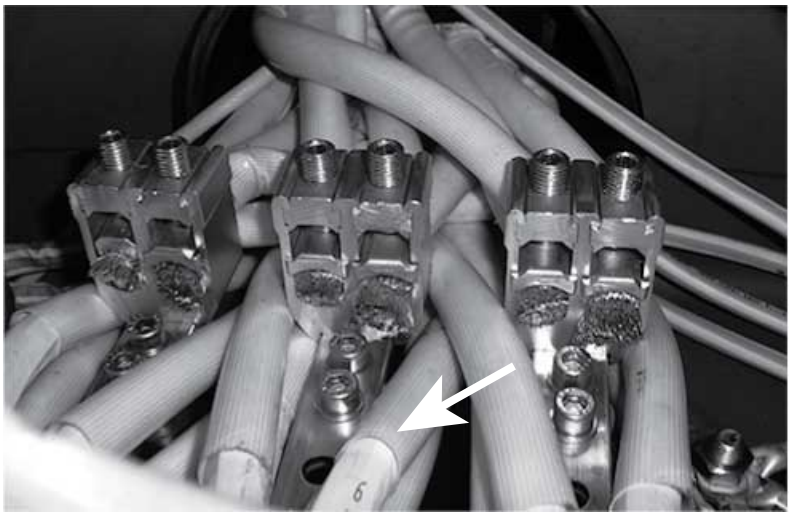


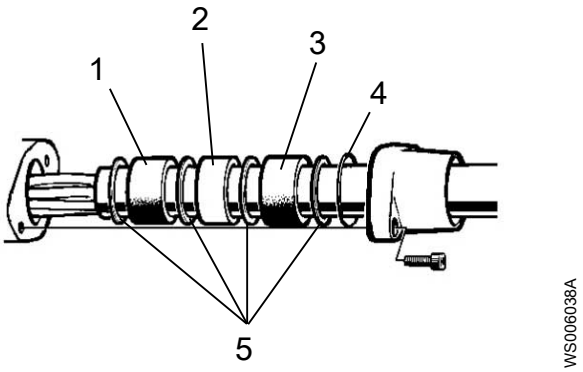
Figure 42: Protective sleeve 94 05 89

c) Connect the power leads to the terminal board connection U1, U2, V1, V2, W1, W2, and ground (earth) according to the cable chart.

See *Cable charts* on page 86.

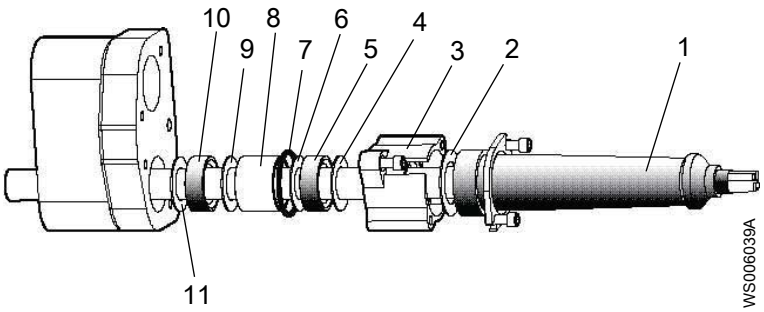
5. Install the entrance flange:

a) Fit the entrance flange parts according to the illustration for the correct drive unit.



1. Seal sleeve
2. Spacer ring
3. Seal sleeve
4. O-ring
5. Washer

Figure 43: Drive units 705–776



1. Protective sleeve
2. Washer
3. Connection flange
4. Washer
5. Seal sleeve
6. Washer
7. O-ring
8. Spacer ring
9. Washer

10. Seal sleeve
11. Washer

Figure 44: Drive unit 805–998

b) Fit the protective rubber sleeve onto the cable where it leaves the connection housing.

   The rubber sleeve must have the correct size to give the correct compression around the cable.

c) Attach the connection flange to the entrance flange.

   Make sure that the seal sleeve is not misaligned with the rubber sleeve. Check that the entrance flange supports the cable so that it cannot be excessively bent.

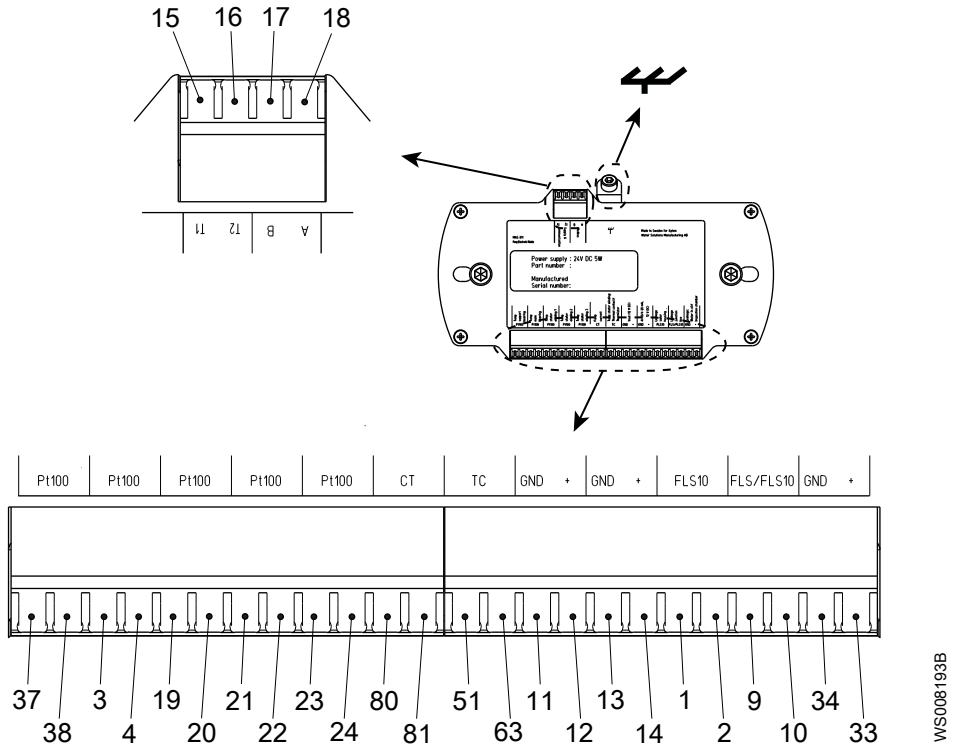
6. Connect the SUBCAB cable phase leads to the starter equipment according to the diagram in *Power cable phase sequence* on page 78.
7. Perform the system setup by using the Setup wizard and other commissioning procedures in the chapter “System Setup” in the SIO Manual for the MAS 801.
8. For pumps with drive units in voltage range 1.2–6.6 kV: Check that the stator alarm settings have been changed to the values in the following table.

Table 23: Stator alarm settings for 1.2–6.6 kV drive units

Stator Alarm	Setting
A	155°C
B	145°C

For more information, see the SIO Manual for the MAS 801. For drive unit voltage ranges, see *Drive units* on page 19.

4.8.4.1 Terminals used in standard applications

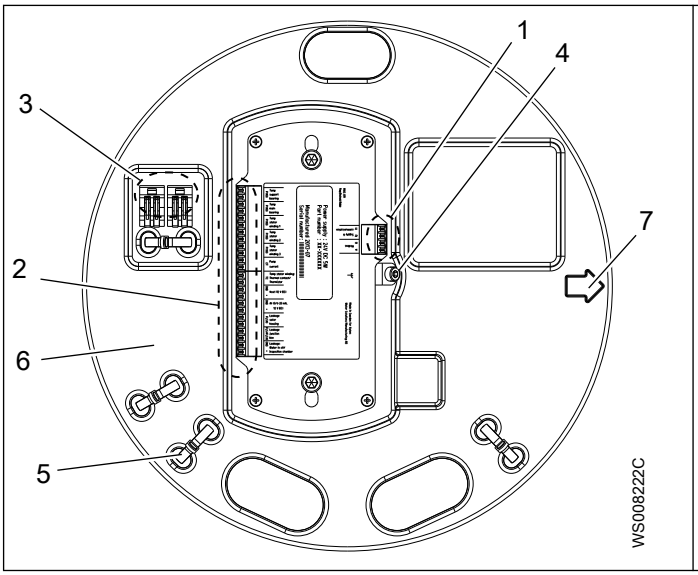


Terminal	Description	Terminal	Description
37, 38	Temperature support bearing, Pt100	13, 14	Analog input 0/4 -20 mA, +12 VDC, GND
3, 4	Temperature main bearing, Pt100	1, 2	Leakage: Inspection chamber or stator housing, FLS/FLS10

Terminal	Description	Terminal	Description
19, 20	Temperature stator winding 1, Pt100	9, 10	Leakage, junction box: FLS/ FLS10
21, 22	Temperature stator winding 2, Pt100	34, 33	Leakage, inspection chamber: FLS10. Water in oil: CLS
23, 24	Temperature stator winding 3, Pt100	15	T1 power supply and communication
80, 81	Pump current, CT	16	T2 power supply and communication
51, 63	Temperature stator winding: Thermal contact or thermistor, TC	17	Not used
11, 12	V_{out} +12 VDC, GND	18	Not used

4.8.5 Connect the cables: Ex-proof pumps with MAS 801

For Ex-proof applications, the stator winding temperature sensors are not connected to terminals 51 and 63 on the PEM. They are connected to the T3 and T4 terminals on the separate plinth.



1. PEM communication terminals
2. PEM control terminals
3. Separate plinth with T3, T4 terminals
4. Functional ground
5. Cable tie
6. Terminal plate
7. Index arrow. The index arrow on the terminal plate is aligned with the cable inlet.

1. Install the monitoring equipment. See the System Installation and Operation (SIO) Manual for the MAS 801 monitoring equipment.
2. Connect the two signal leads that are integrated in the SUBCAB® cable, T1 and T2, to the MAS base unit.

   See the chapter “Installation” in the SIO Manual for the MAS 801 monitoring equipment.
3. Connect the T3 and T4 terminals. See the SIO Manual for the MAS 801.

   Do not connect the stator winding temperature sensor leads to PEM terminals 51 and 63.

Option	Description
Thermal contacts	Connect the thermal contacts in the contactor coil circuit so that the circuit breaks directly. Use an auxiliary relay for the thermal contact status signals.
Thermistors	Connect the leads to a SIL-approved thermistor relay.

   For more information, see the SIO Manual for the MAS 801.
4. If they are not already connected, then connect the T1 and T2 leads integrated in the SUBCAB cable to the PEM. See the illustration and table in *Terminals used in Ex applications* on page 73.

5. If they are not already connected, then connect the power leads:
   a) Check the data plate to determine which connection is valid for the voltage supply.
   b) For 4-cable configurations: Fit the protective sleeve on each cable, where it connects to the terminal board. See the following figure.

      Protective sleeve: 94 05 89. Length: approximately 33 cm (13 in).

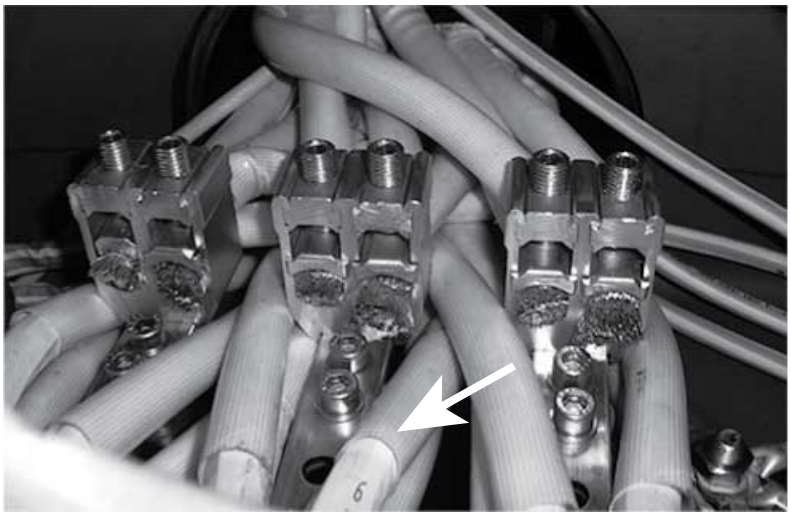
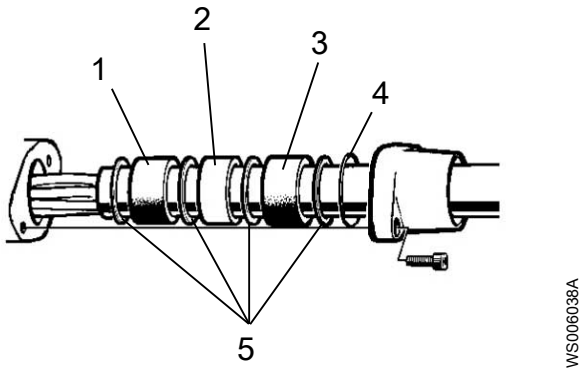


Figure 45: Protective sleeve 94 05 89

   c) Connect the power leads to the terminal board connection U1, U2, V1, V2, W1, W2, and ground (earth) according to the cable chart.

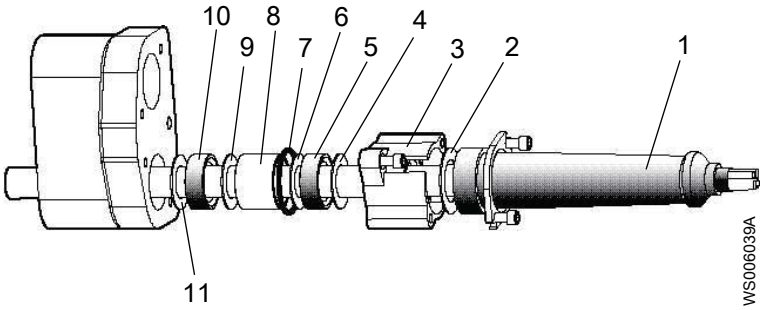
      See *Cable charts* on page 86.

6. Install the entrance flange:
   a) Fit the entrance flange parts according to the illustration for the correct drive unit.



1. Seal sleeve
2. Spacer ring
3. Seal sleeve
4. O-ring
5. Washer

Figure 46: Drive units 705–776



1. Protective sleeve
2. Washer
3. Connection flange
4. Washer
5. Seal sleeve
6. Washer
7. O-ring
8. Spacer ring
9. Washer
10. Seal sleeve
11. Washer

Figure 47: Drive unit 805–998

b) Fit the protective rubber sleeve onto the cable where it leaves the connection housing.

   The rubber sleeve must have the correct size to give the correct compression around the cable.

c) Attach the connection flange to the entrance flange.

   Make sure that the seal sleeve is not misaligned with the rubber sleeve. Check that the entrance flange supports the cable so that it cannot be excessively bent.

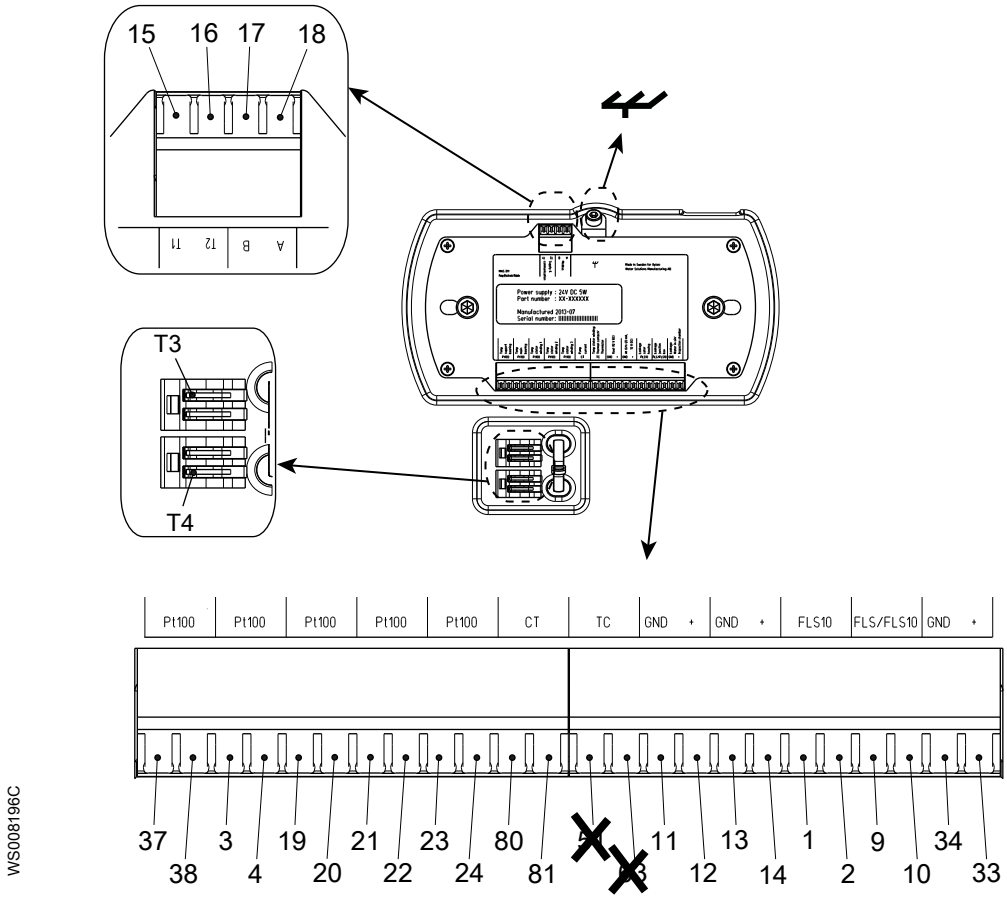
7. Connect the SUBCAB cable phase leads to the starter equipment according to the diagram in *Power cable phase sequence* on page 78.
8. Perform the system setup by using the Setup wizard and other commissioning procedures in the chapter “System Setup” in the SIO Manual for the MAS 801.
9. For pumps with drive units in voltage range 1.2–6.6 kV: Check that the stator alarm settings have been changed to the values in the following table.

Table 24: Stator alarm settings for 1.2–6.6 kV drive units

Stator Alarm	Setting
A	155°C
B	145°C

For more information, see the SIO Manual for the MAS 801. For drive unit voltage ranges, see *Drive units* on page 19.

4.8.5.1 Terminals used in Ex applications



Terminal	Description	Terminal	Description
37, 38	Temperature support bearing, Pt100	1, 2	Leakage: Inspection chamber or stator housing, FLS/FLS10
3, 4	Temperature main bearing, Pt100	9, 10	Leakage junction box, FLS/ FLS10
19, 20	Temperature stator winding 1, Pt100	34, 33	Leakage, inspection chamber: FLS10
21, 22	Temperature stator winding 2, Pt100	15	T1 power supply and communication
23, 24	Temperature stator winding 3, Pt100	16	T2 power supply and communication
80, 81	Pump current, CT	17	Not used
11, 12	V_{out} +12 VDC, GND	18	Not used
13, 14	Analog input 0/4 -20 mA, +12 VDC, GND	T3, T4	Temperature stator winding: Thermal contact or thermistor, TC

4.8.6 Connect the cables: Pumps with MAS 711

1. Connect the monitoring equipment.
2. Connect the cable to the terminal board:
   - If the MAS 711 system is used, then connect the cable to its terminal board according to the illustration and table in *MAS 711 sensor connections* on page 76.

NOTICE:

As the cable ends are sealed to eliminate moisture entrainment during transport and storage, no wire markings for the sensors at the outlet end of the cable are made at the factory. Markings must therefore be carried out during installation of the unit.

3. Synchronize the MAS 711 base unit and the pump memory at the first installation:
   a) Check that the communication between the pump and the MAS base unit is activated.
   b) Upload the factory settings of sensors and related parameters by choosing the command "copy all from pump memory to MAS". For more information about the MAS installation, see the Installation and User Manual for the MAS 711 monitoring equipment.
4. For pumps with drive units in voltage range 1.2–6.6 kV: Change the preset to stator alarms to the values in the following table.

   Table 25: Stator alarm settings for 1.2–6.6 kV drive units

Stator Alarm	Setting
A	155°C
B	145°C

   For more information, see the Installation and User Manual for the MAS 711 monitoring equipment. For drive unit voltage ranges, see *Drive units* on page 19.
5. Connect the power cable:
   a) Check the data plate to determine which connection is valid for the voltage supply.
   b) For 4-cable configurations: Fit the protective sleeve on each cable, where it connects to the terminal board. See the following figure.

      Protective sleeve: 94 05 89. Length: approximately 33 cm.

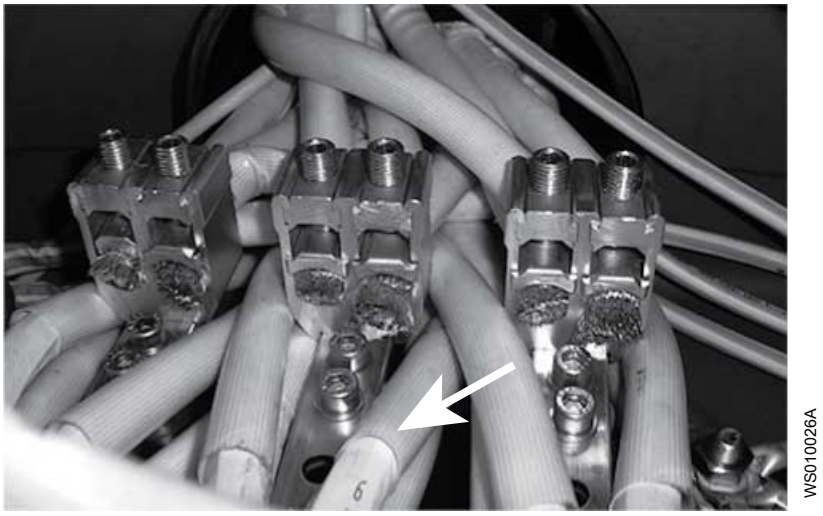
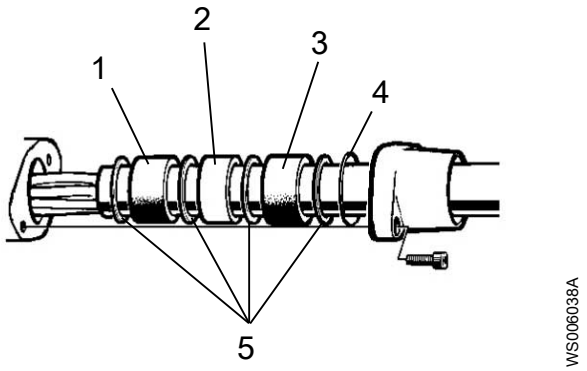


   Figure 48: Protective sleeve 94 05 89

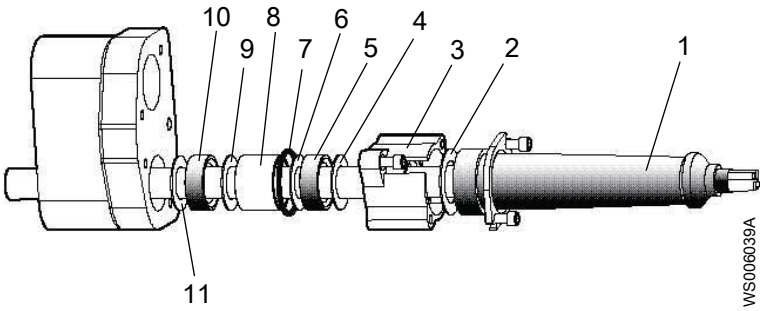
   c) Arrange the connection on the terminal board.
   d) Connect the power cable leads to the terminal board connection U1, U2, V1, V2, W1, W2, and ground (earth) according to the cable chart.

      See *Cable charts* on page 86.
   e) If control elements are present and not used, then cut and cap them.
6. Install the entrance flange:
   a) Fit the entrance flange parts according to the illustration for the correct drive unit.



1. Seal sleeve
2. Spacer ring
3. Seal sleeve
4. O-ring
5. Washer

Figure 49: Drive units 705–776



1. Protective sleeve
2. Washer
3. Connection flange
4. Washer
5. Seal sleeve
6. Washer
7. O-ring
8. Spacer ring
9. Washer
10. Seal sleeve
11. Washer

Figure 50: Drive unit 805-998

b) Fit the protective rubber sleeve onto the cable where it leaves the connection housing.

   The rubber sleeve must have the correct size to give the correct compression around the cable.

c) Attach the connection flange to the entrance flange.

   Make sure that the seal sleeve is not misaligned with the rubber sleeve. Check that the entrance flange supports the cable so that it cannot be excessively bent.

7. Connect the starter equipment:
   a) Connect the power cable to the starter equipment according to the diagram in *Power cable phase sequence* on page 78.
   b) Connect the auxiliary cable to the starter equipment.

4.8.6.1 MAS 711 sensor connections

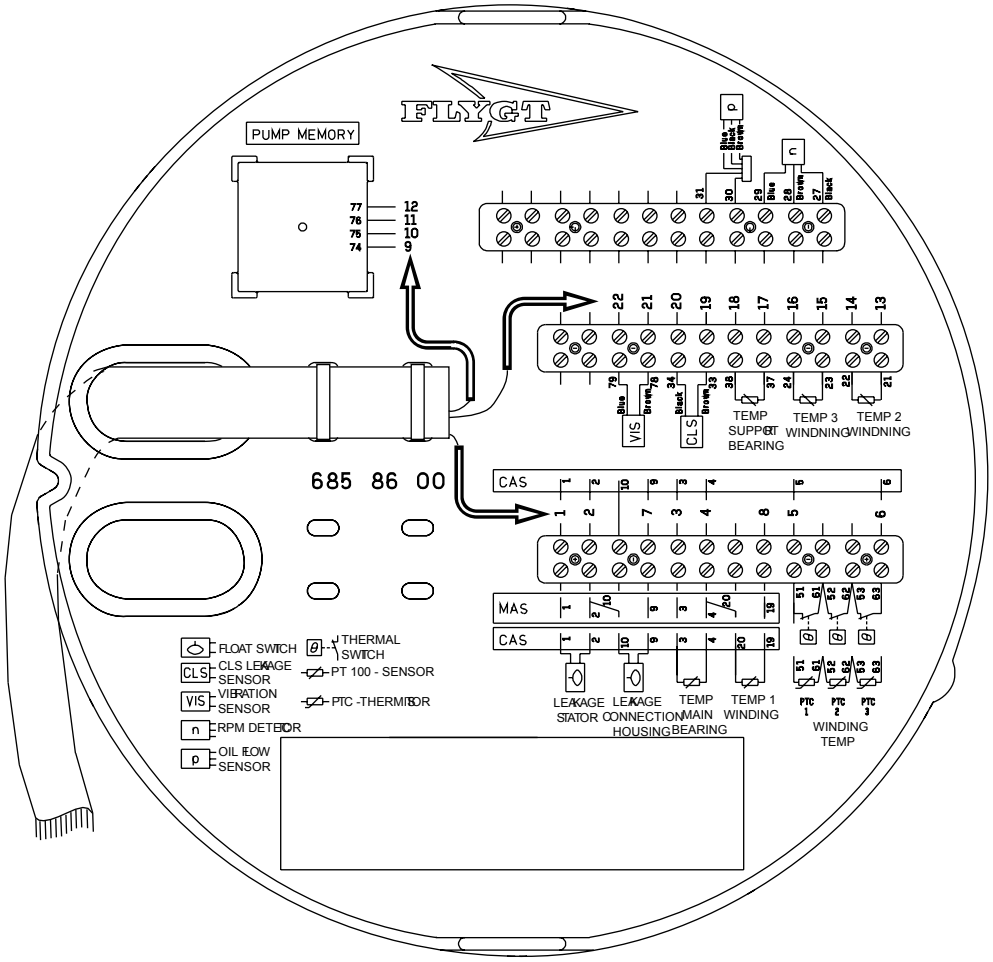


Figure 51: Connections at the product. Arrows indicate SUBCAB™ cable lead numbers.

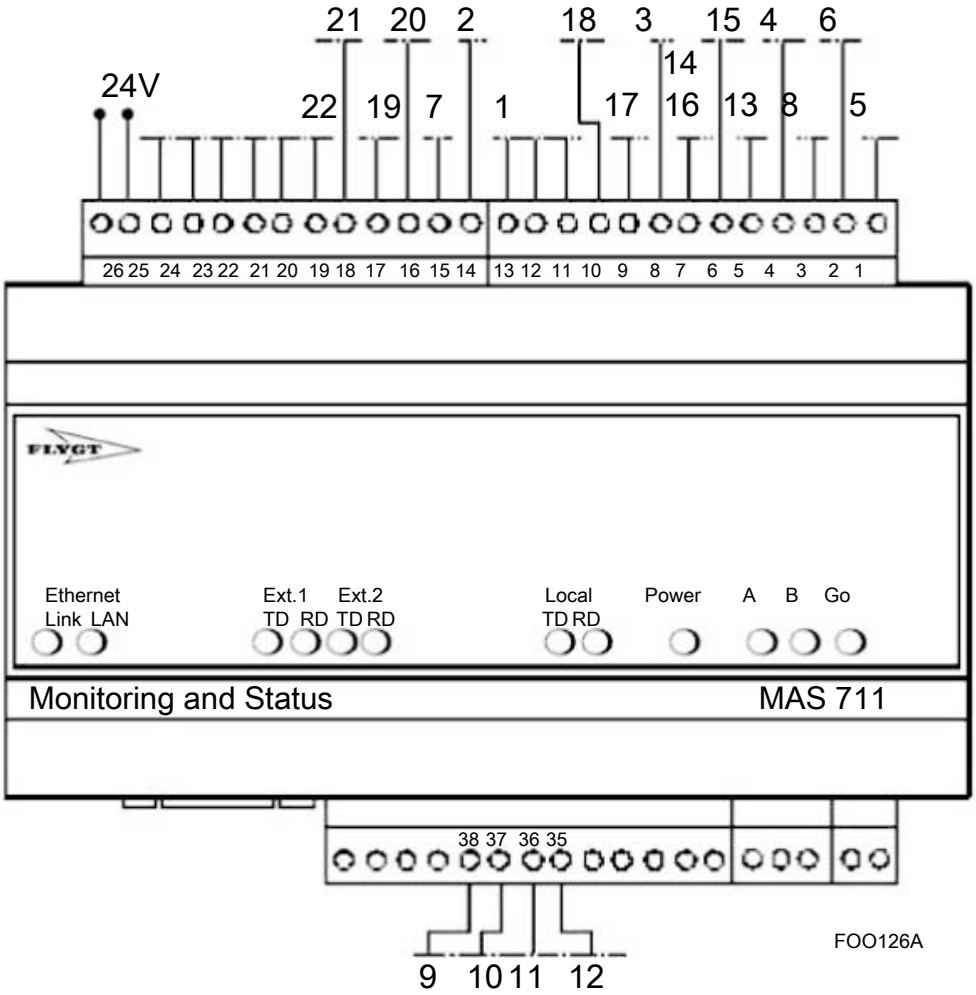


Figure 52: Connections at the MAS 711 base unit

This table shows how the conductors are connected to the different sensors.

Sensor		Terminal block	Conductor number for 12-lead cable	Conductor for 24-lead cable
Float switch in the stator house[2]		1	1	1
		2	2	2
Float switch in the junction box		9	7	7
		2	—	—
Pt100 in the main bearing[3]		3	3	3
		4	4	4
Pt100 in the support bearing		37	—	17
		38	—	18
Thermal contacts or thermistors in the stator		5	5	5
		6	6	6
CLS sensor in the oil housing	+	33	—	19
	–	34	—	20

2 The leakage sensor in the stator housing and the leakage sensor in the junction box use the same terminal (terminal 2) on the terminal block.

3 The Pt100 sensors in the main bearing and the support bearing use the same terminal (terminal 4) on the terminal block.

Sensor		Terminal block	Conductor number for 12-lead cable	Conductor for 24-lead cable
Pt100 in the stator winding 1		19	8	8
		4	—	—
Pt100 in the stator winding 2		21	—	13
		22	—	14
Pt100 in the stator winding 3		23	—	15
		24	—	16
Memory module RS-485 B		74	9	9
Memory module RS-485 A		75	10	10
Memory module supply, ground (earth)		76	11	11
Memory module supply, 12 VDC+		77	12	12
Vibration sensor VIS 10	+	78	—	21
	–	79	—	22

4.8.7 Power cable phase sequence

In the following figure, the triangle marked “L1,” “L2” and “L3” shows the phase sequence.

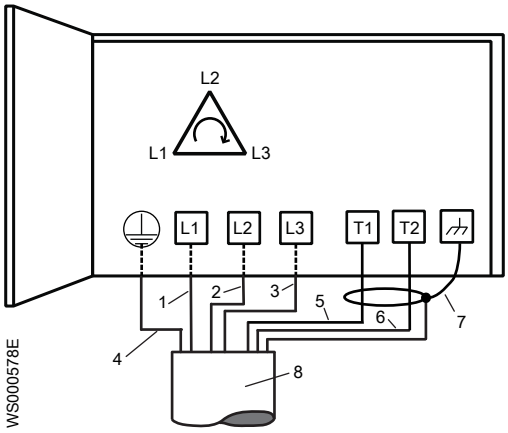


Figure 53: Correct phase sequence

Item	Description	
1	L1 cable lead	Brown
2	L2 cable lead	Black
3	L3 cable lead	Gray
4	Earth PE or ground lead cable	
5	T1 cable lead (control element)	In cables with both power conductors and control element. MAS 801: See the SIO manual for T1, T2, and drain wire connections.
6	T2 cable lead (control element)	
7	Screen (drain wire)	
8	Power cable to unit	

4.8.8 Identifying signal leads connected to the PEM, thermal contacts, or thermistors

This section is for pumps with the MAS 801.

There can be 1–4 SUBCAB™ cables. Each cable contains both power conductors and signal conductors. Only the signal conductors from one cable are used.

Labels are attached to the SUBCAB™ cable which is used for communication when there is more than one SUBCAB™ cable. This section gives instructions for identifying which cable is used for communication, when the label is missing.

A multimeter can be used to identify the following:

- Which signal leads are connected to the PEM
- For explosion-proof pumps: which leads are connected to the thermal contacts or thermistors

Unused leads in the pump are isolated.

4.8.8.1 Measure the resistance

At the PEM, T1 is + and T2 is −.

1. Select a SUBCAB™ cable.
2. Use a multimeter to measure the resistance across T1–T2.

   Measure both polarities.

T1–T2 resistance	T1–T2 resistance Opposite polarity	Conclusion
20–200 kilohms	∞ ohm	The PEM is connected to this cable.
∞ ohm: infinite resistance	∞ ohm	The PEM is not connected to this cable.

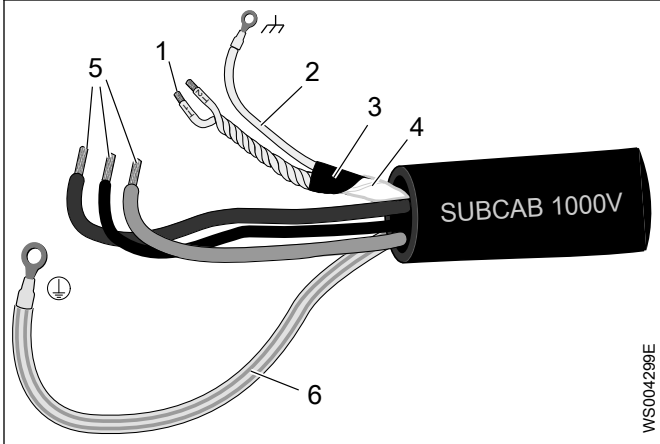
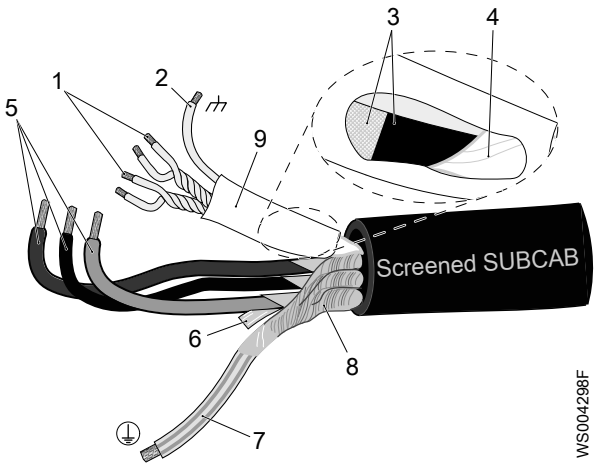
3. Ex-proof pumps only: Use a multimeter to measure the resistance across T3–T4.

T3–T4 resistance	Stator temperature sensors
∞ ohm	The T3–T4 signal leads of this cable are not used.
0–5 ohm	Thermal contacts are connected to this cable.
150–300 ohm	Thermistors are connected to this cable.

4. Repeat this process on the other cables until the signal leads which are used for communication, have been identified.

4.8.9 Prepare the SUBCAB™ cables

This section applies to SUBCAB™ cables with twisted-pair control conductors.

The prepared SUBCAB™ cable	The prepared screened SUBCAB™ cable, without cable lugs
	
1. T1+T2 twisted pairs in control element 2. Drain wire in control element (tinned copper strands) with shrink tube 3. Aluminum and textile layers 4. Insulation jacket or plastic jacket, for the control element 5. Power conductors 6. Ground (earth) conductor with yellow-green shrink tube	1. T1+T2 and T3+T4 twisted pairs in control element 2. Drain wire in control element (tinned copper strands) with shrink tube 3. Aluminum and textile layers 4. Insulation jacket or plastic jacket, for the control element 5. Power conductors 6. Plastic laminated aluminum foil, screen 7. Ground (earth) conductor with yellow-green shrink tube 8. Uncovered screen/braided wire 9. shrink tube

1. Peel off the outer jacket at the end of the cable.
2. Prepare the control element:
   a) Peel the insulation jacket or plastic jacket.
   b) Peel the aluminum and textile layers.

      The aluminum foil is a conductive screen. Do not peel more than necessary, and remove the peeled foil.

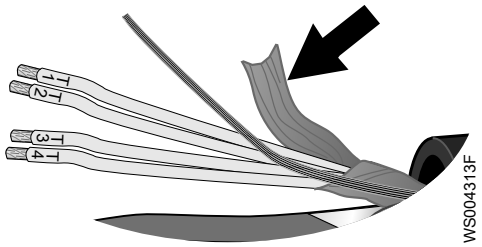


Figure 54: Aluminum foil on the control element.

   c) Put a white shrink tube over the drain wire.
   d) Twist T1+T2 and T3+T4.
   e) Put a shrink tube over the control element.

      Make sure that the conductive aluminum foil and drain wire are covered.
3. Prepare the ground (earth) conductor of the SUBCAB™ cable:
   a) Peel the yellow-green insulation from the ground (earth) conductor.
   b) Check that the ground (earth) conductor is at least 10% longer than the phase conductors in the cabinet.
   c) If applicable, put a cable lug on the ground conductor.
4. Prepare the ground (earth) conductor of the screened SUBCAB™ cable:
   a) Untwist the screens around the power conductors.
   b) Twist all power conductor screens together to create a ground (earth) conductor.
   c) Put a yellow-green shrink tube over the ground (earth) conductor.

Leave a short piece uncovered.

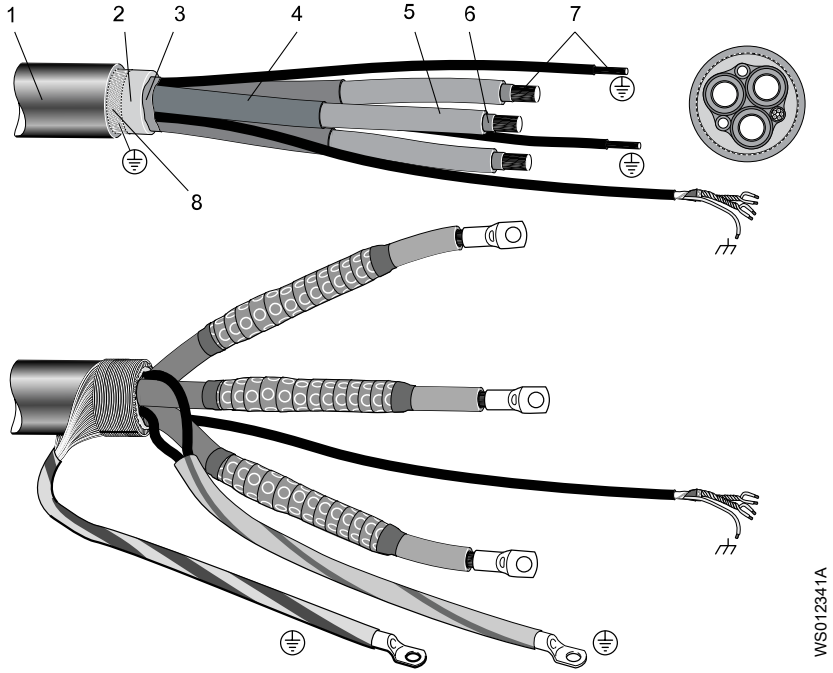
d) Check that the connected ground (earth) conductor has sufficient slack. The conductor must stay connected even if the power conductors are pulled loose.

5. Prepare the power conductors:
   a) Remove the aluminum foil around each power conductor.
   b) Peel the insulation from each power conductor.
6. Prepare the ends of the ground (earth) conductor, the power conductors, and the drain wire:

Connection type	Action
Screw	Fit cable lugs to the ends.
Terminal block	Fit end sleeves or leave the ends as they are.

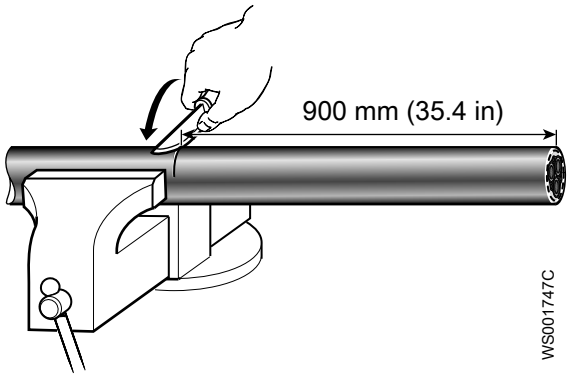
4.8.10 Prepare the medium-voltage cable

This instruction is for preparing medium voltage (1.2–15 kV) power cables before connecting them at the pump.

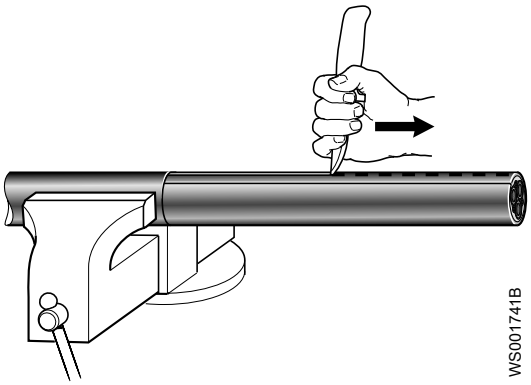


1. Outer cable sheath
2. Inner sheath
3. Conductive foil
4. Semi-conductive layer
5. Conductor insulation
6. Conductive foil
7. Copper conductor
8. Screen wires

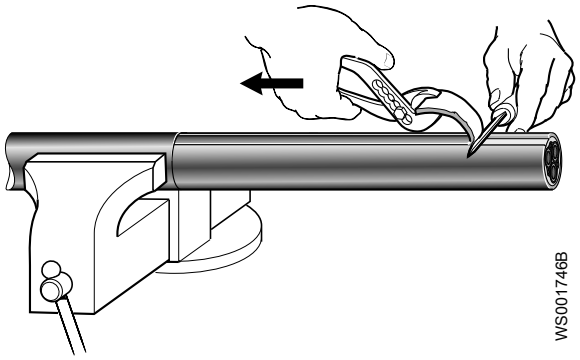
1. Peel off the outer cable sheath at the connection end of the cable.
   a) Make the vertical cut.



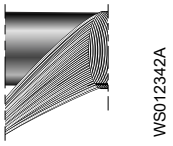
b) Make the horizontal cut.



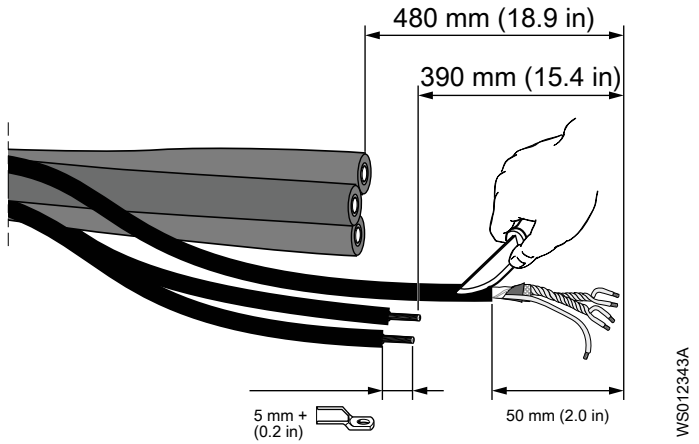
c) Remove the outer cable sheath.



2. Collect and fold away the screen wires to the side.



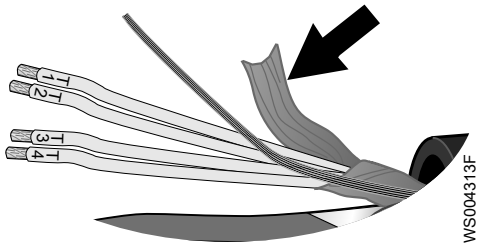
3. Peel off the inner sheath and the conductive foil.
4. Shorten the power conductors.



5. Prepare the ground (earth) conductors:
   a) Shorten the conductors.
   b) Peel off the sheath.
6. Prepare the control element:
   a) Peel the sheath and the aluminum foil.

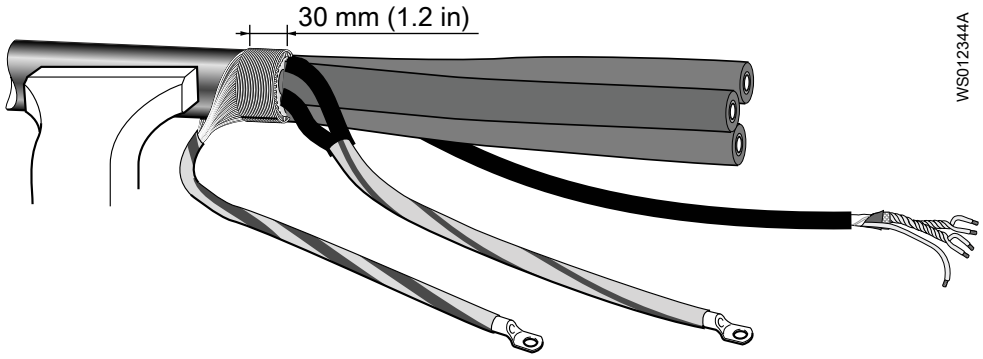
      If the control element is connected to MAS, then see the SIO manual for information on the preparation of the control element.

      The aluminum foil is a conductive screen. Do not peel more than necessary, and remove the peeled foil.



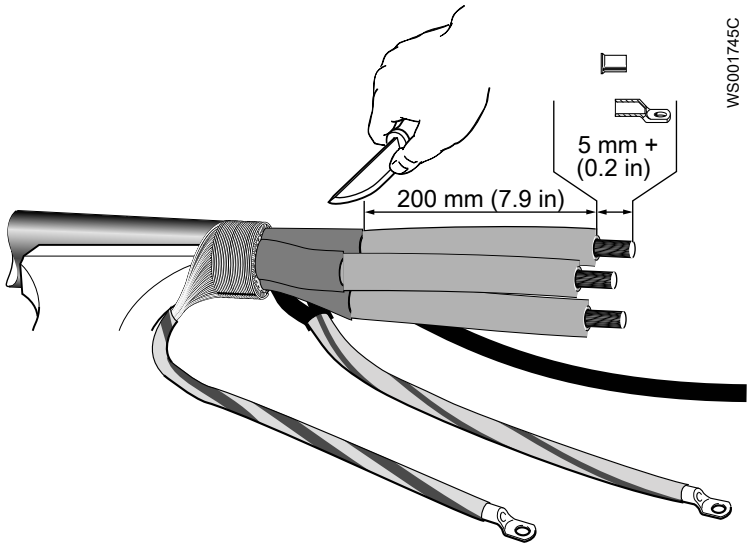
   b) Put a white shrink tube over the drain wire.
   c) Twist T1+T2 and T3+T4.
   d) Put a shrink tube over the control element.

      Make sure that the conductive aluminum foil and drain wire are covered.
7. Fold the screen wires over the outer cable sheath.

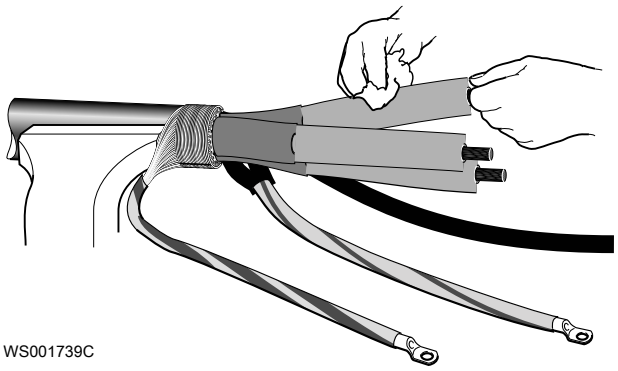


8. Fit a yellow-green shrink tube over the screen wires.
9. Fit a yellow-green shrink tube over the ground (earth) conductors.
10. Fit cable lugs on the screen wires and the ground (earth) bundles.
11. Prepare the power conductors:

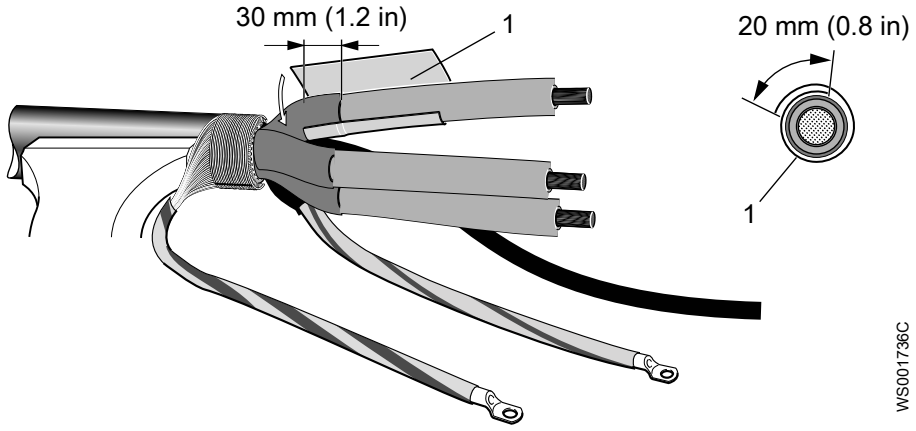
a) Peel off the semi-conductive layer.



b) Clean the power leads. Use chemically pure petrol.



c) Attach the FSD stress-grading pad to the leads.

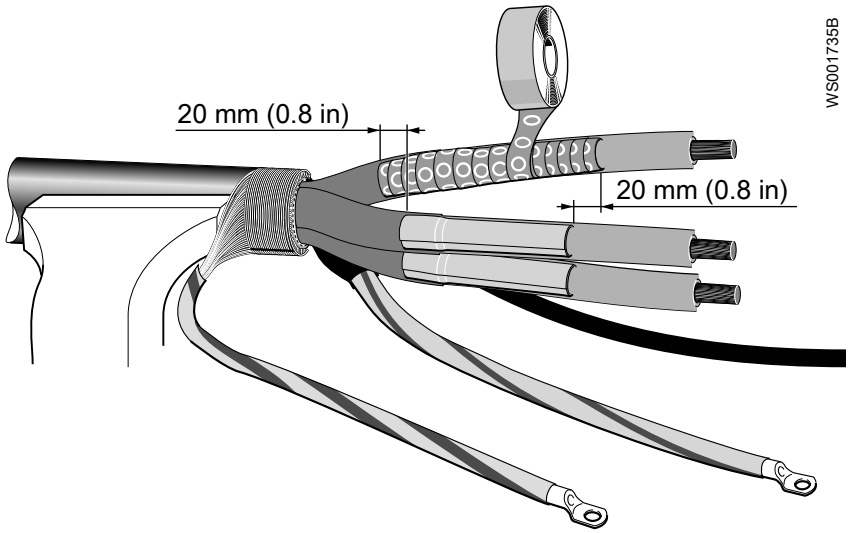


1. FSD, stress-grading pad

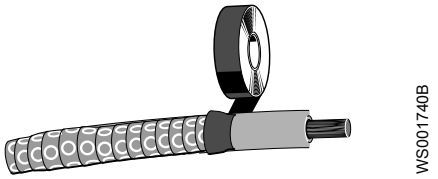
d) Apply four turns of IV tape with half overlap.

IV tape is an insulating and self-bonding type of tape.

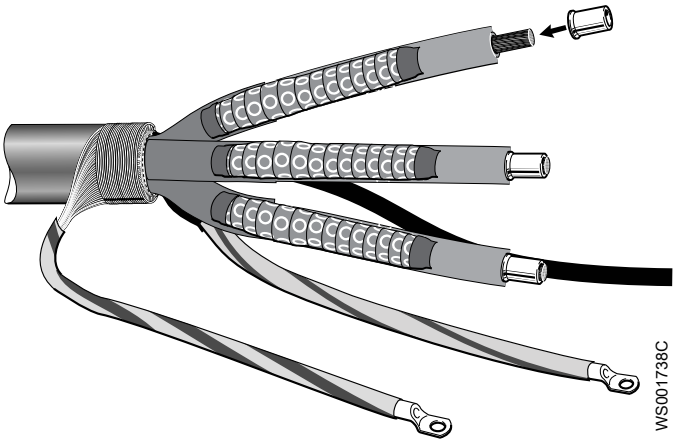
Stretch the tape until the markings are circular.



e) Use electrical tape to attach the IV tape ends.



f) Fit the cable lugs or end sleeves to the leads.



Example of cable end at electrical panel:

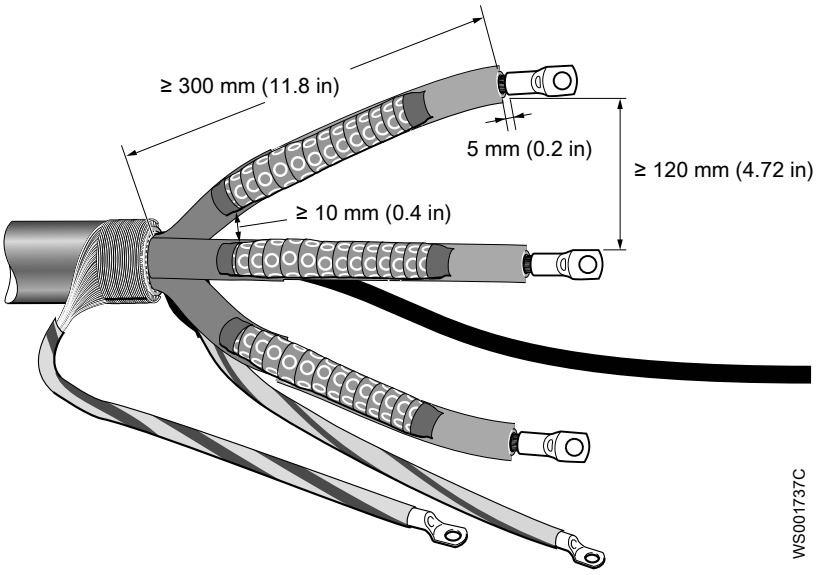


Figure 55: Recommended distances

4.9 Cable charts

NOTICE:

Leakage into the electrical parts can cause damaged equipment or a blown fuse. Keep the end of the motor cable dry at all times.

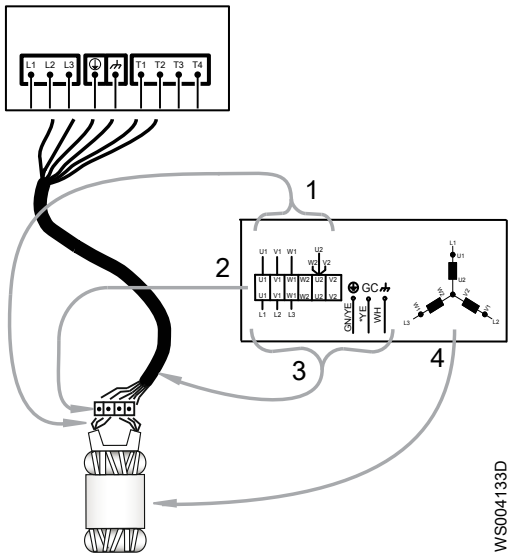
Stator leads connection to terminal board

Terminal board	Stator leads connection to terminal board			
	3 leads Y	6 leads D	6 leads Y	6 leads Y/D
U1	U	U1	U1	U1
V1	V	V1	V1	V1
W1	W	W1	W1	W1
W2	-	W2	W2	W2
U2	-	U2	U2	U2
V2	-	V2	V2	V2

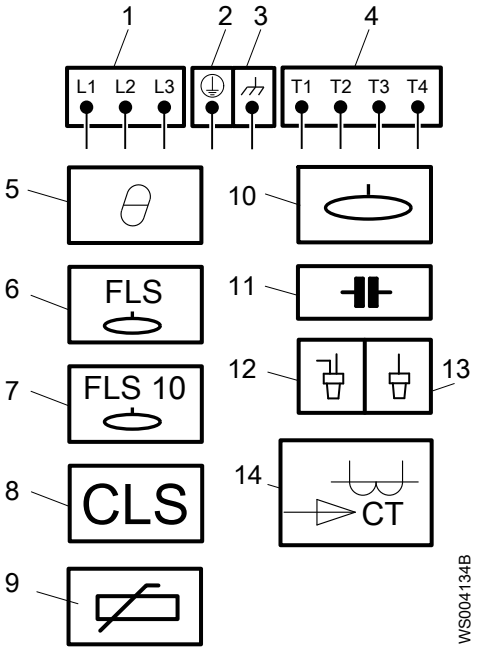
WS007848A

Connection locations

The figures in this section illustrate how to interpret the connection strip symbols.



1. Stator leads
2. Terminal board
3. Power cable leads
4. Stator (internal connection illustrated)



1. Starter equipment and mains leads (L1, L2, L3)
2. Ground (earth)
3. Functional ground
4. Control leads (T1, T2, T3, T4)
5. Thermal contact
6. FLS
7. FLS 10
8. CLS
9. Thermistor
10. Level sensor
11. Capacitor
12. Crimp connection
13. Crimp isolation
14. Current transformer

3-phase connection, screened

If a separate control cable is used, then the control conductors in the power cable are never used.

The following figure shows screened SUBCAB cable without a separate ground conductor. The ground conductor is made of stranded ground conductors. T1 and T2 are twisted together.

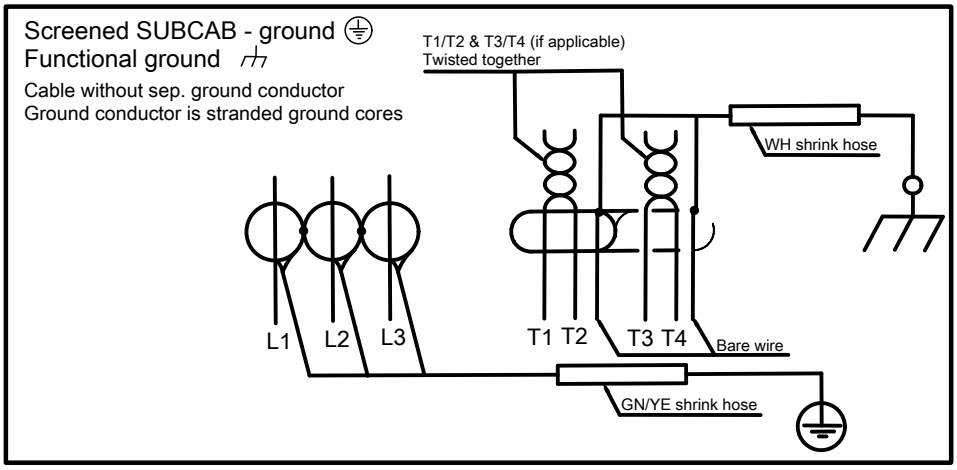


Figure 56: Without separate ground conductor

The following figure shows screened SUBCAB with a functional ground. T1 and T2 are twisted together.

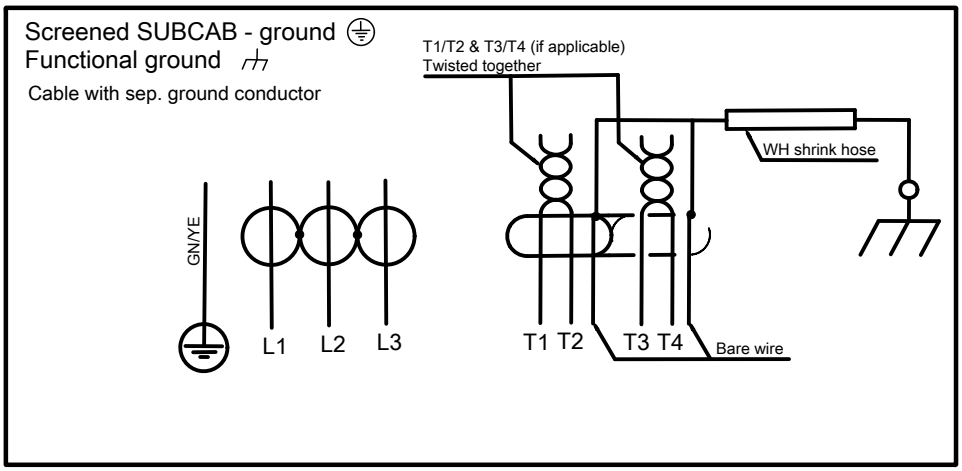


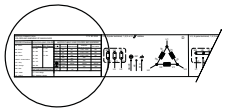
Figure 57: With functional ground

4.9.1 Colors and markings of leads

MOTOR CONNECTION
COLORS AND MARKING OF MAIN LEADS

773 30 00 (REV 5)

COLOR STANDARD	STATOR LEAD COLORS		MOTOR CABLE LEAD COLORS AND MARKING				
	LV Stators	MV Stators	3 ~	SUBCAB	SUBCAB AWG	SUBCAB S6x95+95+S(4x0.5)	MV cables
BK - Black	U1 - RD	U - BK	L1	BN	RD	1 WH , 4 WH	BK
BN - Brown	U2 - GN	V - BK	L2	BK	BK	2 WH , 5 WH	BK
BU - Blue	V1 - BN	W - BK	L3	GY	WH	3 WH , 6 WH	BK
GN - Green	V2 - BU		T1, T2	WH	WH	WH	-
GN/YE - Green/Yellow	W1 - YE		T3, T4	WH	WH	WH	-
GY - Grey	W2 - BK		⏚	GN/YE	GN/YE	GN/YE	GN/YE
OG - Orange			⏚	WH	-	WH	WH
RD - Red	VOLTAGE DENOMINATIONS		GC	-	YE	-	-
WH - White	LV - Low voltage						
YE - Yellow	MV - Medium voltage						



WS004335D

Color code standard

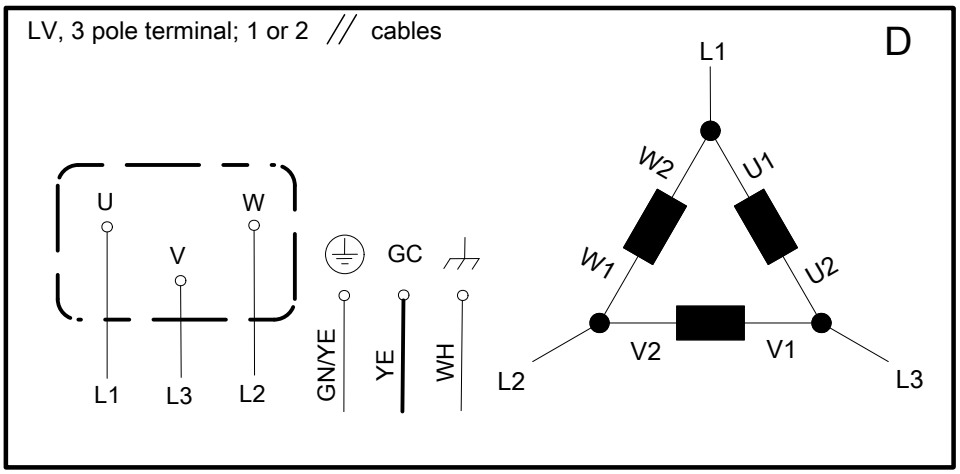
Code	Description
BN	Brown

Code	Description
BK	Black
WH	White
OG	Orange
GN	Green
GNYE	Green-Yellow
RD	Red
GY	Grey
BU	Blue
YE	Yellow

4.9.2 Power wiring diagrams: Drive units up to 1.1 kV

4.9.2.1 D-connection, 3-pole terminal

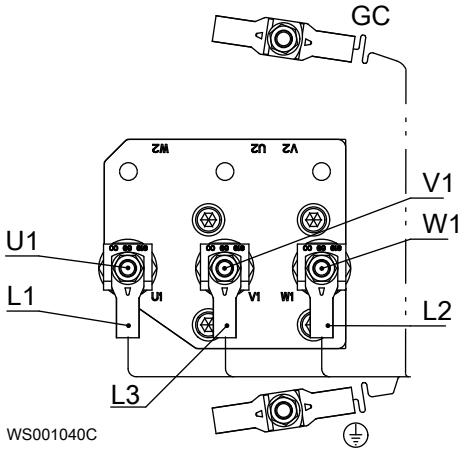
Schematic diagram



Drive units with small connection housing

Drive units:

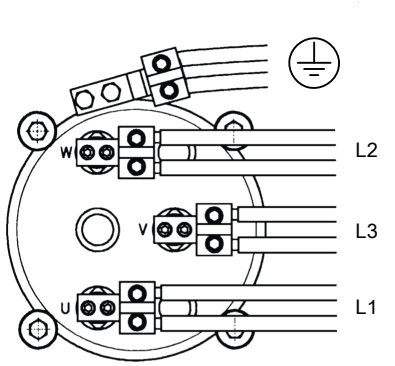
- 705/715, 735/745, 765/775 with large connection housing
- 706/716, 736/746, 766/776 with large connection housing



Drive units with large connection housing

Drive units:

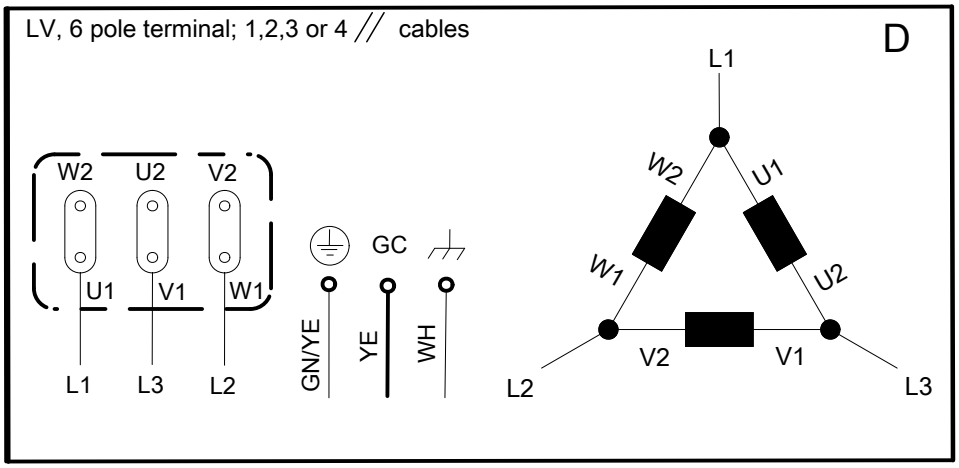
- 705/715, 735/745, 765/775 with large connection housing
- 706/716, 736/746, 766/776 with large connection housing
- 805/815, 835/845, 865/875, 885/895
- 806/816, 836/846, 866/876, 886/896
- 905/915, 935/945, 965/975
- 906/916, 936/946, 966/976



WS008999B

4.9.2.2 D-connection, 6-pole terminal; 1 cable

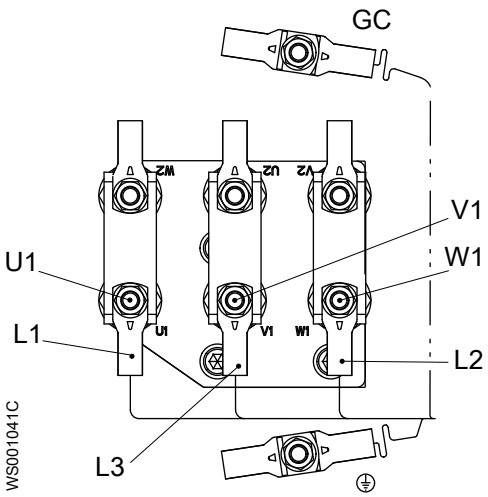
Schematic diagram



WS003911B

Drive units:

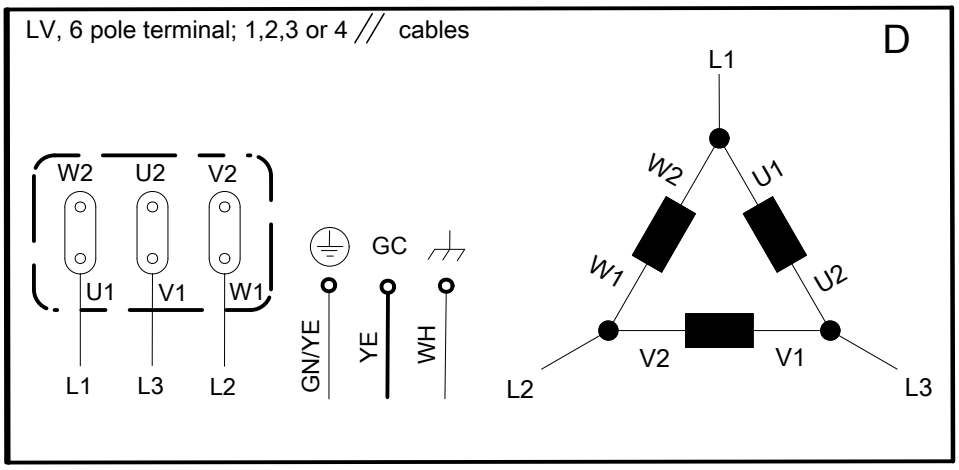
- 705/715, 735/745, 765/775 with small connection housing
- 706/716, 736/746, 766/776 with small connection housing



WS001041C

4.9.2.3 D-connection, 6-pole terminal; 2 cables

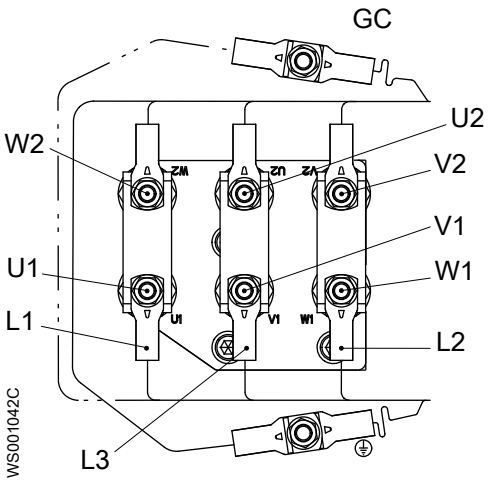
Schematic diagram



Drive units with small connection housing

Drive units:

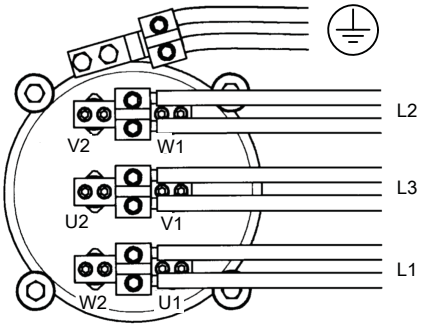
- 705/715, 735/745, 765/775 with small connection housing
- 706/716, 736/746, 766/776 with small connection housing



Drive units with large connection housing

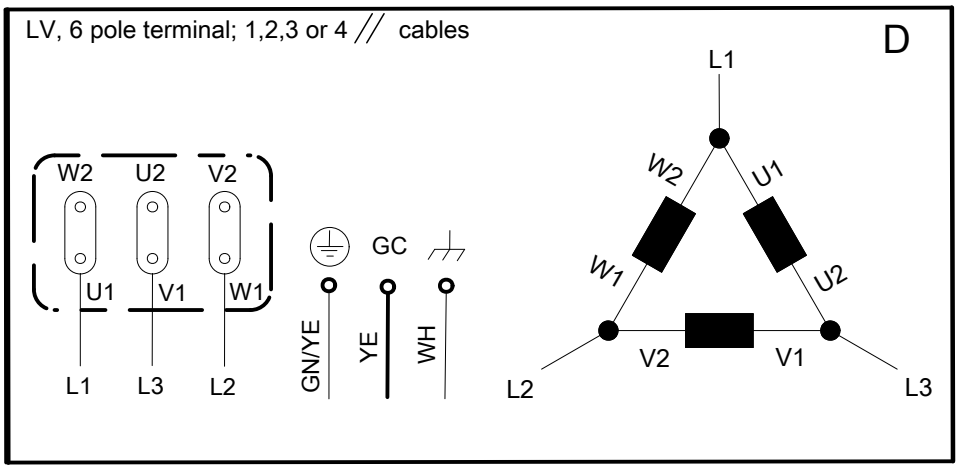
Drive units:

- 705/715, 735/745, 765/775 with large connection housing
- 706/716, 736/746, 766/776 with large connection housing
- 805/815, 835/845, 865/875, 885/895
- 806/816, 836/846, 866/876, 886/896
- 905/915, 935/945, 965/975
- 906/916, 936/946, 966/976



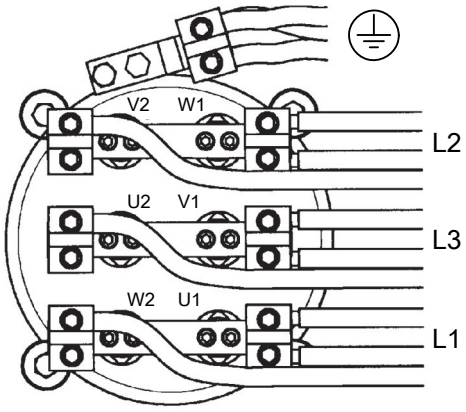
4.9.2.4 D-connection, 6-pole terminal; 3 cables

Schematic diagram



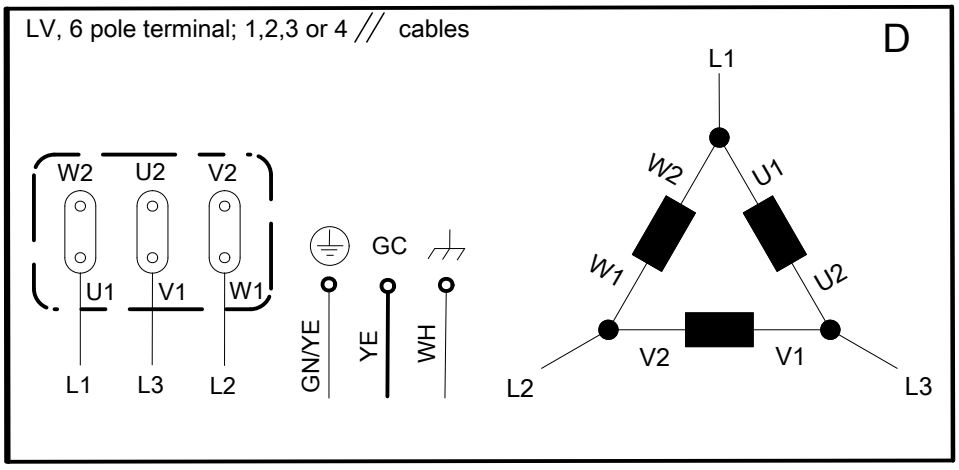
Drive units:

- 705/715, 735/745, 765/775 with large connection housing
- 805/815, 835/845, 865/875, 885/895
- 806/816, 836/846, 866/876, 886/896
- 905/915, 935/945, 965/975
- 906/916, 936/946, 966/976



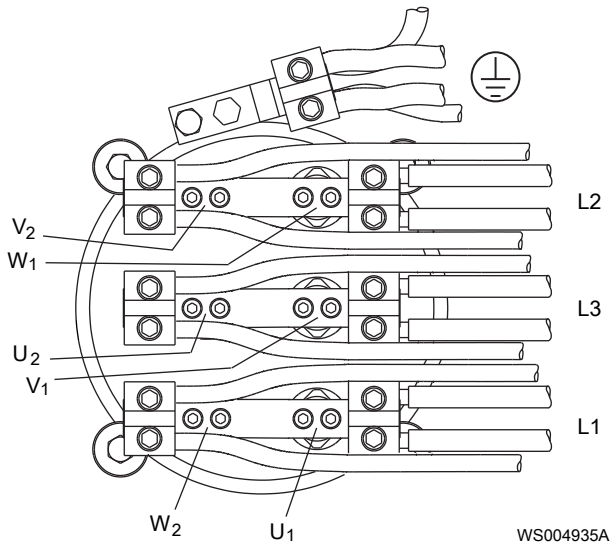
4.9.2.5 D-connection, 6-pole terminal; 4 cables

Schematic diagram



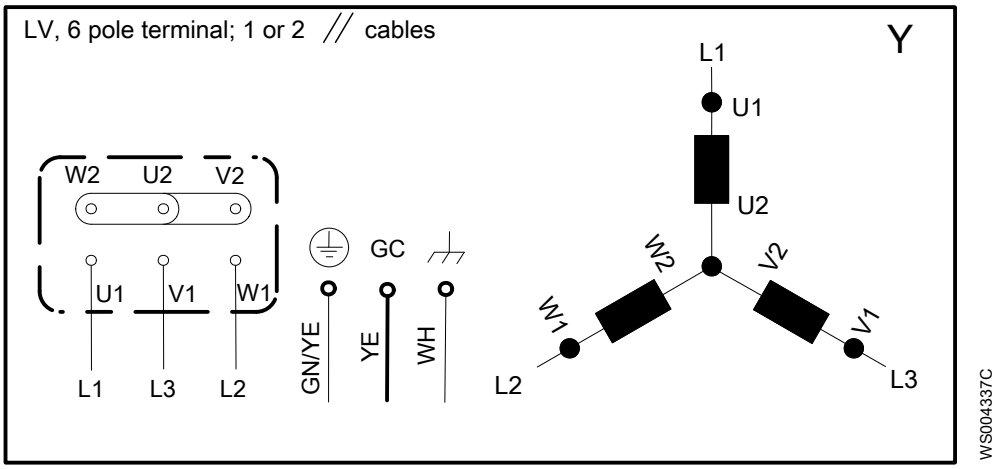
Drive units:

- 965/975
- 966/976



4.9.2.6 Y-connection

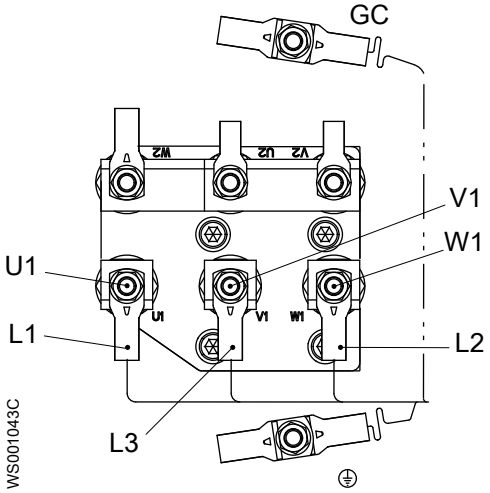
Schematic diagram



Drive units with small connection housing: 1 cable

Drive units:

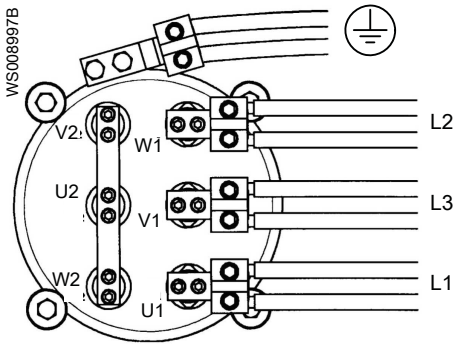
- 705/715, 735/745, 765/775 with small connection housing
- 706/716, 736/746, 766/776 with small connection housing



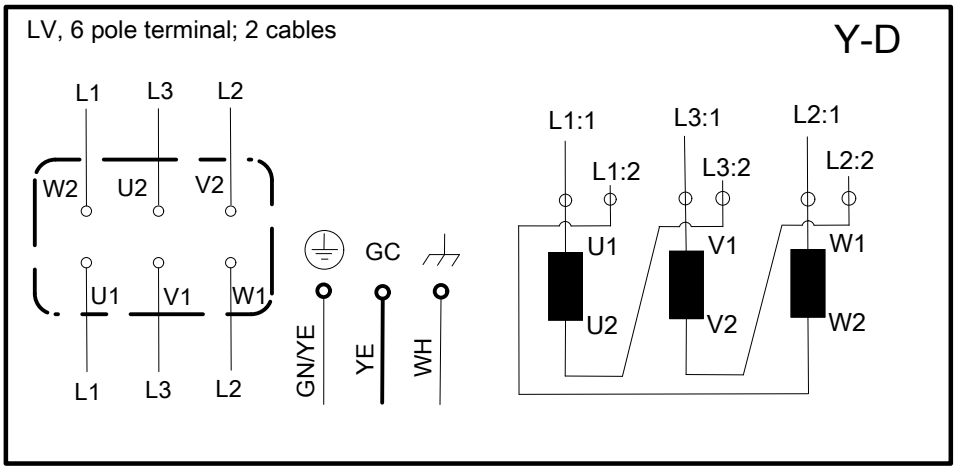
Drive units with large connection housing: 2 cables

Drive units:

- 705/715, 735/745, 765/775 with large connection housing
- 706/716, 736/746, 766/776 with large connection housing
- 805/815, 835/845, 865/875, 885/895
- 806/816, 836/846, 866/876, 886/896
- 905/915, 935/945, 965/975
- 906/916, 936/946, 966/976



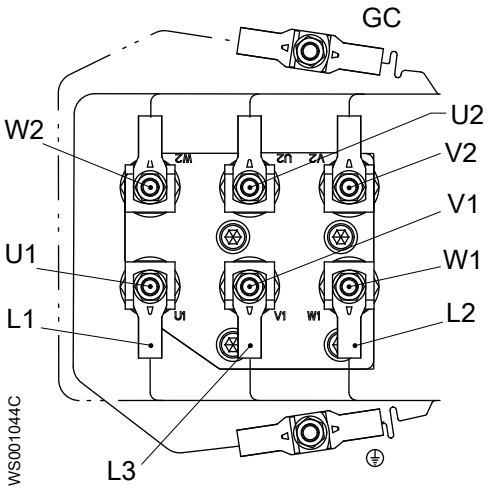
4.9.2.7 Y/D-connection



Drive units with small connection housing

Drive units:

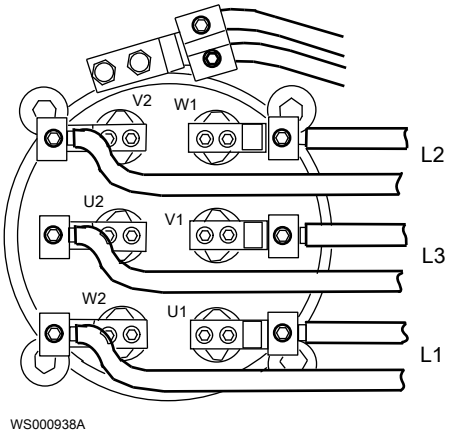
- 705/715, 735/745, 765/775 with small connection housing
- 706/716, 736/746, 766/776 with small connection housing



Drive units with large connection housing

Drive units:

- 705/715, 735/745, 765/775 with large connection housing
- 706/716, 736/746, 766/776 with large connection housing
- 805/815, 835/845, 865/875, 885/895
- 806/816, 836/846, 866/876, 886/896
- 905/915, 935/945, 965/975
- 906/916, 936/946, 966/976



4.9.3 Power wiring diagram: Drive units 1.2–6.6 kV

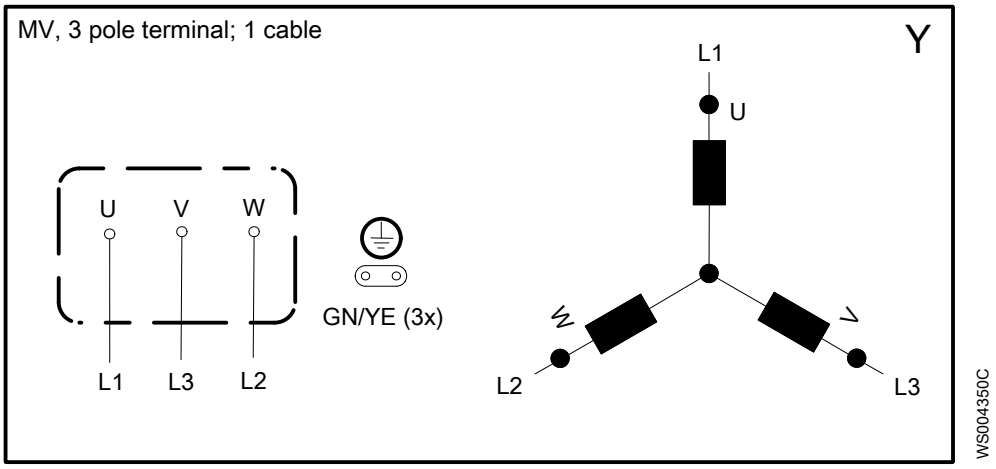
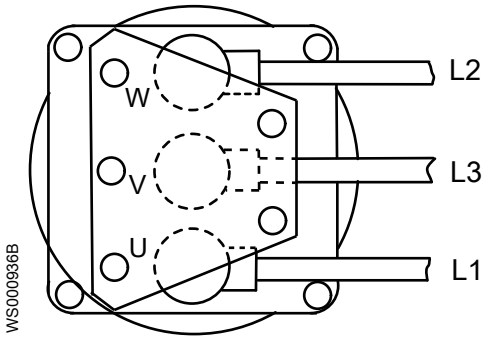


Figure 58: Wiring diagram for medium-voltage (1.2–6.6 kV) drive units

Medium-voltage drive units:

- 862/872, 882/892
- 863/873, 883/893
- 950/960, 985/995, 988/998
- 951/961, 986/996, 987/997



4.10 Connect the coolant

This instruction applies to pumps with external or integrated cooling. It does not apply to pumps with internal cooling.

4.10.1 Connect the integrated cooling system

This instruction is for connecting a drainage pipe to the bottom of the cooling jacket for pumps using integrated cooling. The pumped fluid is used as coolant in these systems. When integrated cooling is used, coolant supply and return lines are not required.

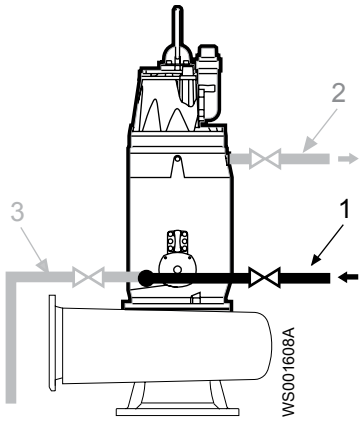
Connect the fittings to drain the coolant as shown in *Fittings needed to drain cooling jackets: drive units with external or integrated cooling systems* on page 36.

4.10.2 Connect the external cooling system

This instruction is for connecting external cooling systems to the pump.

1. Connect the coolant supply line to the pump inlet.

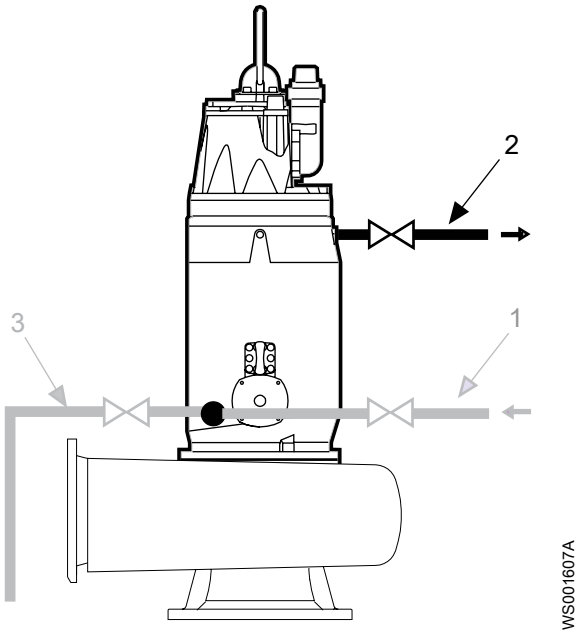
   For location of the inlet connection on the drive unit, see *Coolant supply and return connections* on page 97.



1. Coolant supply line
2. Coolant return line
3. Line to drain

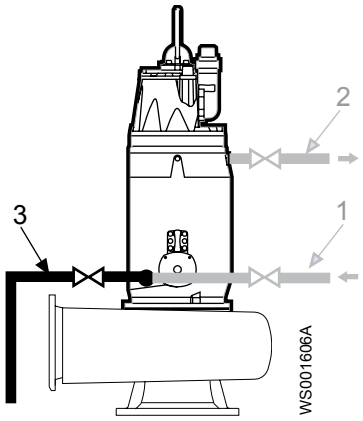
2. Connect the coolant return line to the outlet on the pump.

   For location of the return line connection on the drive unit, see *Coolant supply and return connections* on page 97.



1. Coolant supply line
2. Coolant return line
3. Line to drain

3. Connect the fittings to drain the coolant, see *Fittings needed to drain cooling jackets: drive units with external or integrated cooling systems* on page 36.



1. Coolant supply line
2. Coolant return line
3. Line to drain

4.10.3 Coolant supply and return connections

700-, 800-, and 900-series drive units with external or integrated cooling

This section applies to the following drive units:

- 705, 715, 735, 745, 765, 775
- 805, 815, 835, 845, 862, 865, 872, 875, 882, 892
- 905, 915, 935, 945, 950, 960, 965, 975, 985, 995, 988, 998

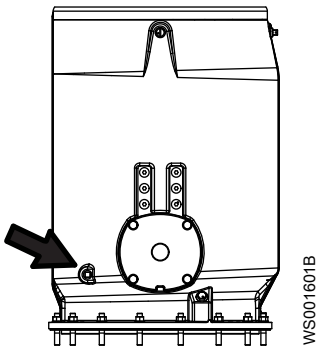


Figure 59: Inlet for coolant supply line

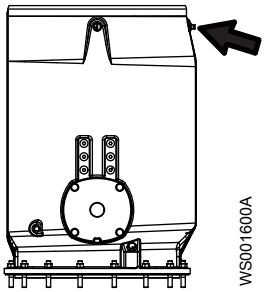


Figure 60: Coolant return line

External cooling: Drive units equipped with internal CLC jackets

The following drive units are designed primarily for closed-loop cooling, but can be used also in external cooling configurations:

- 706, 716, 736, 746, 766, 776
- 806, 816, 836, 846, 863, 866, 873, 876, 883, 893
- 906, 916, 936, 946, 951, 961, 966, 976, 986, 996, 987, 997

In external cooling configurations, the two coolant plugs at the top of the cooling jacket are used for coolant supply and return lines. See *Lubricant and coolant plugs* on page 113.

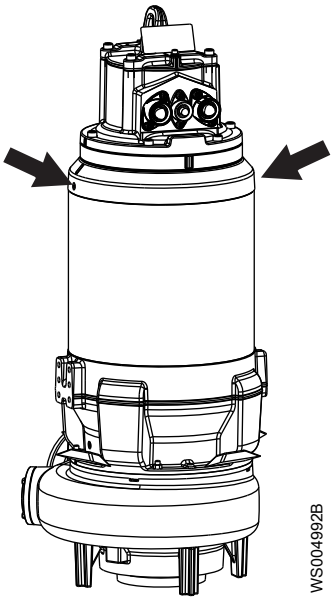


Figure 61: Connections for coolant supply and return lines. A generic CLC drive unit is shown.

4.11 Connect the seal flushing

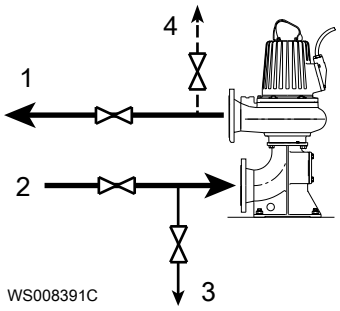
This instruction is for connecting the seal flushing water to the pump, in applications where seal flushing is used.

1. Check that the supply of incoming seal flushing water has been arranged as shown in *Circuit diagram for seal flushing* on page 38.
2. Connect the seal flushing supply water to the pump.

   See *Connections for seal flushing* on page 39.

4.12 T-installation: Bleed air before starting pump

1. Open the valve on the air vent line and bleed out the air. See the following figure.



1. Outlet line
2. Inlet line
3. Line to drain
4. Air vent

Figure 62: T-installation

2. Close the valve on the air vent line before the pump is started.

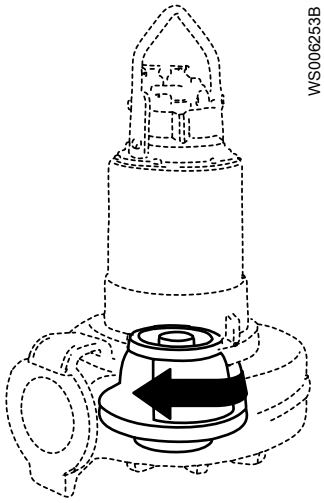
4.13 Check the impeller rotation

CAUTION: Crush Hazard

The starting jerk can be powerful. Make sure nobody is close to the unit when it is started.

1. Start the motor.
2. Stop the motor after a few seconds.
3. Check that the impeller rotates according to this illustration.

   The figure shows a generic impeller pump.



   The correct direction of impeller rotation is clockwise when you look at the pump from above.
4. If the impeller/propeller rotates in the wrong direction, then check that the phase leads are correctly connected. See *Power cable phase sequence* on page 78.

   After reconnecting phase leads, do this procedure again.

5 Operation

5.1 Precautions

Before taking the unit into operation, check the following:

- All recommended safety devices are installed.
- The cable and cable entry have not been damaged.
- All debris and waste material has been removed.

NOTICE:

Never operate the pump with the discharge line blocked, or the discharge valve closed.

WARNING: Crush Hazard

Risk of automatic restart.

Distance to wet areas

WARNING: Electrical Hazard

Risk of electrical shock or burn. You must connect an additional ground- (earth-) fault protection device to the grounded (earthed) connectors if persons are likely to come into contact with liquids that are also in contact with the pump or pumped liquid.

CAUTION: Electrical Hazard

Risk of electrical shock or burn. The equipment manufacturer has not evaluated this unit for use in swimming pools. If used in connection with swimming pools then special safety regulations apply.

5.2 Noise level

In certain installations and at certain operating points on the pump performance curve, the sound pressure level can exceed 70 dB(A). Pumps with power output greater than 30 kW, as shown in the diagram below, may have a sound pressure level between 70 dB(A) and maximum 85 dB(A) at the best efficiency point.

Make sure that you understand the noise level requirements in the environment where the product is installed. Failure to do so may result in hearing loss or violation of local laws.

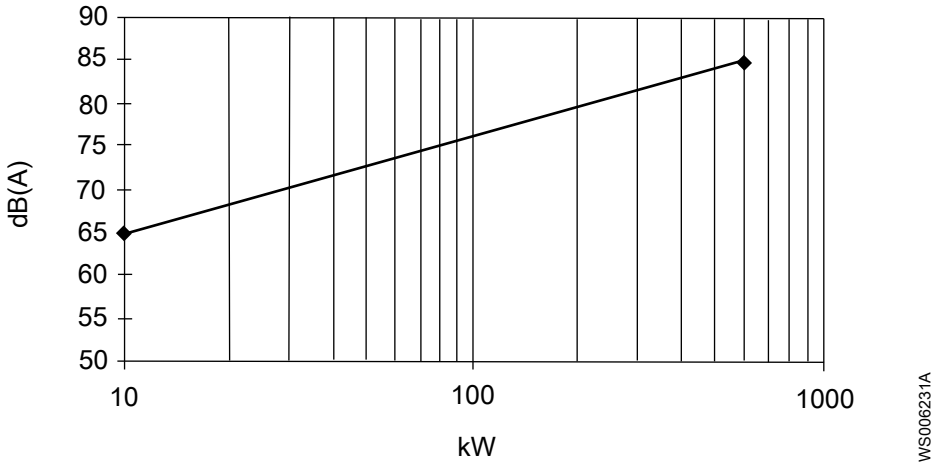


Figure 63: Sound pressure

5.3 Estimate zinc anode replacement intervals

The mass and surface area of the zinc anodes are designed to protect the pump surface for 1 year in sea water with an average temperature of 20°C (68°F). Shorter inspection intervals and anode replacement can be required, depending upon the water temperature and the chemical composition as well as the presence of other metals in the vicinity of the pump.

The rate of zinc consumption, and the appropriate inspection intervals, can be estimated by measuring how much zinc is consumed during the first two months following installation.

Anodes are replaced when the anode mass is reduced to a selected fraction of its initial mass. The recommended interval for the selection fraction is 0.25–0.50 (25–50%).

1. Remove, weigh, and reinstall one or more of the exterior zinc anodes before starting up the pump.
2. After two months, remove and weigh the same zinc anode or anodes again.
3. Divide the lapsed time in days (between steps 1 and 2) by the anode weight loss in grams to get the calculated anode consumption rate (days/gram).

   If multiple anodes were weighed, then use the anode which has lost the most weight for this calculation.
4. Calculate future replacement intervals so that they occur when the selected fraction of zinc is remaining.

5.4 Start the pump

CAUTION: Crush Hazard

The starting jerk can be powerful. Make sure nobody is close to the unit when it is started.

1. Check that:
   a) The monitoring equipment works.
   b) The starter equipment is installed according to the instructions from the manufacturer.
   c) All the alarms function.
   d) The lubricant is at the correct level.
2. Remove the fuses or open the circuit breaker, and check that the impeller can be rotated freely.

   WARNING: Crush Hazard

   Never put your hand into the pump housing.

   Make sure that the locking device has been removed. See *The locking device* on page 48.

   Make sure that the propeller rotates in the correct direction. See *Check the impeller rotation* on page 98.
3. Conduct insulation test phase to ground. To pass, the value must be more than 5 megohms. See *Checking insulation and sensors* on page 107.
4. Start the pump.

Check that:

- The machine works without noise or vibration.
- All electrical values are correct.
- All accessories work correctly.

Record any abnormalities.

5.5 Modifications for freezing conditions

If the pump is installed in such a way that it can be exposed to temperatures at or below the freezing point (that is, the pump is not totally submerged), then special modifications must be made to the pump and the installation.

For more information, please contact your local sales and service representative.

6 Maintenance

6.1 Precautions

Before starting work, make sure that the safety instructions have been read and understood.

DANGER: Crush Hazard

Moving parts can entangle or crush. Always disconnect and lock out power before servicing to prevent unexpected startup. Failure to do so could result in death or serious injury.

WARNING: Biological Hazard

Infection risk. Rinse the unit thoroughly with clean water before working on it.

CAUTION: Thermal Hazard

The surfaces or parts of the unit may become hot during operation. Allow surfaces to cool before starting work, or wear heat-protective clothing.

The following requirements apply:

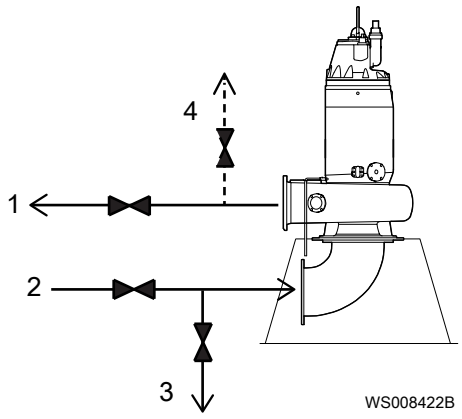
- Make sure that all safety guards are in place and secure.
- Make sure that equipment is in place so that the unit cannot roll or fall over during the maintenance process.
- Make sure that you have a clear path of retreat.
- Never work alone.
- Check the explosion risk before you weld or use electrical hand tools.
- Before starting work, make sure that the work area is well-ventilated.
- Do not open any vent or drain valves or remove any plugs while the system is pressurized. Make sure that the pump is isolated from the system and that pressure is relieved before you disassemble the pump, remove plugs, or disconnect piping.

Ground continuity verification

A ground (earth) continuity test must always be performed after service.

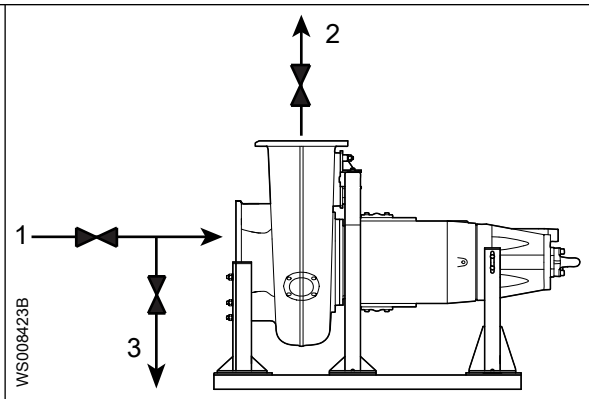
6.2 T- and Z-installation: Drain before servicing

Before servicing the pump or drive unit, the system must be drained.



1. Outlet line
2. Inlet line
3. Line to drain
4. Air vent

Figure 64: T-installation



1. Inlet line
2. Outlet line
3. Line to drain

Figure 65: Z-installation

1. Close the inlet and outlet lines.
2. Drain the system.

6.3 Service

Regular inspection and service of the pump makes sure that operation will be more reliable.

Every time the site is visited, visually examine the accessories and sump for corrosion, wear or damage.

Table 26: Service intervals

Type of service	Purpose	Interval
Initial inspection	To make a check up of the pump condition by an authorized Xylem service representative and, based on the result and findings from these measures, to determine the intervals for periodical inspection and major overhaul for the specific installation.	In the first year of operation.
Periodical inspection	To prevent operational interruptions and machine breakdown. Measures to secure performance and efficiency are defined and decided for each individual application. It can include such things as impeller trimming, wear part control and replacement, control of zinc-anodes and control of the stator.	12,000 hours or 3 years, whichever comes first. Applies to normal applications and operating conditions at media (liquid) temperatures < 40°C (104°F).
Major overhaul	To secure a long operating lifetime for the product. It includes the replacement of key components and the measures that are taken during an inspection.	24,000 hours or 6 years, whichever comes first. Applies to normal applications and operating conditions at media (liquid) temperatures < 40°C (104°F).

NOTICE:

Shorter intervals may be required when the operating conditions are extreme, for example with very abrasive or corrosive applications or when the liquid temperatures exceed 40°C (104°F).

6.3.1 Inspection

CAUTION: Compressed Gas Hazard

Air inside may cause parts or liquid to be propelled with force. Be careful when opening.

Regular inspection and service of the pump makes sure that the operation is more reliable.

For seal lubricant information, see *Lubricants and coolants used in the drive units* on page 109.

Do the following to service the pump:

Part to service	Action
Pump exterior	Check the entire pump and the cables for external mechanical damage.
Cable	1. If the outer jacket is damaged, replace the cable. 2. Check that the cables do not have any sharp bends and are not pinched. 3. Check that the leads and cable entry screws are correctly connected and tightened to the correct torque.
Lifting handle	Check the lifting handle for corrosion or other damage.
Junction box	1. General: Check that it is clean and dry. If it is wet: a. Check the cable entry. b. Replace the O-rings. Fit new O-rings to all O-ring seal joints which are opened during inspection. 2. Terminal board: Check that the connections are properly secured.
Junction box insulation: Drive units up to 1.1 kV	Check the condition and function. See *Check the insulation, up to 1 kV drives or generators* on page 108.
Junction box insulation: Drive units 1.2–6.6 kV	Check the condition and function. See *Check the insulation, 1.2–6.6 kV drives* on page 108.
Stator housing Drive units with oil as the seal lubricant.	1. Check that it is clean and dry. – If there is oil in the stator housing, then drain and clean it. Check the stator housing again after one week of operation. If there is still oil in the stator housing, then change the seals. – If there is water in the stator housing and there was water in the oil, change the seals immediately. – If there is water in the stator housing, but there was no water in the oil, check all other connections. 2. Replace the O-rings.
Stator housing Drive units with water-glycol as the seal lubricant, and internal closed-loop cooling.	1. Check that it is clean and dry. If there is any fluid, then drain and clean it. 2. Replace the O-rings.

Part to service	Action
Stator housing Drive units with water-glycol as the seal lubricant, and direct cooling.	1. Check that it is clean and dry. – If there is fluid in the stator housing, then drain and clean it. Check the stator housing again after one week of operation. If there is still fluid in the stator housing, then change the seals. 2. Replace the O-rings.
Inspection chamber: Drive units with internal closed-loop cooling.	1. Check that it is clean and dry: – If there is fluid in the inspection chamber, then drain and clean it. Check the inspection chamber again after one week of operation. If there is still fluid in the inspection chamber, then change the seals. 2. Replace the O-rings.
Oil housing Drive units with oil as the seal lubricant	1. Check the oil quality: – If there is water in the oil, then drain the oil and replace with new oil. After one week of operation, check the oil quality again. – If the oil is free from water, then fill the oil to the correct level, if necessary. 2. Replace the filling plug O-rings.
Seal lubricant: Drive units with water-glycol as the seal lubricant	Check the lubricant level. Fill to the correct level, if necessary.
Hydraulic parts	1. Check the general condition of the impeller or propeller and the wear ring. 2. Replace if necessary. 3. If applicable, check O-ring.
Zinc anodes	Check and change if necessary.
Screw joints	Check all externally accessible screw joints, and tighten if necessary to the correct torque. See *Torque values* on page 147.
Electrical cabinets	Check that it is clean and dry.
Connection to power	Check that the connections are properly secured.
Level regulators	Check the condition and function. See *Check the leakage detectors* on page 108.
Temperature sensors	Check the condition and function. See *Check the temperature sensors* on page 108.

After any service involving the power connections, you must check the rotation before operating the pump. See *Check the impeller rotation* on page 98.

6.3.2 Major overhaul

1. Perform a complete inspection service. See *Inspection* on page 105.
2. Do these additional steps:

Part to service	Action
Motor: insulation check Drive units up to 1.1 kV	Check that the resistance between earth and phase lead is more than 5 MΩ. Use a 500 VDC or 1000 VDC insulation and continuity tester.
Motor: insulation check 1.2–6.6 kV drive units	1. Check that the resistance between earth and phase lead is more than the minimum for the motor voltage. Recommended test voltage: 2500 VDC The resistance value is related to the motor voltage and must have minimum value of 5 MΩ/kV at a temperature of 25°C (77°F). For example, for a 6 kV motor the resistance between earth and phase lead must be more than 30 MΩ.
Cable	Check that the rubber sheathing is undamaged. Change if necessary.

Part to service	Action
Oil housing	Change the lubricant. For lubricant information, see *Lubricants and coolants used in the drive units* on page 109.
General dismantling and cleaning	1. Dismantle the pump completely. 2. Clean all the parts. 3. Reassemble after replacing bearings, O-rings, and seals.
Bearings	Replace the bearings with new bearings.
O-rings and other rubber sealing parts	Replace O-rings and other rubber sealing parts.
Seals	Replace with new seals.
Sensors	Check the following: 1. Stator temperature sensors 2. Bearing temperature sensors 3. FLS and CLS sensors See *Check the temperature sensors* on page 108 and *Check the leakage detectors* on page 108.
Impeller or propeller	Check the general impeller or propeller status. Change if necessary. Check general wear ring status. Change if necessary.
Zinc anodes	Check their condition. Replace if necessary.
Screw joints	Check all externally accessible screw joints and tighten if necessary to the correct torque. See torque table and Parts List.
Lifting handle	Check its condition. Replace if necessary.
Painting	Touch up any painting if necessary.
Rotational direction	Check the impeller or propeller rotation direction. See *Check the impeller rotation* on page 98.
Voltage and amperage	Check the running values.
Electrical cabinets or panels	Check that it is clean and dry.
Connection to power	Check the cable connections. Tighten if necessary.
Overload protection and other protections	Check the correct settings.
Level regulators	Check condition and function.

After any service involving the power connections, check the rotation before operating the pump. See *Check the impeller rotation* on page 98.

6.3.3 Checking insulation and sensors

It is important that the checks for motor insulation, temperature sensors and leakages sensors are performed correctly and using appropriate tools. Parts of the unit, for example temperature sensors or the PEM, can be damaged if a megger or other device is used to apply a voltage higher than 2.5 V.

Use the following table to choose the appropriate procedures.

Item	Section
Motor insulation, drive units or generators up to 1 kV	*Check the insulation, up to 1 kV drives or generators* on page 108
Motor insulation, drive units or generators 1.2–6.6 kV	*Check the insulation, 1.2–6.6 kV drives* on page 108

Item	Section
Thermal contacts	*Check the temperature sensors* on page 108
PTC thermistors	
Pt100	
FLS leakage detector	*Check the leakage detectors* on page 108
CLS leakage detector	

6.4 Check the insulation, up to 1 kV drives or generators

1. Check that the resistance between earth and phase lead is more than 5 MΩ.

   Use a 500 VDC or 1000 VDC megger.
2. Keep a record of the results.

6.5 Check the insulation, 1.2–6.6 kV drives

1. Check that the resistance between earth and phase lead is above the minimum for the motor voltage.

Motor rating	Recommended test voltage
1.0 – 2.5 kV AC	1.0 – 2.5 kV DC
2.5 – 6.6 kV AC	2.5 – 5 kV DC

   The resistance value is related to the motor voltage and should have minimum value of 5 MΩ/kV at a temperature of 25°C (77°F).

   For example, for a 6 kV motor the resistance between earth and phase lead should be more than 30 MΩ.
2. Keep a record of the results.

6.6 Check the temperature sensors

If the unit is connected to the MAS monitoring system, then it is recommended that the sensors be checked in the MAS unit. Otherwise, use a multimeter.

The different types of temperature sensors are:

- Thermal switches
- Pt100

NOTICE:

Do not use a megger or other device applying a higher voltage than 2.5 V.

1. Disconnect the sensor wires.
2. Check the status of the sensor and wiring by measuring the resistance according to the values in *Product Description* on page 19.
3. Measure between each sensor lead and ground (earth) to establish that the resistance is infinite (or at least several megohms).

6.7 Check the leakage detectors

If the unit is connected to the MAS monitoring system, then it is recommended that the sensors be checked in the MAS unit. Otherwise, use a multimeter.

1. Check the float switch (FLS) in the stator housing, according to the values in *Product Description* on page 19.

In drive units with internal closed-loop cooling, the FLS is located in the inspection chamber.

2. Check the float switch (FLS) in the junction box or connection housing.
3. If the drive unit is equipped with a CLS water-in-oil sensor in the oil housing, then check the CLS by following this procedure.
   a) Connect the CLS to a 12 VDC supply.

      The sensor must have the correct polarity to be checked. However, a switched plus and minus does not damage the sensor.
   b) Use the multimeter as an ammeter and connect it in series with the sensor.
   c) If the sensor is accessible, then check: the alarm function by gripping the sensor with the hand.

      Skin tissue and blood contain a high content of water.

   For interpretation of the CLS measurement results, see *Product Description* on page 19.

6.7.1 FLS

Table 27: Float switch sensor (FLS)

Description	Measured value	Fault values
The float switches are leakage sensors. Drive units with direct, external or integrated cooling: The float switches are located in the lower part of the stator housing and in the junction box. Drive units with internal closed-loop cooling: The float switches are leakage sensors located in the inspection chamber and in the junction box.	Resistance. 2 sensor variants: FLS: • Normal: 1530 ohm • Alarm: 330 ohm FLS 10: • Normal: 1200 ohm • Alarm: 430 ohm	> 10% (approx.) deviation from rated ohm values indicates sensor fault, or fault in the wiring.

6.8 Lubricants and coolants used in the drive units

Drive units	Coolant, if cooling jacket is used	Seal lubricant
605, 615, 665, 675	Water For instructions about emptying the coolant, see *Empty the cooling jacket: drive units with external or integrated cooling* on page 109.	Oil For instructions about changing the oil, see *Change the oil* on page 111.
705, 715, 735, 745, 765, 775		
805, 815, 835, 845, 865, 875		
905, 915, 935, 945, 965, 975 950, 960, 985, 995, 988, 998		
706, 716, 736, 746, 766, 776	Water-glycol mixture For instructions about emptying the coolant, see *Change the water-glycol mixture* on page 112.	Water-glycol mixture For instructions about emptying the lubricant, see *Change the water-glycol mixture* on page 112.
806, 816, 836, 846, 866, 876 863, 873, 883, 893		
906, 916, 936, 946, 966, 976 951, 961, 986, 987, 996, 997		

6.9 Empty the cooling jacket: drive units with external or integrated cooling

This section applies to drive units using one of the following:

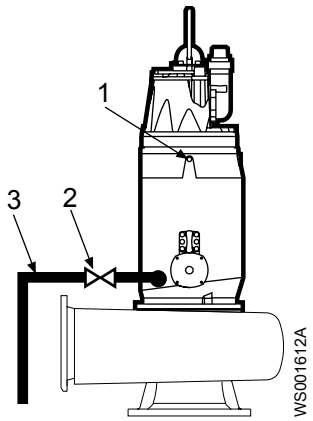
- Integrated cooling
- External cooling

To check whether these instructions apply to a specific drive unit, see *Lubricants and coolants used in the drive units* on page 109.

6.9.1 Empty the coolant (integrated cooling)

The cooling jacket must be drained before service.

1. Remove the vent plug marked “1” in the figure below.
2. Depressurize the cooling system by opening the stop-cock marked “2” in the figure below (if applicable).
3. Remove the coolant filling plug and empty the coolant through the drainage pipe, marked “3” in the figure below.
4. After you empty the cooling jacket on P and S installations, run the pump run dry for no more than 30 seconds to expel all water from the impeller area.



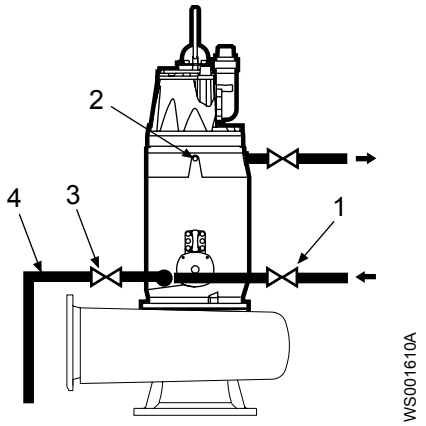
1. Vent plug
2. Stop-cock
3. Drainage pipe

Figure 66: T and Z installations with integrated cooling

6.9.2 Empty the coolant (external cooling)

Before starting work, check that the cooling jacket has been drained.

1. Turn off the supply of coolant to the pump, see “1” in the figure below.
2. Remove the vent plug marked “2” in the figure below.
3. Depressurize the cooling system by opening the stop-cock marked “3” in the figure below (if applicable).
4. Remove the coolant filling plug and empty the coolant through the drainage pipe, marked “4” in the figure below.
5. After you empty the cooling jacket on P and S installations, run the pump dry for no more than 30 seconds to expel all water from the impeller area.



1. Coolant inlet
2. Vent plug
3. Stop-cock
4. Drainage pipe

Figure 67: P, S, and T installations with external cooling

6.10 Change the oil

To check which pumps use oil as the seal lubricant, see *Lubricants and coolants used in the drive units* on page 109.

The pump is delivered with a tasteless, odorless, medical white oil of a paraffin type that fulfills FDA 172.878.

Examples of suitable oil types are the following:

- Statoil MedicWay 32™
- BP Enerpar M 004™
- Shell Ondina 927™
- Shell Ondina X430™

The amount of oil is given in the table. Fill up the oil to the bottom thread.

Table 28: Volume of oil

Drive unit	Pumps with cooling jacket	Pumps without cooling jacket
7X5	5.5 L (5.8 quarts)	8.4 L (8.9 quarts)
8X5	11 L (11.6 quarts)	8.4 L (8.9 quarts)
9X5	9 L (9.5 quarts)	9 L (9.5 quarts)

Empty the oil

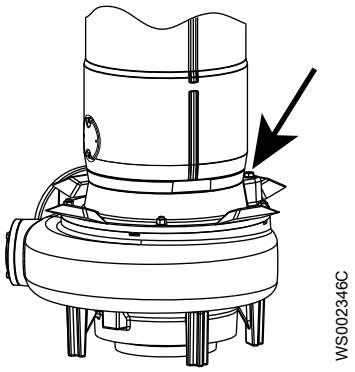
1. Unscrew the oil plugs.

CAUTION: Compressed Gas Hazard

Air inside the chamber may cause parts or liquid to be propelled with force. Be careful when opening. Allow the chamber to de-pressurize before removal of the plug.

2. Pump out the oil.

   Use the oil drainage pump 83 95 42. Make sure that the plastic tube goes all the way to the bottom of the oil housing.



Fill with oil

1. Fill up with the new oil.
   Make sure that the oil reaches the oil holes when the pump is in a vertical position.
2. Insert and tighten plugs with the new O-rings and plugs.
   Tightening torque: 80 Nm (60 lbf·ft)
3. Check the paint; if damaged, repaint.

6.11 Change the water-glycol mixture

For information about which pumps use water-glycol as coolant or seal lubricant, see *Lubricants and coolants used in the drive units* on page 109.

In drive units with internal closed-loop cooling, the same glycol-water mixture is used for cooling the motor, and for lubricating the seals.

6.11.1 Water–glycol amounts

Glycol-water mixture

Use a coolant that is a mixture of 70% water and 30% monopropylene glycol. The monopropylene glycol must fulfill the Xylem material standard M0800.82.0002. An example of an acceptable coolant is DOWCAL 200™ from Dow Chemical Company.

NOTICE:

Deionized or distilled water must be used in the water-glycol mixture.

If the pumped liquid includes potable water or substances to be ingested, then contact your local Xylem sales representative.

Volume of water-glycol mixture

Table 29: 700-series drive units

Hydraulic unit	With cooling jacket, liter (qt.)			Without cooling jacket, liter (qt.)
	706 / 716	736 / 746	766 / 776	
N3531	77 (81)	93 (98)	106 (112)	8.4 (8.9)

Table 30: 800-series drive units

Hydraulic unit	With cooling jacket, liter (qt.)				Without cooling jacket, liter (qt.)
	806, 816	836, 846	863, 873 866, 876	883 / 893	
N3531	119 (126)	140 (148)	161 (170)	192 (203)	8.4 (8.9)

Table 31: 900-series drive units

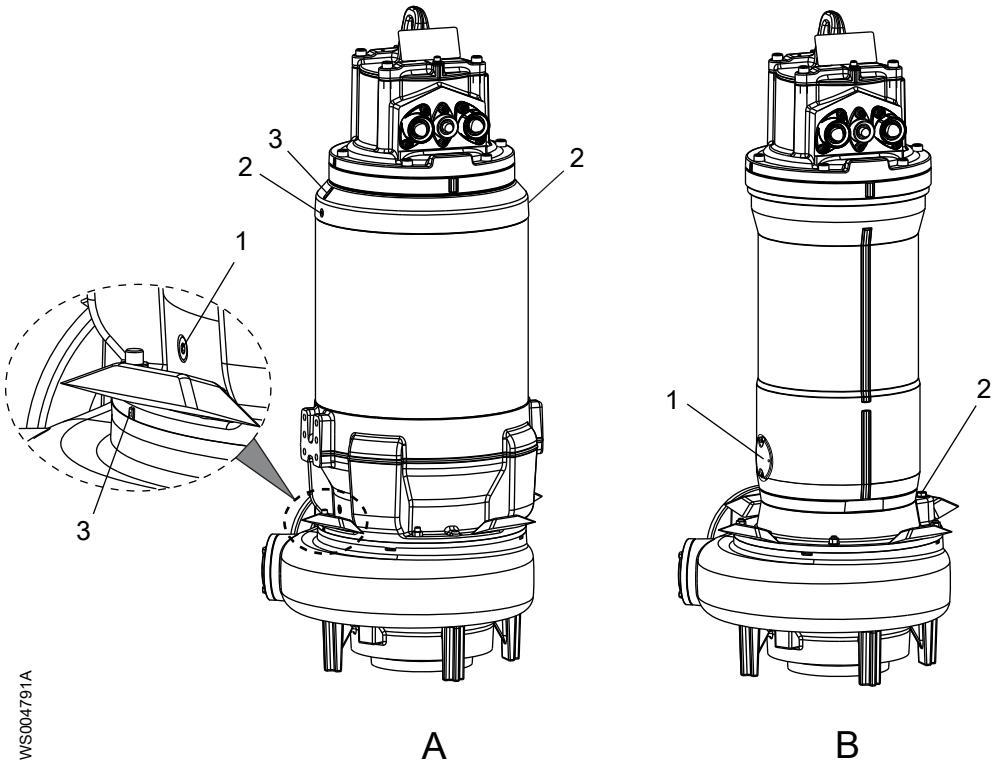
Hydraulic unit	With cooling jacket, liter (qt.)						Without cooling jacket, liter (qt.)
	906, 916	936, 946	951, 961	966, 976	986, 996	987, 997	
N3531	168 (178)	208 (220)	208 (220)	245 (259)	245 (259)	278 (294)	9 (9.5)

6.11.2 Lubricant and coolant plugs

700-series drive units

This section is valid for C-pumps and N-pumps equipped with the following drive units:

- 706/716, 736/746, 766/776



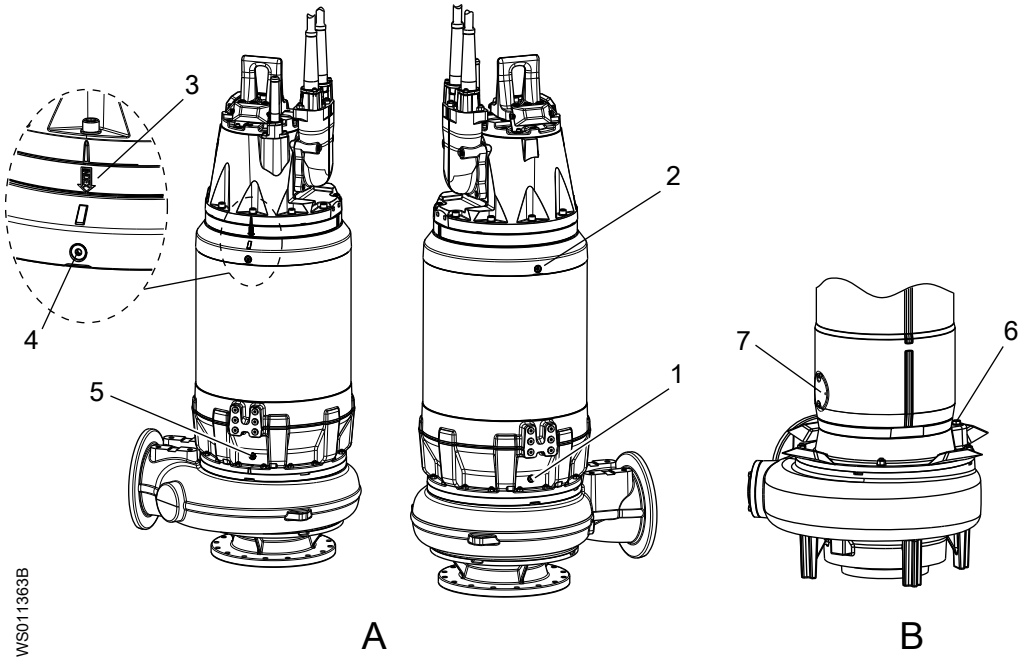
1. Inspection
2. Coolant or lubricant
3. Index

Figure 68: A: Drive unit with cooling jacket. B: Drive unit without cooling jacket.

800-series drive units

This section is valid for C-pumps and N-pumps equipped with the following drive units:

- 806/816, 836/846, 866/876
- 863/873, 883/893, 886/896



1. Coolant plug at bottom
2. Coolant plug at top
3. Index mark
4. Coolant plug at top
5. Inspection plug
6. Lubricant
7. Inspection

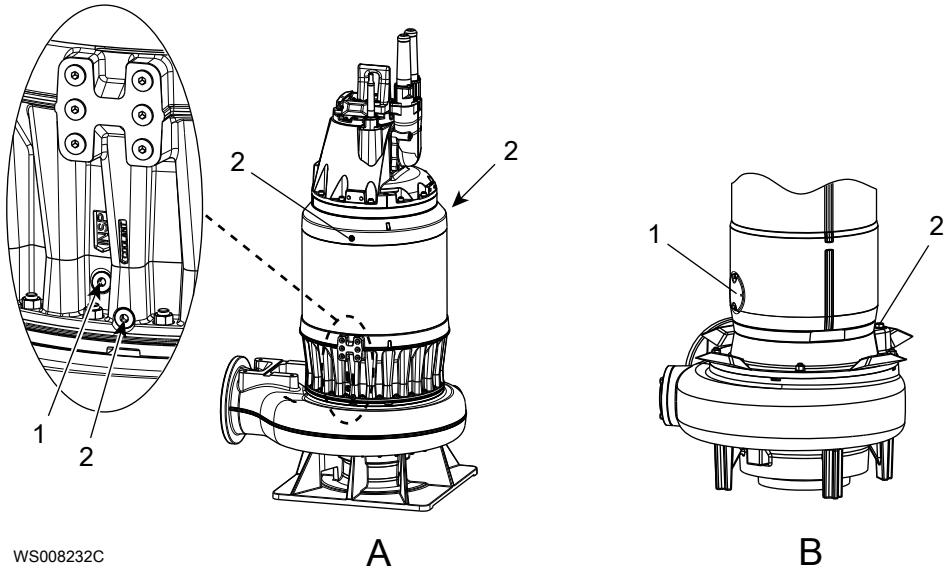
Figure 69: A: Drive unit with cooling jacket. B: Drive unit without cooling jacket.

On the cooling jacket of these drive units, the inspection plug and the lower coolant plug are on opposite sides. The inspection plug is aligned with the “Index” mark at the top of the cooling jacket.

900-series drive units

This section is valid for C-pumps and N-pumps equipped with the following drive units:

- 906/916, 936/946, 966/976
- 951/961, 986/996, 987/997



1. Inspection
2. Coolant or lubricant

Figure 70: A: Drive unit with cooling jacket. B: Drive unit without cooling jacket.

6.11.3 Drive units with cooling jacket

This section provides instructions for changing the water-glycol mixture used as both coolant and seal lubricant.

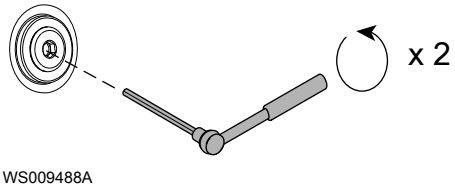
6.11.3.1 Empty the inspection chamber

CAUTION: Compressed Gas Hazard

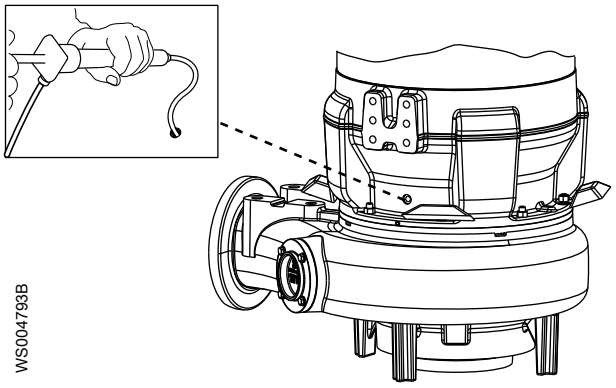
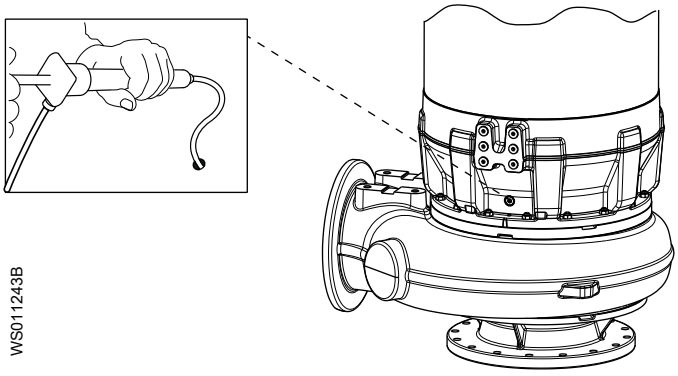
Air inside the chamber may cause parts or liquid to be propelled with force. Be careful when opening. Allow the chamber to de-pressurize before removal of the plug.

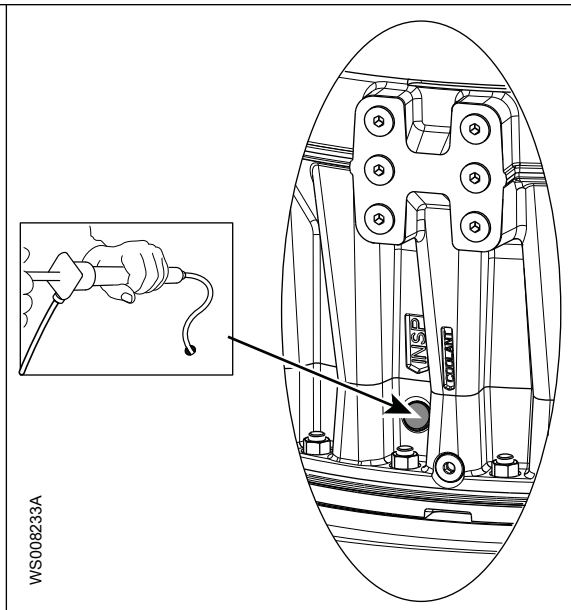
See *Lubricant and coolant plugs* on page 113 for the location of the coolant and inspection plugs.

1. Follow this procedure to remove the inspection plug:
   a) Partially unscrew the inspection plug. Unscrew two turns only.



   b) Push inwards on the inspection plug. If there is resistance, then wait for the built-up pressure inside the chamber to release.
   c) Push on the inspection plug again. If it is loose and has no resistance, then the pressure has been released.
   d) Unscrew and remove the inspection plug.
2. Pump out any liquid from the inspection chamber, as shown here.

700-series with internal closed-loop cooling	
800-series with internal closed-loop cooling	



900-series with internal closed-loop cooling

3. Replace the inspection plug and O-ring and tighten. Use the tightening torque that is shown in the following table.

Drive unit	Plug	Tightening torque, Nm (lbf·ft)
700-series with internal closed-loop cooling	M16	44 (33)
800-series with internal closed-loop cooling	M20	76 (57)
900-series with internal closed-loop cooling	M20	76 (57)

6.11.3.2 Empty the coolant: complete pump

Follow these instructions when the drive unit has not been separated from the pump housing.

CAUTION: Compressed Gas Hazard

Air inside the chamber may cause parts or liquid to be propelled with force. Be careful when opening. Allow the chamber to de-pressurize before removal of the plug.

1. If the pump is in a vertical position, then empty the coolant by following this procedure:
   a) Put a container under the coolant outlet.
   b) Partially unscrew the coolant plug. Unscrew two turns only.

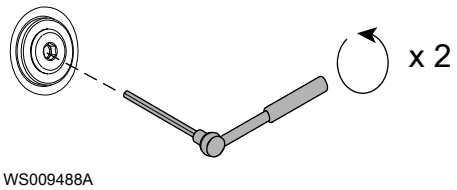
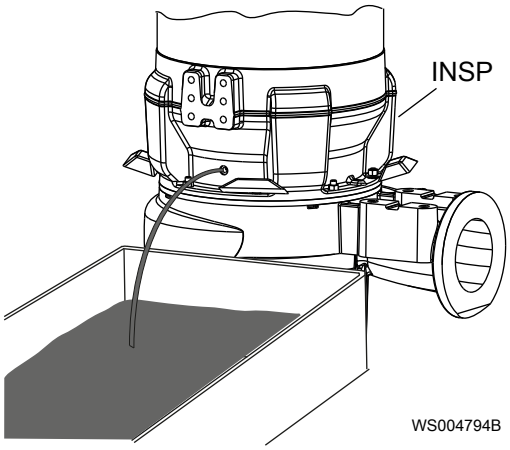
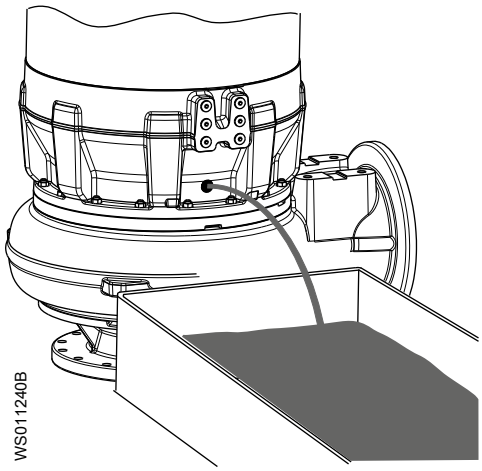
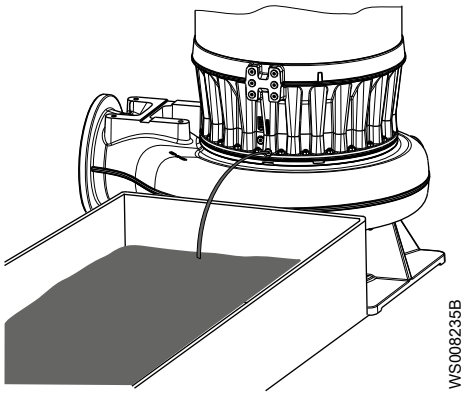


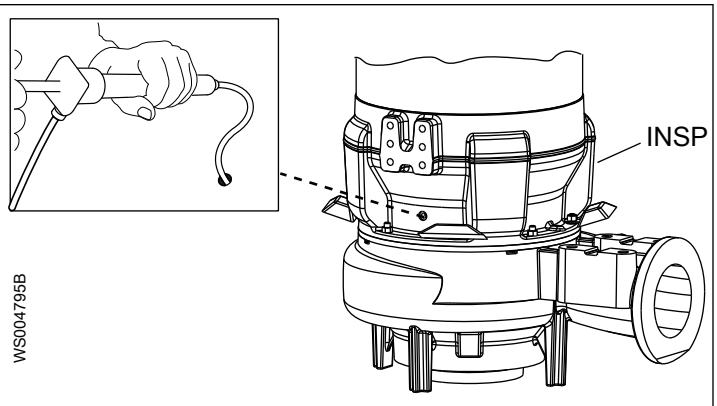
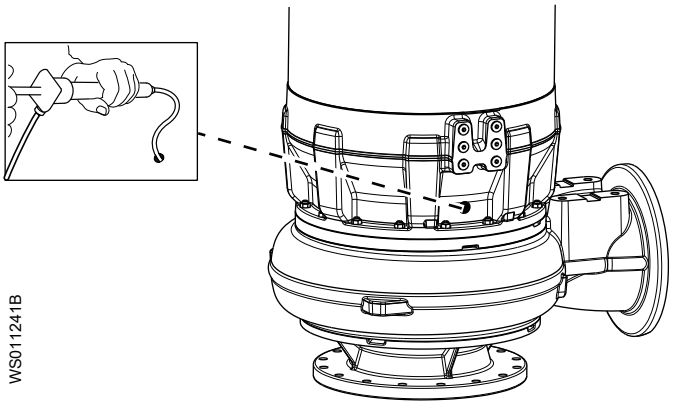
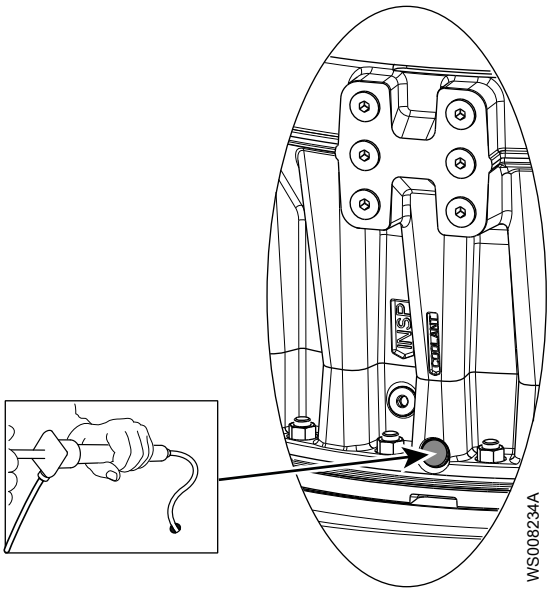
Figure 71: Loosening the coolant plug by two turns

   c) Push inwards on the coolant plug. If there is resistance, then wait for the built-up pressure inside the chamber to release.
   d) Push the coolant plug again. If it is loose and has no resistance, then the pressure has been released.
   e) Remove the coolant plug and empty the water-glycol mixture.

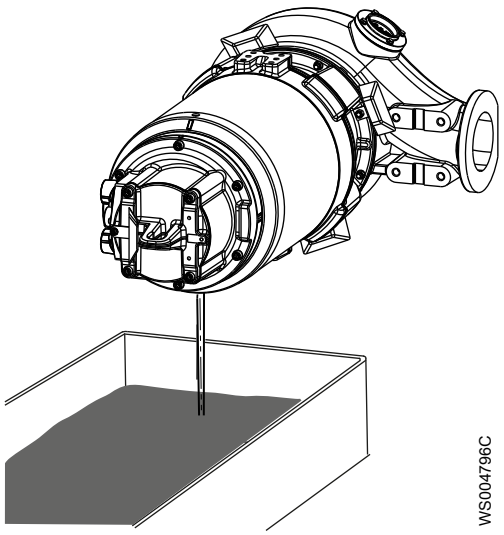
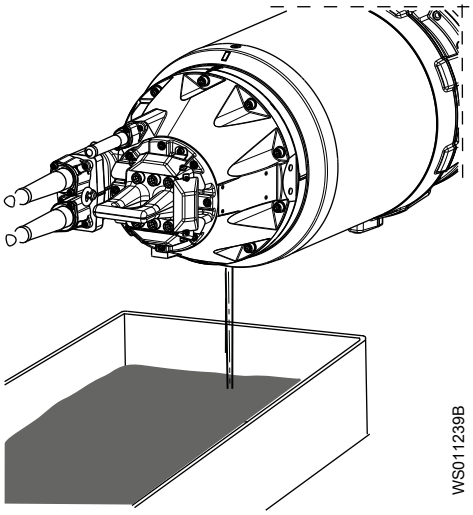
700-series with internal closed-loop cooling Liquid volume: Up to 106 liters (112 qt.)	
800-series with internal closed-loop cooling Liquid volume: Up to 195 liters (206 qt.)	
900-series with internal closed-loop cooling Liquid volume: Up to 294 liters (311 qt.)	

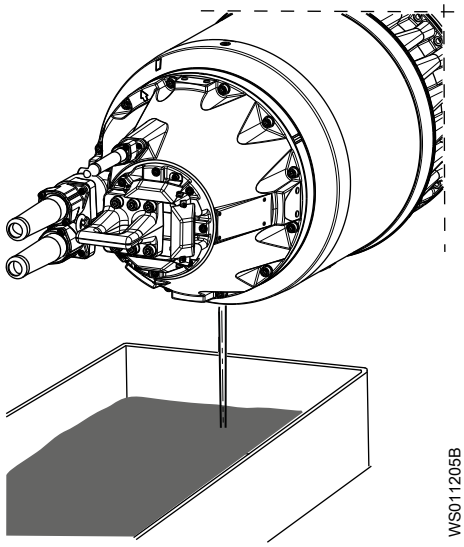
Most of the liquid drains by gravity.

f) Use the hand pump to remove the remaining water-glycol mixture.

700-series with internal closed-loop cooling	
800-series with internal closed-loop cooling	
900-series with internal closed-loop cooling	

2. If the pump is in a horizontal position, then empty the water-glycol mixture by following this procedure:
   a) Put a container under the pump.
   b) Remove the coolant plug and empty the water-glycol mixture.

700-series with internal closed-loop cooling Liquid volume: Up to 106 liters (112 qt.)	
800-series with internal closed-loop cooling Liquid volume: Up to 195 liters (206 qt.)	

900-series with internal closed-loop cooling Liquid volume: Up to 294 liters (311 qt.)	

6.11.3.3 Empty the remaining coolant: T- and Z-installations

Follow these instructions after the drive unit has been separated from the pump housing, for T- and Z-installations. Two sets of lifting equipment are required for this procedure.

CAUTION: Compressed Gas Hazard

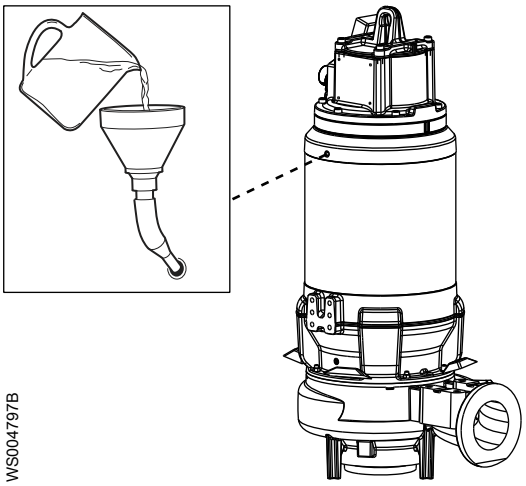
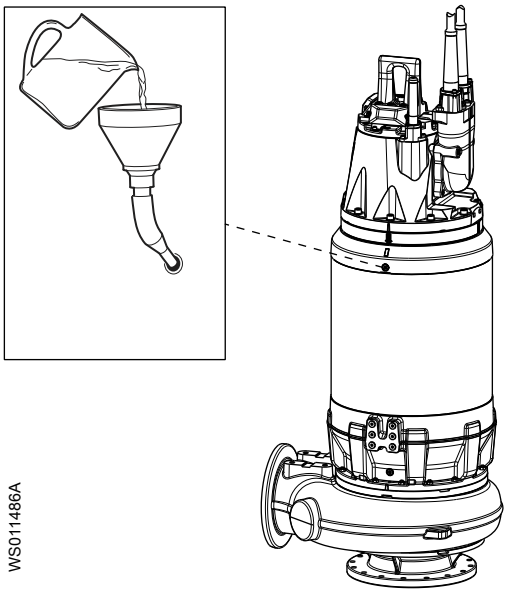
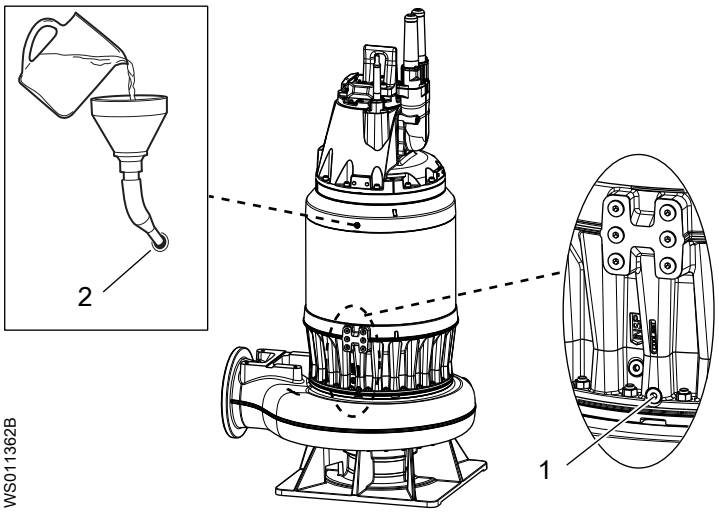
Air inside the chamber may cause parts or liquid to be propelled with force. Be careful when opening. Allow the chamber to de-pressurize before removal of the plug.

1. Use two lifting devices to maneuver the drive unit so that the coolant plug is at the lower end.
2. Position a container under the pump.
3. Remove the coolant plug and empty the water-glycol mixture.

6.11.3.4 Fill with water-glycol mixture

See *Lubricant and coolant plugs* on page 113 for the location of the coolant and inspection plugs.

1. Make sure that the plug at the bottom has been replaced.
2. Remove the coolant plugs at the top.
3. Fill with water-glycol mixture until it overflows through the opposite hole.

700-series with internal closed-loop cooling	 WS004797B
800-series with internal closed-loop cooling	 WS011486A
900-series with internal closed-loop cooling	 WS011362B 1. Coolant plug at bottom of cooling jacket 2. Coolant plugs at top of cooling jacket

4. Replace the O-rings and the coolant plugs.
5. Tighten the coolant plugs. Use the tightening torque that is shown in the following table.

Drive unit	Plug	Tightening torque, Nm (lbf·ft)
700-series with internal closed-loop cooling	M16	44 (33)
800- and 900-series with internal closed-loop cooling	M20	76 (57)

6.11.4 Drive units without cooling jacket

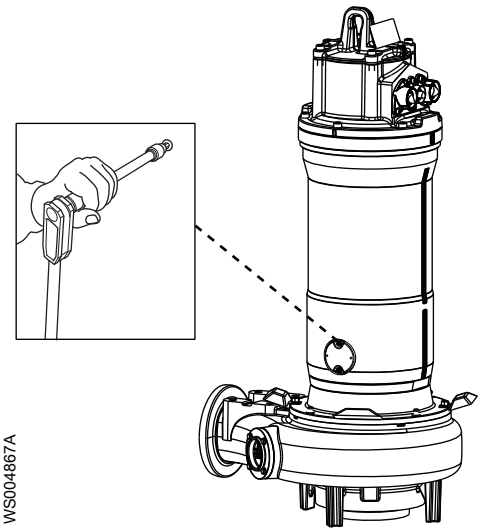
This section provides instructions for changing the water-glycol mixture used as seal lubricant.

6.11.4.1 Empty the lubricant

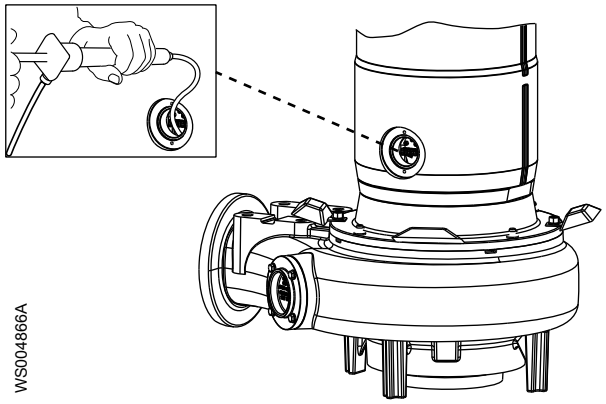
CAUTION: Compressed Gas Hazard

Air inside the chamber may cause parts or liquid to be propelled with force. Be careful when opening. Allow the chamber to de-pressurize before removal of the plug.

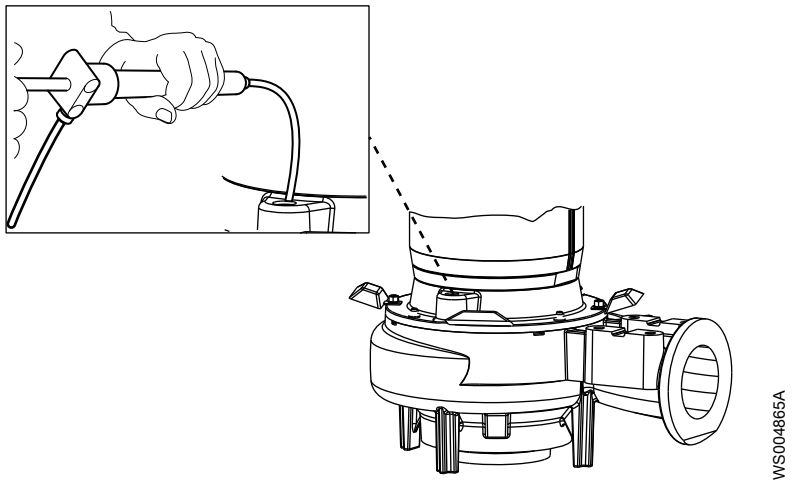
1. Remove any liquid from the stator housing:
   a) Remove the cover.



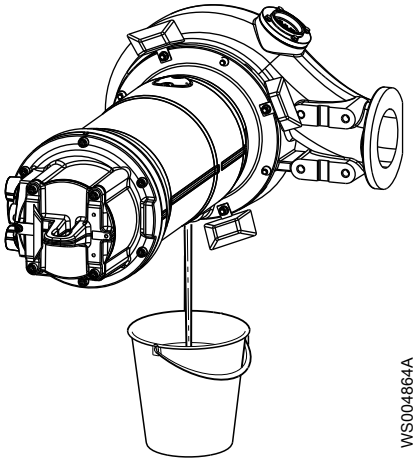
   b) Pump out any liquid from the stator housing, as shown here.



   c) Replace the cover.
2. If the pump is in a vertical position, then empty the lubricant by following this procedure:
   a) Use the hand pump to remove the water-glycol mixture.

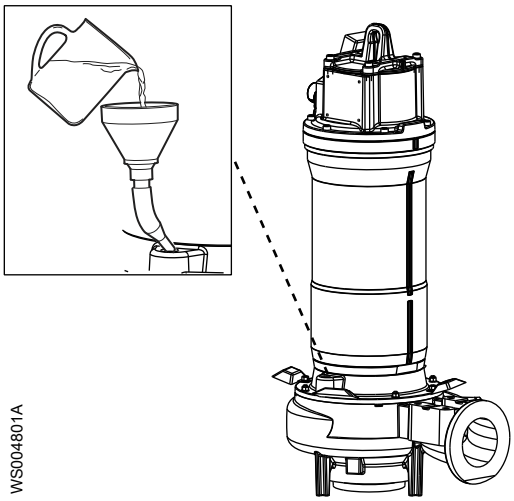


3. If the pump is in a horizontal position, then empty the lubricant by following this procedure:
   a) Place a container under the pump.
   b) Remove the plug and empty the water-glycol mixture.



6.11.4.2 Fill with lubricant

1. Fill the stator housing with water-glycol mixture, as shown here.



2. Replace the O-ring and the plug.
3. Tighten the plug.
   Tightening torque: 80 Nm (60 ft-lb)

6.12 Drive unit lifting

Two sets of lifting equipment, or one service lifting device, must be used to lift the drive unit for repair work.

The drive unit must never be placed on the shaft unit or the impeller/propeller. Damage to the impeller/propeller, seals or bearings can result from placing the drive unit on the impeller/propeller or shaft.

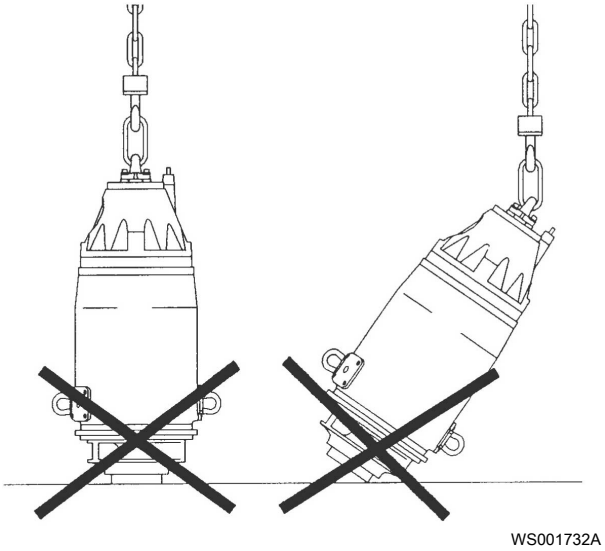


Figure 72: Incorrect lifting method

Use one of the prescribed methods to lift the drive unit.

6.12.1 Lift with two sets of lifting equipment

1. To secure the drive unit, fasten two sets of lifting equipment.

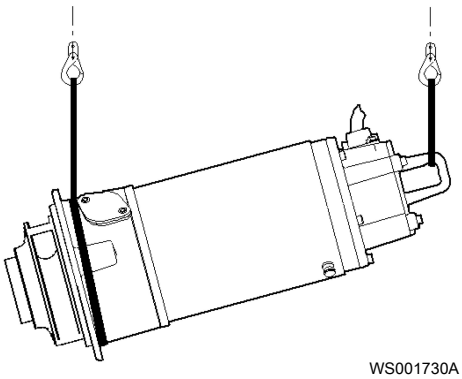


Figure 73: Lift using sling and lifting handle

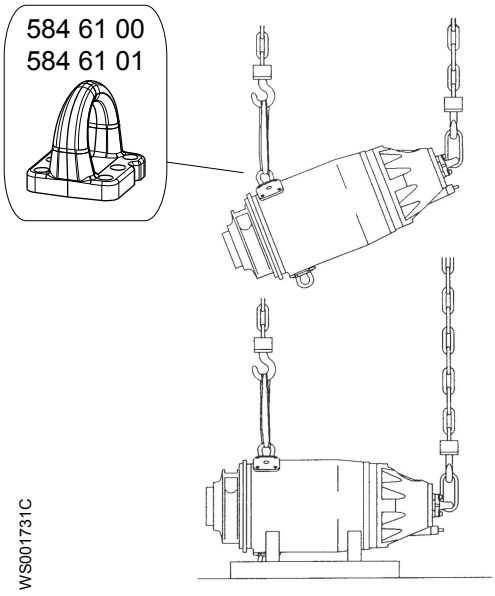


Figure 74: Lift using the lifting handle at top of drive unit, plus the lifting eye bracket. The set 584 61 00 has one lifting eye bracket, and the set 584 61 01 has two brackets.

2. If the pump is in a Z-installation, then remove the support stands from the pump top.

3. Remove the screws that attach the drive unit to the hydraulic unit.
4. Remove the drive unit.

6.12.2 Lift the drive unit with the service lift

This topic applies to pumps equipped with the service lift for 7XX, 8XX, and 9XX drive units. The service lift can lift the drive unit plus impeller, but it cannot lift the entire pump.

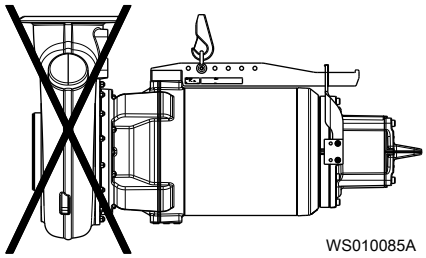
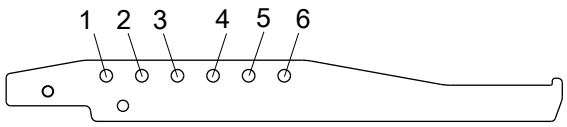
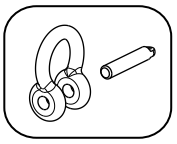


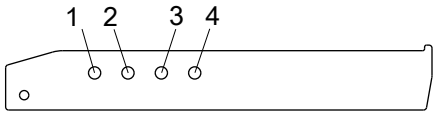
Figure 75: Do not lift the entire pump

1. Attach the shackle.
   Use the following figure and table to find the correct hole for the shackle.

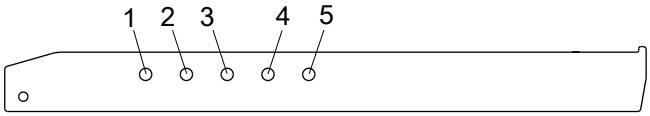


803 35 01
(7XX)





802 66 01
(8XX/9XX)



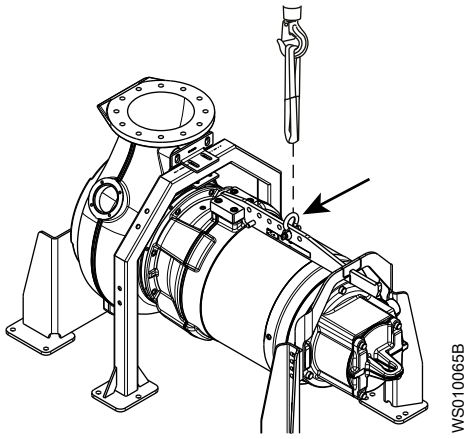
802 66 00
(8XX/9XX)

WS010082B

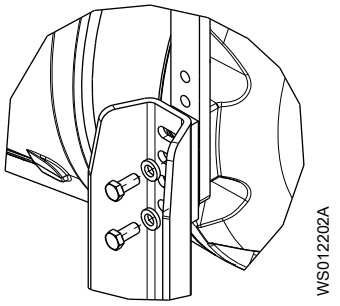
Drive unit	Lifting plate	Shackle position for lifting drive unit and impeller
705, 715	803 35 01	1 or 2
706, 716		2
735, 736, 745, 746		3 or 4
765, 766, 775, 776		4 or 5
805, 815	802 66 01	1
806, 816		2 or 3
835, 845		1 or 2
836, 846		3 or 4
865, 875	802 66 00	1
863, 866, 873, 876		2
885, 895		2
883, 886, 893, 896		3 or 4
905, 915	802 66 01	4
906, 916		2 or 3
935, 945, 950, 960	802 66 00	3

Drive unit	Lifting plate	Shackle position for lifting drive unit and impeller
936, 946, 951, 961		2
965, 975, 985, 995		4
966, 976, 986, 996		2 or 3
988, 998		4 or 5
987, 997		3

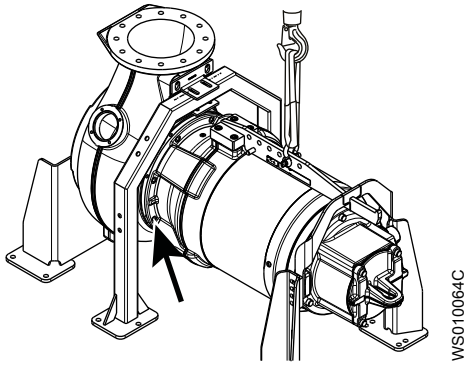
2. Attach the external lifting equipment to the shackle on the service lift.



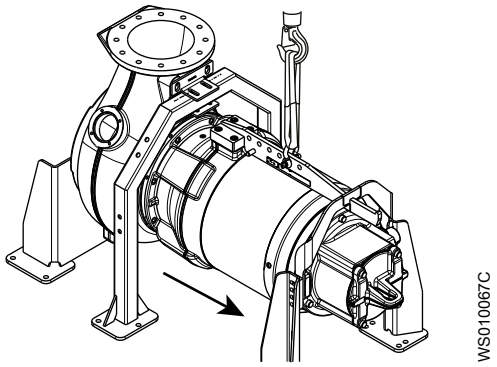
3. Lift the lifting strap or chain until it is taut.
4. Unbolt the legs at the connection house end.



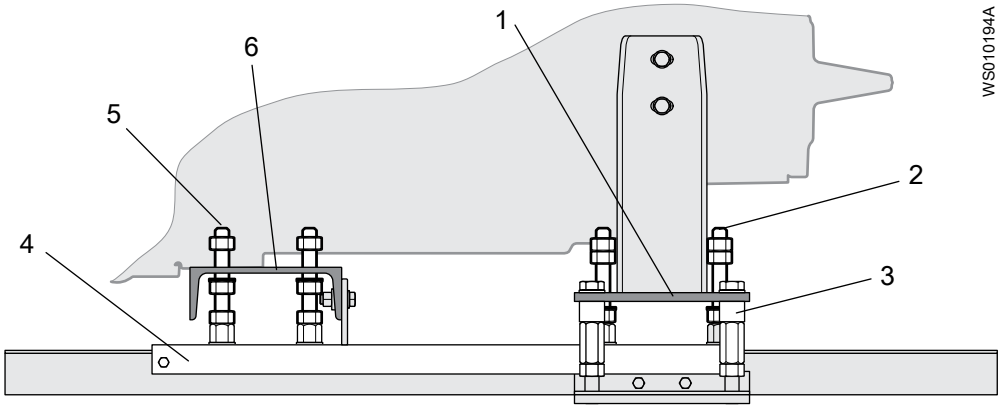
5. Remove the bolts which fasten the drive unit to the hydraulic unit. See the following figure.



6. Remove the drive unit with impeller.



6.13 Z-service sled operation



1. Support plate near connection house
2. Support leg for support plate near connection house
3. Outer column support
4. Gliding shoe
5. Support leg for support plate near hydraulic end
6. Support plate near hydraulic end

6.13.1 Move the drive unit away from the pump housing

1. Prepare to move the drive unit:

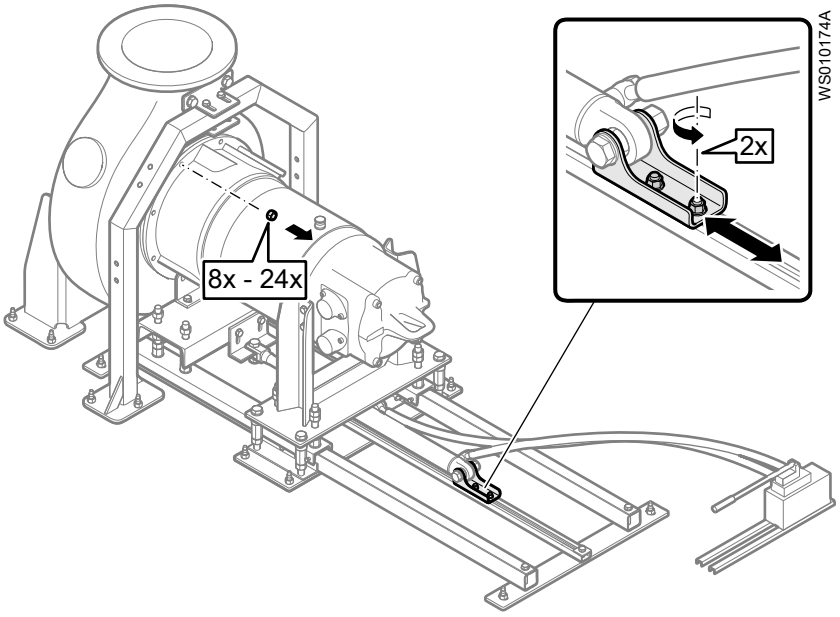


Figure 76: Preparing to move the drive unit

a) Remove the nuts from the fasteners securing the drive unit to the hydraulic unit.
b) Loosen the two nuts in front on the hand pump piston.

2. Transfer the drive unit weight from the outer columns to the gliding shoes by following this procedure:
   a) Remove the bolts from the outer columns on the support plate near the connection house.

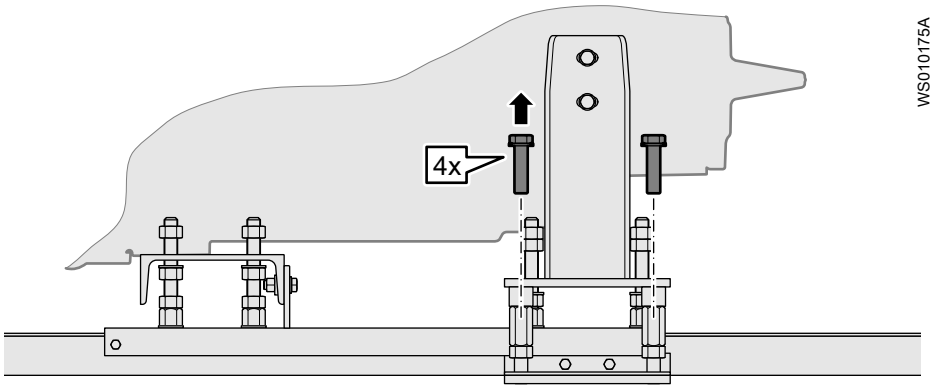


Figure 77: Removing bolts

   b) Under both of the support plates, move the nuts upwards until they have taken up the weight of the drive unit.

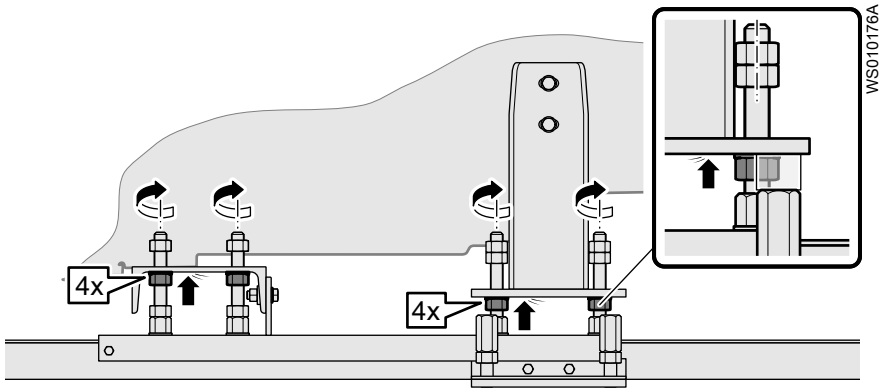


Figure 78: Moving nuts upwards under both support plates

   c) Lower the outer columns on the support plate near the connection house.

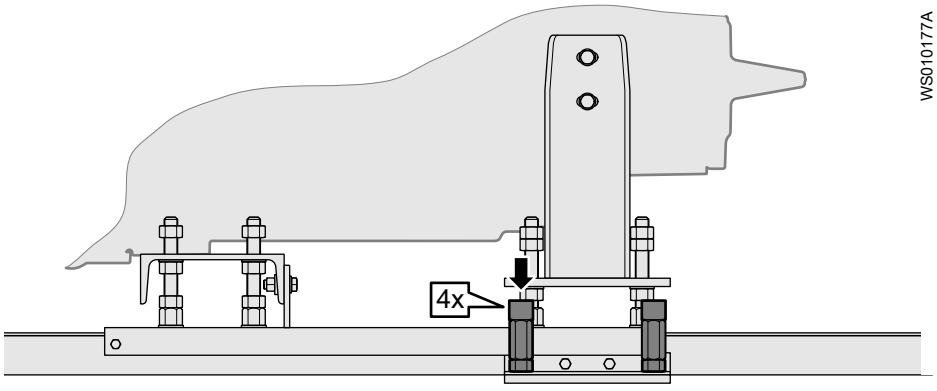


Figure 79: Lowering outer columns

3. Use a mallet and chisel to detach the drive unit from the pump housing.
   Approximately 10 mm separation is sufficient.

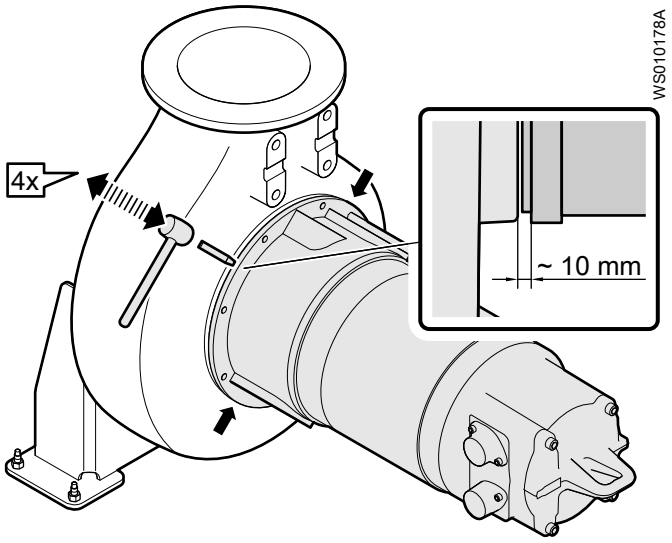


Figure 80: Detaching the drive unit

4. Tighten the two nuts at the hand pump piston.

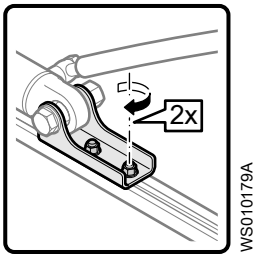


Figure 81: Tightening nuts at hand pump piston

5. Use the hand pump to move out the drive unit for service.

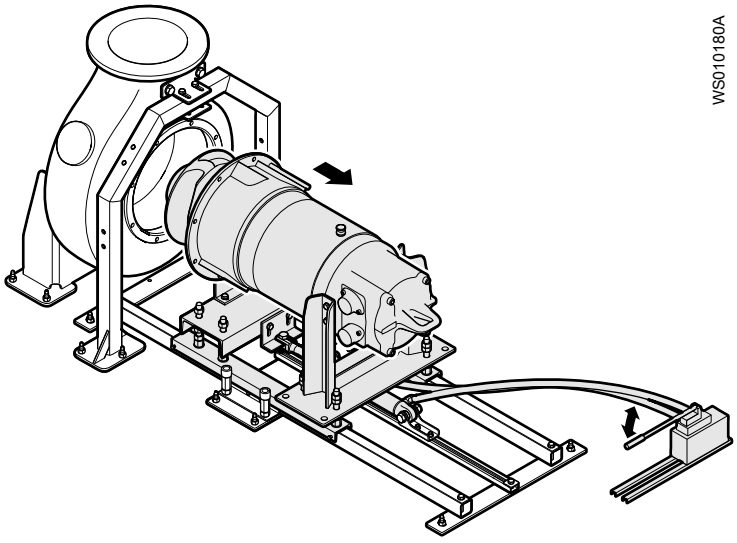


Figure 82: Moving out the drive unit with the hand pump

6.13.2 Reinstall the drive unit into the pump housing

1. Use the hand pump to move the drive unit towards the pump housing.

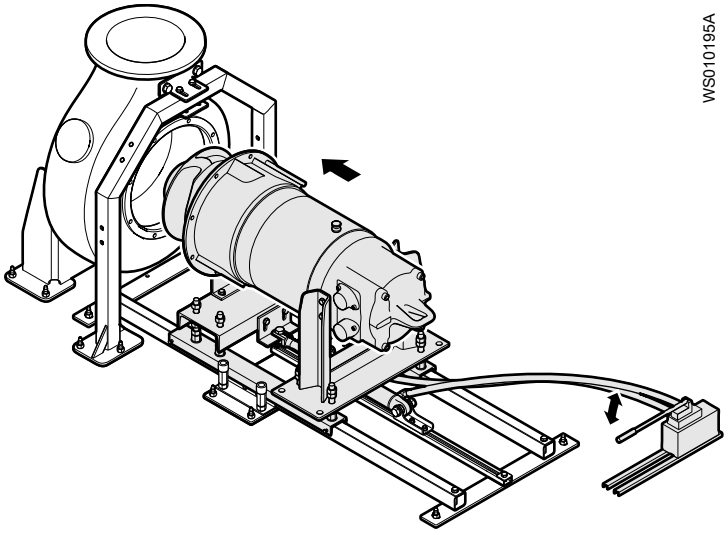


Figure 83: Moving the drive unit with the hand pump

2. Align the holes on the drive unit to the studs on the pump housing:

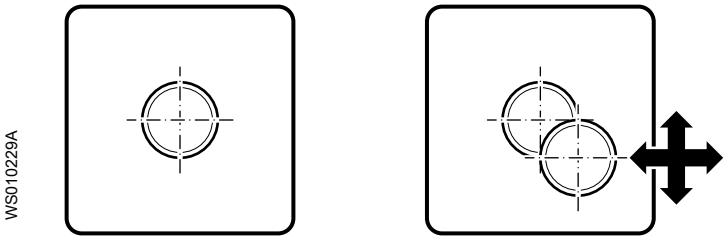


Figure 84: Aligning drive unit holes and pump housing studs

a) To make horizontal adjustments, use the screws on the sides of the gliding shoes.
b) To make vertical adjustments, raise or lower the nuts under the support plate near the hydraulic end.

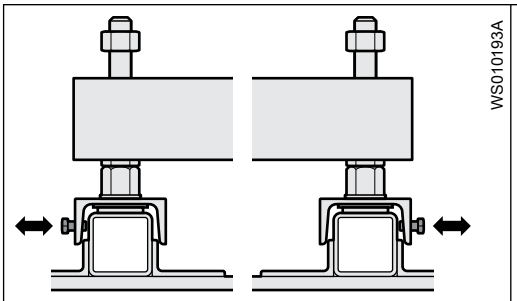


Figure 85: Horizontal adjustments

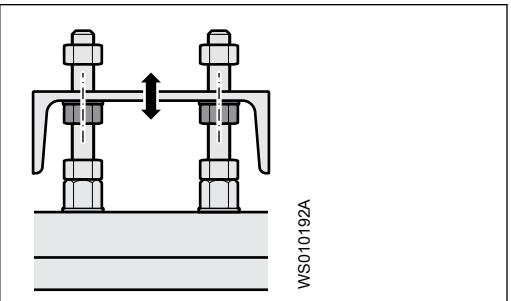


Figure 86: Vertical adjustments

3. Loosen the two nuts at the hand pump piston.

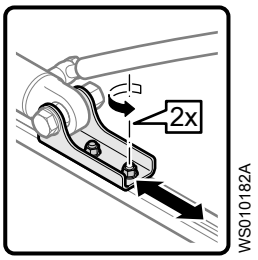


Figure 87: Loosening nuts at the piston

4. Attach the nuts securing the drive unit to the hydraulic unit.

Tighten to the correct torque for the pump.

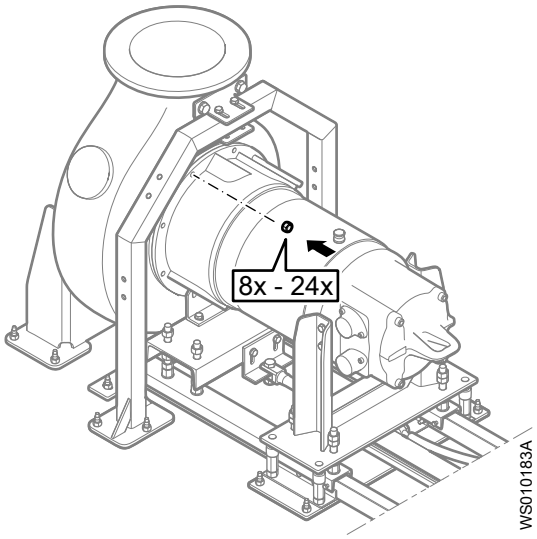


Figure 88: Fastening the drive unit to the hydraulic unit

5. Transfer the drive unit weight from the gliding shoes to the outer columns by following this procedure:
   a) Raise the outer columns on the support plate near the connection house, until they take up the weight of the drive unit.

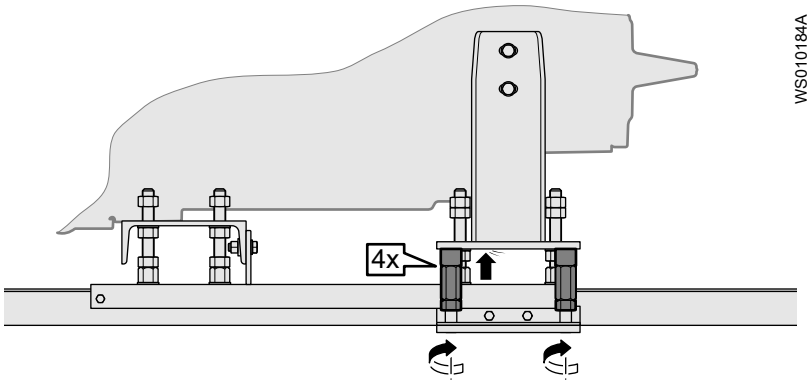


Figure 89: Raising outer columns

   b) Under both of the support plates, move the nuts downwards.

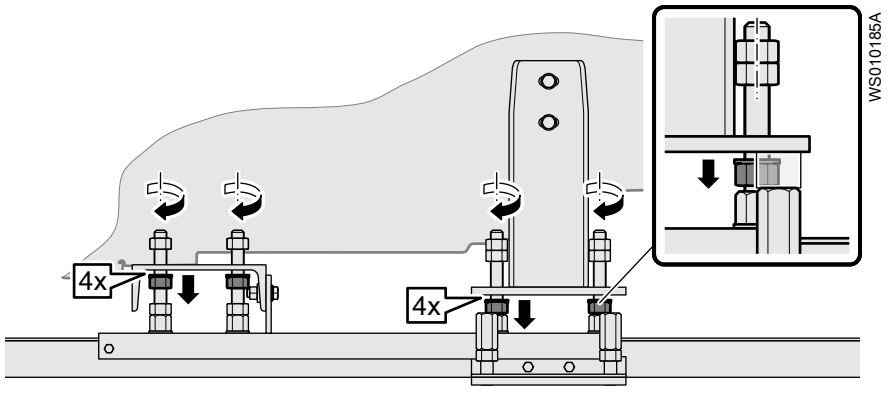


Figure 90: Moving nuts downwards under both support plates

   c) Insert the bolts for the outer columns on the support plate near the connection house, and tighten.

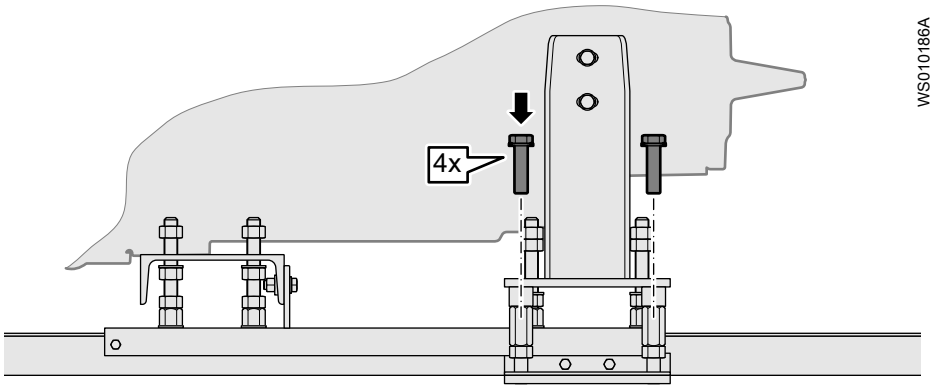
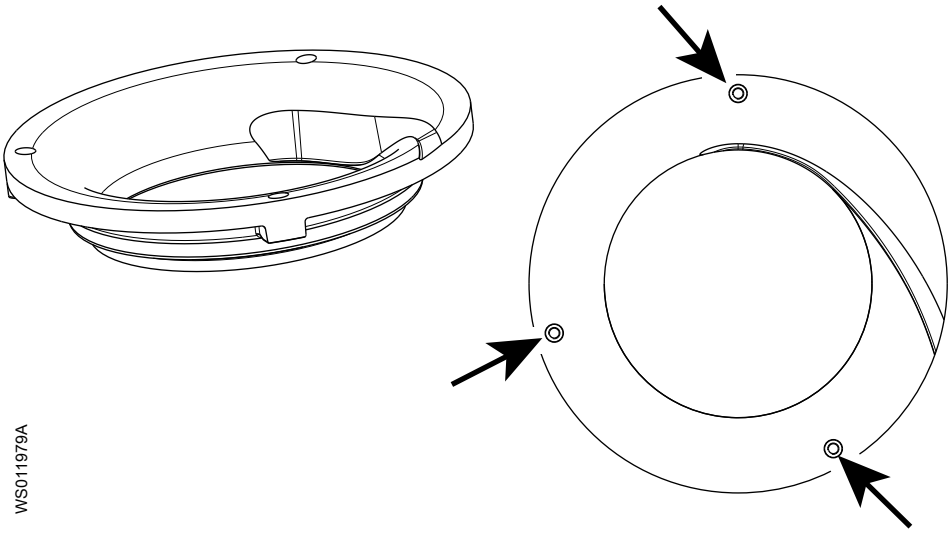


Figure 91: Inserting bolts for outer columns

6.14 Replace the insert ring

The drive unit and impeller must be removed from the pump housing before starting this procedure.

1. Remove the M16 fastening screws which hold the insert ring.

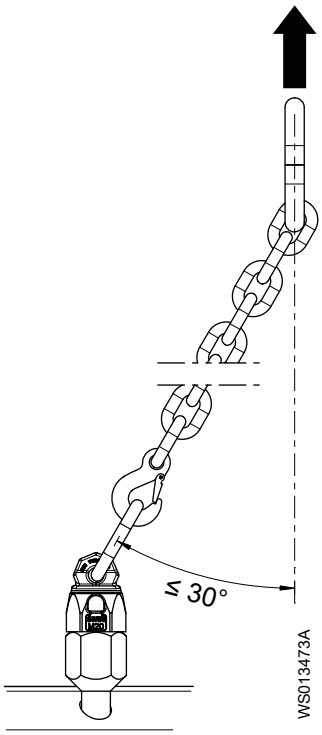


2. Attach three M20 lifting eyes to the insert ring.

   The holes in the insert ring are threaded with a larger thread than the thread on the fastening screws.

   The M20 fasteners must be sufficiently long, so that they are held by the threaded part of the hole.

3. Connect the lifting equipment to the lifting eyes.



All lifting points must be used.

4. Lift the insert ring out of the pump housing.

5. Disconnect the lifting equipment.
6. Remove the lifting eyes.
7. Measure the distance B on the new insert ring.

   B is measured from the top edge of the insert ring to the site for the shims. Record the value. The value will be used for trimming the impeller, see *Trimming impeller clearance* on page 142.

   The shims are not added at this point.

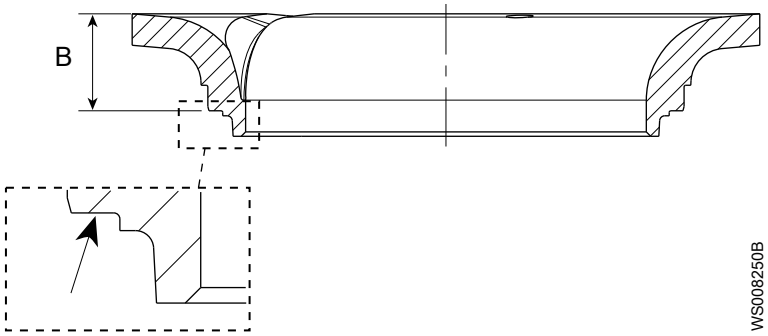
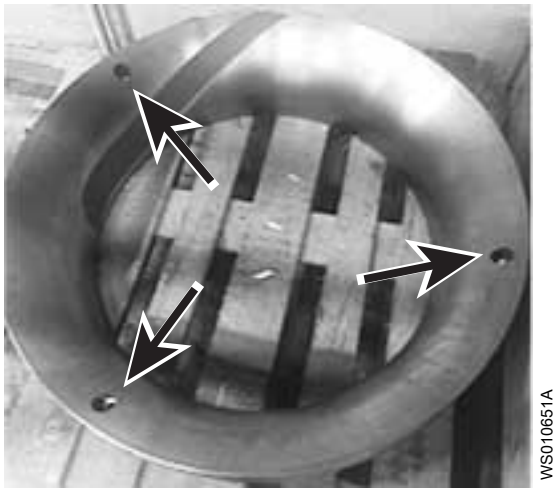


Figure 92: Measuring the distance B.

8. Attach three lifting eyes into the new insert ring. See the following figure.



9. Connect the lifting equipment to the lifting eyes.
10. Lift the insert ring into the pump housing.
11. Disconnect the lifting equipment.
12. Remove the lifting eyes.
13. Install the M16 screws on the insert ring.
    Work around the ring and tighten in stages for an even movement.

6.15 Replacing the impeller

Drain the oil

Before starting work, drain the oil in the oil housing. See *Empty the oil* on page 111.

Plan the work

To ensure safe work, the impeller replacement must be planned before starting. Items to be considered include the following:

- The drive unit must be in a vertical position, with the impeller at the top.
- Two lifting units and the lifting eye bracket are needed, to turn the drive unit upside-down. See *Lifting eye bracket* on page 157.
- The drive unit must be secured at all times, so that it cannot fall over.
- A safe working area near the impeller is needed. See *Prerequisites* on page 134.

6.15.1 Prerequisites

Drive unit in vertical position

The impeller must be replaced while the drive unit is in a vertical position. The drive unit must be upside-down, with the impeller at the top.

Secure the drive unit

CAUTION: Crush Hazard

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

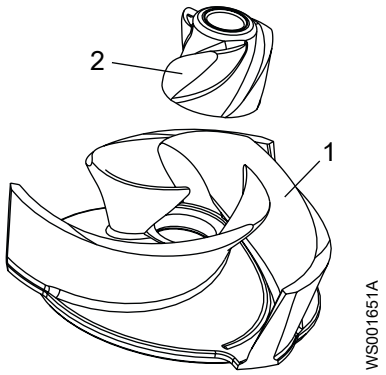
Safe working area near the impeller

Because of the height of the drive unit, arrangements must be made for a safe working area near the impeller.

For example, a working platform can be constructed around the drive unit.

6.15.2 The impeller and the impeller part

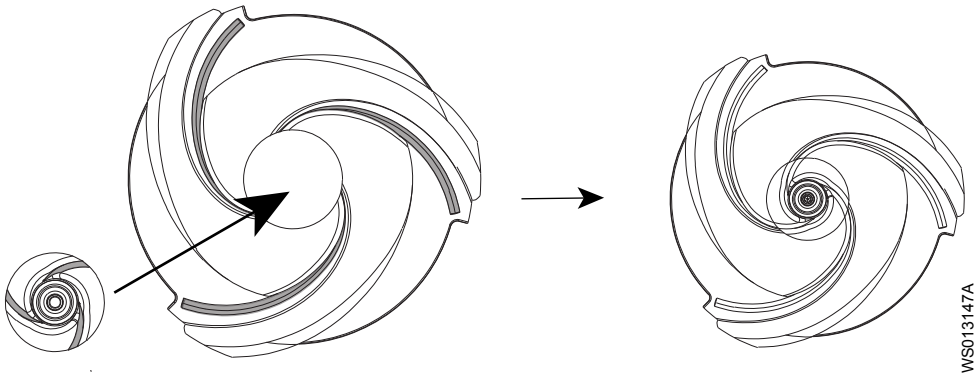
This figure shows the two components of the N-impeller.



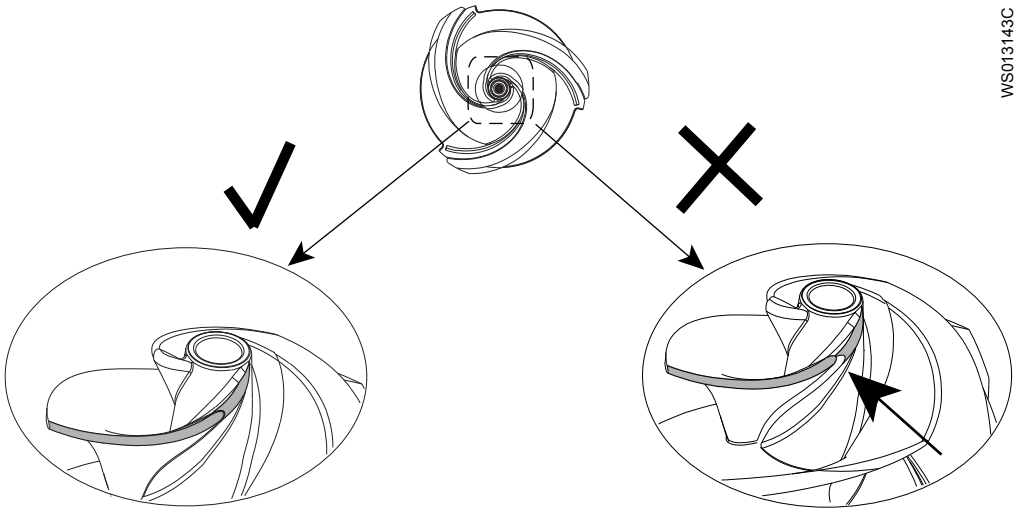
1. Impeller
2. Impeller part

Alignment

There are three vanes, so there are three possible positions for the impeller part. When these parts are being replaced, check all three positions to find the best match between the vanes on the impeller, and the vanes on the impeller part.



After the best fit vane-to-vane match has been found, the fit of the impeller part can be adjusted to give a smooth suction surface.



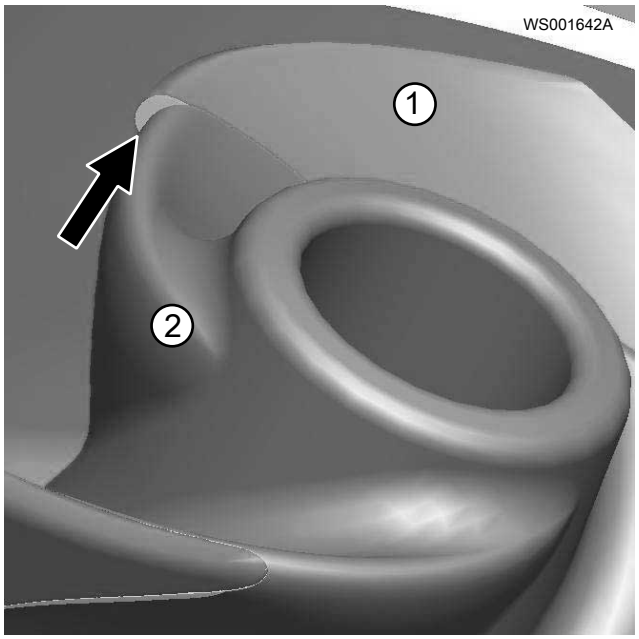
Matched set

The two components are a matched set. In the manufacturing process, the impeller and the impeller part are checked for fit after casting, machining and hardening. If necessary, manual grinding is done so that the two components form a well-matched set with a smooth surface.

NOTICE:

It is important to keep the matched impeller and impeller part together as a set. Components from different impeller variants must not be mixed. Nor should old and new components be mixed, because of different wear patterns.

If the impeller is replaced, then the impeller part must be replaced as well. If the impeller is replaced without also replacing the impeller part, then the impeller part may not cover the front edge of the new impeller. Rags can be caught on to the front edge. This can create an increased risk for clogging.



1. New impeller
2. Old impeller part

Figure 93: Exposed front edge of new impeller

6.15.3 Remove the impeller part

CAUTION: Cutting Hazard

Worn parts can have sharp edges. Wear protective clothing.

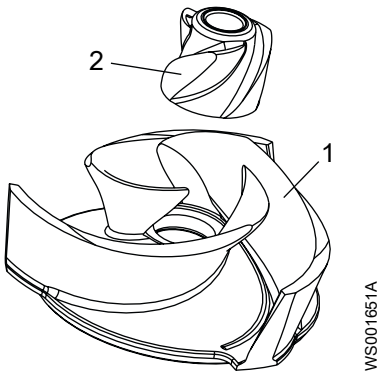
1. Prepare the drive unit as follows:
   a) Disconnect and lift off the drive unit from the pump housing. For Z-installations, see *Drive unit lifting* on page 124.
   b) Follow the work plan to attach the lifting equipment and the lifting eye bracket.
   c) Turn the drive unit upside-down.
   d) Lower the drive unit into the place specified in the work plan.
   e) Secure the drive unit in place.

   CAUTION: Crush Hazard

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

   f) If needed, construct a working platform around the drive unit, near the impeller. See the work plan.
2. Remove the center screw in the impeller part.

   Use a 19 mm Allen key.
3. Remove the impeller part.



1. Impeller
2. Impeller part

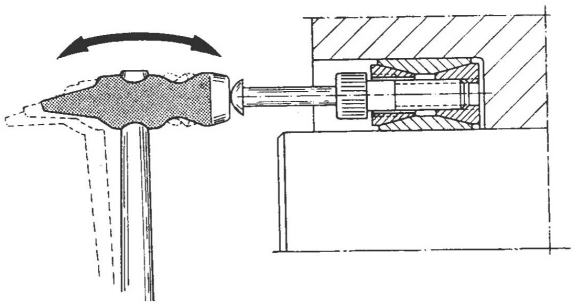
The locking assembly is now accessible for removal.

6.15.4 Remove the locking assembly

1. Locking assemblies 84 59 12, 84 59 13, 84 59 14 and 84 59 17: Loosen the screws on the locking assembly evenly and in sequence. See *Sequence for tightening or loosening locking assembly bolts* on page 146.

   If the locking assembly is still locked, then do as follows:

   a) Loosen the inner ring by tapping it lightly, as shown in the following illustration.



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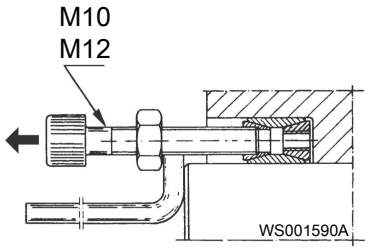
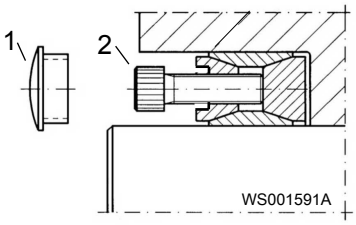
b) If tapping did not loosen the ring, then replace the three "light-colored" screws with three M10 draw-bolts (for 84 59 12 and 84 59 13) or M12 draw-bolts (for 84 59 14 and 84 59 17).



2. Locking assembly 84 60 11:
   a) Remove the four plastic plugs (labeled “1” in the following figure) covering the threaded holes for the special separation screws.



   b) Loosen the inner ring by means of four locking assembly screws (M14) as separation screws (labeled “2” in figure above). See the following illustration.
3. Remove the locking assembly.
4. Pull off the impeller:
   a) Fit the tools that are required for impeller removal according to the tool list for the appropriate pump. See *Tools* on page 148.
   b) Pull off the impeller.

      Use the hydraulic unit with the partially threaded screw in the Basic kits for removal.

6.15.5 Install the impeller

When installing a stainless steel impeller onto a stainless steel shaft, the shaft end should be greased with National Chemsearch THREAD-EZE. Make sure that no grease is on the contact surfaces of the locking assembly.

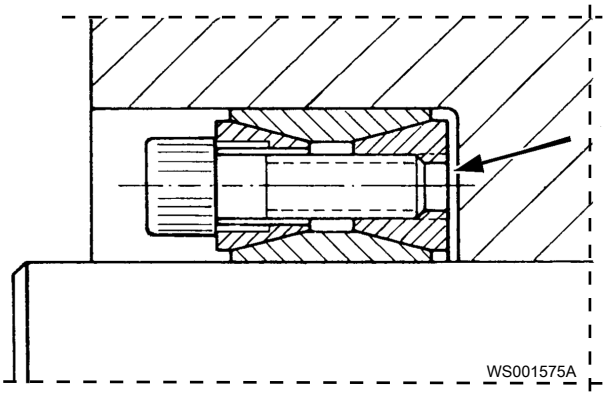
1. Make sure that the end of the shaft is clean and free of burrs.

   Polish off any flaws with fine emery cloth.
2. Grease the end of the shaft and the impeller hub.
3. Place the impeller on the shaft and fit the hydraulic tool with the M16 screw.
4. Use the appropriate washer to press the impeller in place.
5. Remove the hydraulic tool.
6. Go on to *Install the locking assembly* on page 139.

6.15.6 Install the locking assembly

1. Fit the locking assembly in place:
   a) Apply a thin layer of grease at the surface indicated by the arrow in the illustration below.

      Do not use oil containing molybdenum disulphide (MoS_2).



   b) Fit the locking assembly (well-oiled) in the impeller hub without tightening any screws.
2. Fit the impeller:
   a) Place the washer over the locking assembly.

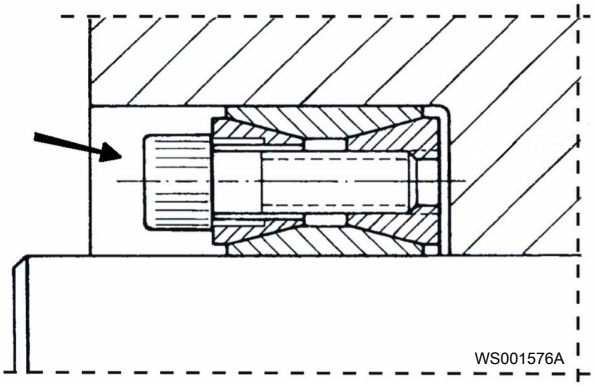
      See *Tools* on page 148 for the washer for the respective pump.

      For the correct position, use an Allen key through one of the slots in the washer and into one of the "light-colored" screws in the locking assembly.
   b) Fit the impeller screw, or the screw unit (with hydraulic tool if applicable), through the center hole in the washer and into the shaft end.

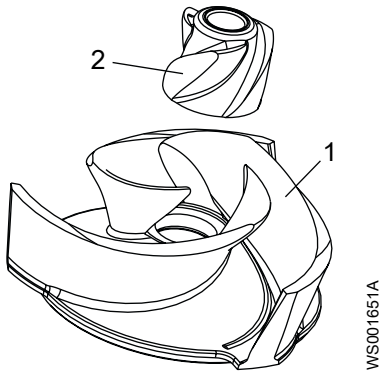
      See *Tools* on page 148 for the screw/screw unit for the respective pump.
   c) Tighten the center screw so that the washer keeps the locking assembly and the impeller in place.
   d) When the impeller is firmly seated, slightly tighten the three "light-colored" screws in the locking assembly through the slots in the washer.

      This keeps the impeller in place against the shaft shoulder.
   e) Remove the center screw and the washer.
3. Tighten the locking assembly screws evenly in three stages, following the sequence and tightening torques that are given in *Sequence for tightening or loosening locking assembly bolts* on page 146.
4. Fill the space with grease, allowing space for the sealing washer.

   The space to be filled with grease is indicated by the arrow in the illustration below.



5. Fit the impeller part.



1. Impeller
2. Impeller part

Figure 94: Impeller and impeller part

6. Tighten the center screw and the sealing washer to the correct torque.

After installing the impeller you must do the following:

1. Check that the impeller can be rotated by hand.
2. Check the zinc anodes (if applicable) to make sure that they are large enough and intact. Replace after approximately 75% consumption.
3. Fit the drive unit to the pump housing. Make sure that the pump housing has the correct orientation. Remember the O-ring between the pump housing and the drive unit.
4. For Z-installations, install the support stands. Fasten the drive unit to the stands.

More extensive repairs require special tools and should be carried out by a service technician authorized by Xylem.

6.15.7 Check the impeller clearance

After mounting the impeller, the clearance between the impeller and the insert ring has to be checked.

The drive unit is still in the upside-down position, with the mounted impeller facing upwards.

1. Measure the distance C at the drive unit.

   C is the height from the impeller vane, measured at the maximum diameter (E) of the impeller, to the flange of the drive unit. See the following figure.

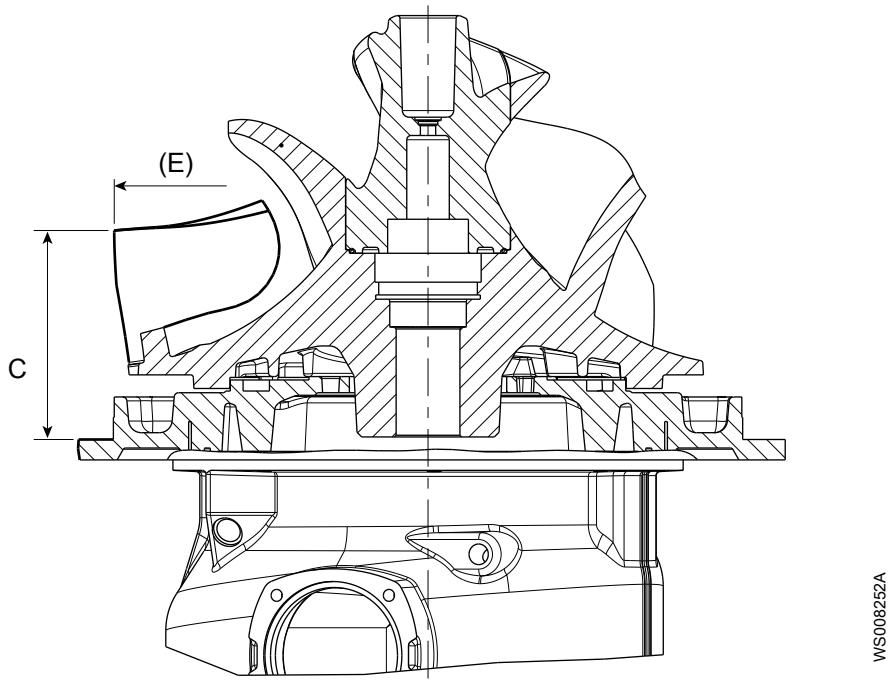


Figure 95: Measuring the distance C.

2. Measure the distance F in the pump housing.

   F is the distance from the top surface of the pump housing to the top edge of the insert ring. See the following figure.

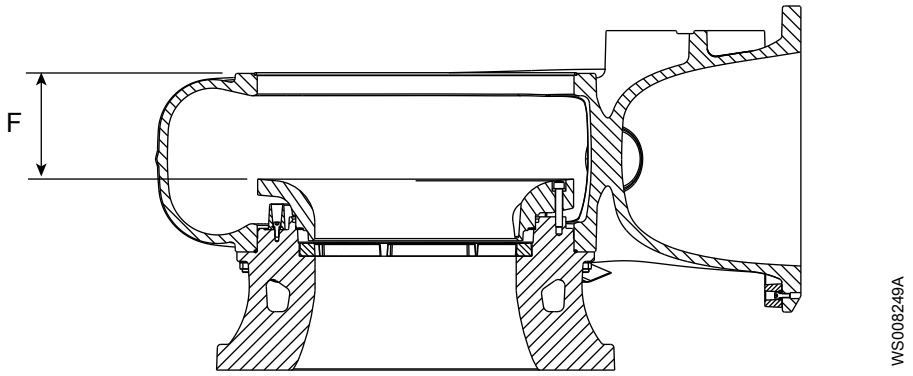


Figure 96: Measuring the distance F. Generic N-pump shown.

3. Use the following table to find the correction factor D, for the specific impeller variant.

   The correction factor D is based on the maximum impeller diameter (E).

Table 32: Maximum impeller diameter (E) and correction factor D for variants 00–47

Variant Number	Maximum Impeller Diameter (E)	Correction Factor D	Variant Number	Maximum Impeller Diameter (E)	Correction Factor D
00 — 05	738.0	0.0	27	647.5	4.0
06	733.7	0.2	28	642.7	4.2
07	731.5	0.3	29	637.9	4.6
08	726.6	0.5	30	633.1	5.0
09	721.6	0.7	31	628.4	5.4

Variant Number	Maximum Impeller Diameter (E)	Correction Factor D	Variant Number	Maximum Impeller Diameter (E)	Correction Factor D
10	719.4	0.8	32	623.7	5.9
11	714.5	1.0	33	621.9	6.1
12	709.6	1.2	34	617.3	6.7
13	704.7	1.5	35	612.7	7.3
14	702.5	1.6	36	608.1	8.0
15	697.6	1.8	37	606.5	8.3
16	692.8	2.0	38	602.0	9.1
17	690.6	2.1	39	597.6	9.9
18	685.7	2.3	40	593.2	10.7
19	680.9	2.5	41	591.7	11.0
20	676.0	2.7	42	587.4	12.0
21	671.1	2.9	43	583.1	13.0
22	669.0	3.0	44	578.9	14.0
23	664.1	3.2	45	574.7	15.1
24	659.3	3.4	46	573.4	15.4
25	654.4	3.7	47	569.3	16.6
26	649.5	3.9			

4. Calculate the clearance by using the following equation:

   Clearance = F + D – C

5. For the calculated clearance, follow the instructions in this table.

Calculated clearance (F + D – C)	Action
Less than 0.5 mm (0.02 in)	Adjust the clearance according to the instructions in *Trimming impeller clearance* on page 142.
0.5–1.4 mm (0.02–0.06 in)	There is no need for trimming the clearance. Proceed to next step.
Greater than 1.4 mm (0.06 in)	Adjust the clearance according to the instructions in *Trimming impeller clearance* on page 142.

6. Install the drive unit on the pump housing:
   a) Turn the drive unit right-side up.
   b) Put a new, lubricated O-ring between the pump housing and the drive unit.
   c) Install the drive unit on the pump housing.

      Make sure that the pump housing has the correct orientation.
   d) Check that the impeller can be rotated by hand.
   e) For Z-installations, install the support stands. See *Installing with Z-installation* on page 52.

More extensive repairs require special tools and should be carried out by a service technician that is authorized by Xylem.

6.15.8 Trimming impeller clearance

The impeller is mounted on the drive unit shaft.

1. Remove the insert ring. See *Replace the insert ring* on page 132.
2. Measure the distance A in the pump housing.

A is measured from the top edge of the pump housing, to the bottom of the seat for the insert ring.

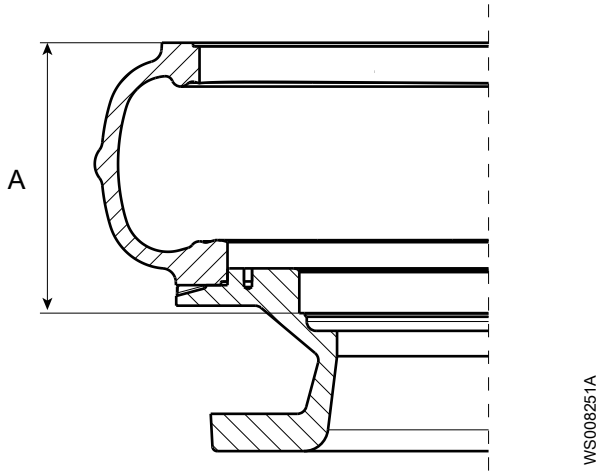


Figure 97: Measuring the distance A

3. Measure the distance B at the insert ring.

   B is measured from the top edge of the insert ring to the seat for the shims.

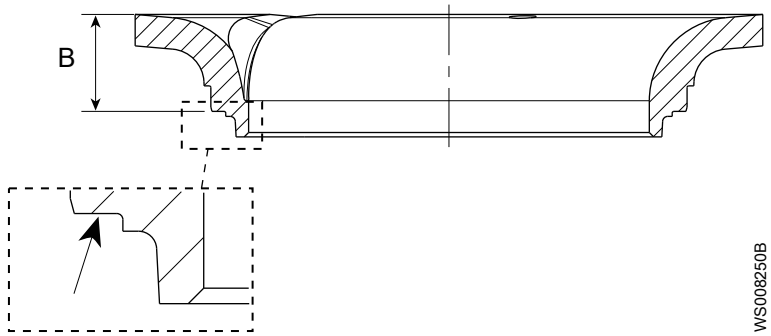


Figure 98: Measuring the distance B

4. Measure the distance C at the drive unit.

   C is the height from the impeller vane to the flange of the drive unit. The height from the impeller vane is measured at the maximum diameter (E) of the impeller.

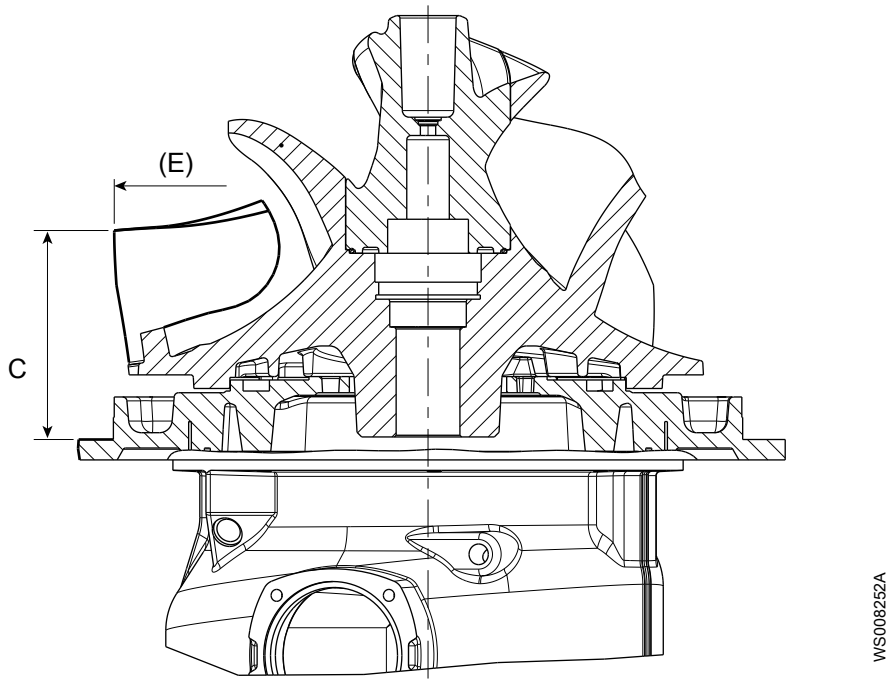


Figure 99: Measuring the distance C

5. Use the following table to find the correction factor D, for the specific impeller variant. The correction factor D is based on the maximum impeller diameter (E).

Table 33: Maximum impeller diameter (E) and correction factor D for variants 00–47

Variant Number	Maximum Impeller Diameter (E)	Correction Factor D	Variant Number	Maximum Impeller Diameter (E)	Correction Factor D
00 — 05	738.0	0.0	27	647.5	4.0
06	733.7	0.2	28	642.7	4.2
07	731.5	0.3	29	637.9	4.6
08	726.6	0.5	30	633.1	5.0
09	721.6	0.7	31	628.4	5.4
10	719.4	0.8	32	623.7	5.9
11	714.5	1.0	33	621.9	6.1
12	709.6	1.2	34	617.3	6.7
13	704.7	1.5	35	612.7	7.3
14	702.5	1.6	36	608.1	8.0
15	697.6	1.8	37	606.5	8.3
16	692.8	2.0	38	602.0	9.1
17	690.6	2.1	39	597.6	9.9
18	685.7	2.3	40	593.2	10.7
19	680.9	2.5	41	591.7	11.0
20	676.0	2.7	42	587.4	12.0
21	671.1	2.9	43	583.1	13.0
22	669.0	3.0	44	578.9	14.0

Variant Number	Maximum Impeller Diameter (E)	Correction Factor D	Variant Number	Maximum Impeller Diameter (E)	Correction Factor D
23	664.1	3.2	45	574.7	15.1
24	659.3	3.4	46	573.4	15.4
25	654.4	3.7	47	569.3	16.6
26	649.5	3.9			

6. Calculate the required shims height, X, by using the formula: X = A – B – C + D – 0.5
7. For the calculated X, find the number of shims that are needed by using the shims table in *Shims* on page 146.

   The total height of the shims should be as near as possible to the calculated height X, but must not be more than the calculated X.
8. Calculate the clearance S by using to the formula: S = A – B – C + D – t

   t: Height of the shims used
9. Fit the insert ring and the chosen shims into the pump housing.
10. Check that the difference between the distance F and the distance C is in the range 0.5–1.4 mm (0.02–0.055 in).

    For an illustration of F, see *Check the impeller clearance* on page 140.
11. Fit the drive unit to the pump housing.

    Do not forget the O-ring between pump housing and drive unit.
12. Make sure that the pump housing has the right orientation.
13. Measure the clearance S. Check through the outlet of the pump housing. The clearance should accord with the calculated value.

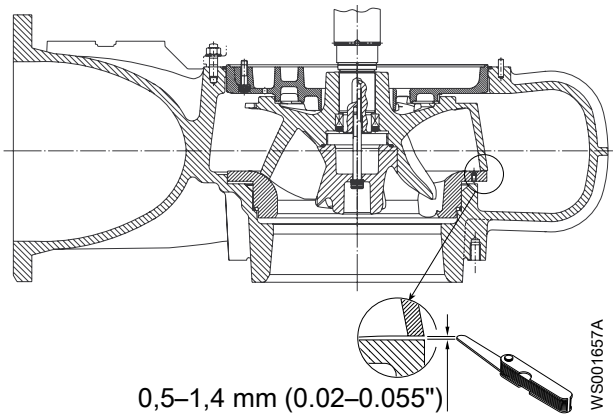


Figure 100: Measuring the distance S

CAUTION: Cutting Hazard

Worn parts can have sharp edges. Wear protective clothing.

More extensive repairs require special tools. A service technician that is authorized by Xylem should carry out more extensive repairs.

6.15.9 Shims

Shim quantities

Calculated shim height required (X), in mm	Quantity	
	T1 shims (1.5 mm)	T2 shims (2.0 mm)
3–(3.5)	2	–
3.5–(4)	1	1
4–(4.5)	–	2
4.5–(5)	3	–
5–(5.5)	2	1
5.5–(6)	1	2
6–(6.5)	0	3
6.5–(7)	3	1
7–(7.5)	2	2
7.5–(8)	1	3
8–(8.5)	–	4
8.5–(9)	3	2
9–(9.5)	2	3
9.5–(10)	1	4

Shim part numbers

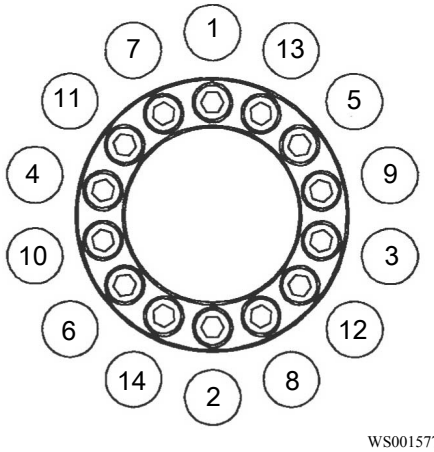
Table 34: Shim (supporting ring) part numbers

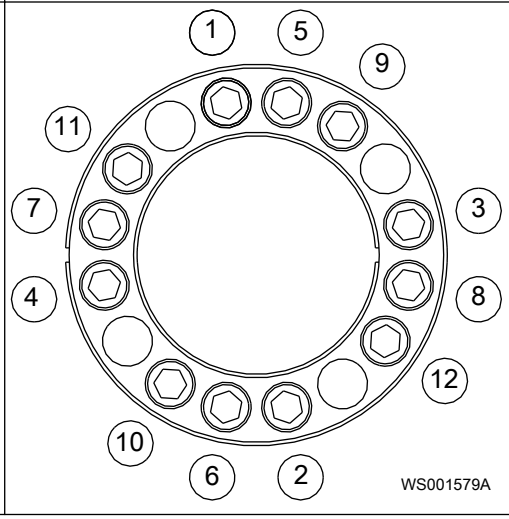
T1 shims (1.5 mm)	T2 shims (2.0 mm)
690 84 10	690 84 09

6.15.10 Sequence for tightening or loosening locking assembly bolts

Bolt sequence

The following illustrations show the sequence used for tightening or loosening the impeller locking assembly bolts.

Locking assembly	Sequence for tightening or loosening bolts
84 59 12	
84 59 13	
84 59 14	

Locking assembly	Sequence for tightening or loosening bolts
84 60 11	

Tightening torques

The table below gives the torque which should be used in each stage of the bolt-tightening process.

Locking assembly	Torque for tightening bolts
84 59 12 84 59 13	• Stage 1: 12 Nm (8.8 ft-lb) • Stage 2: 24 Nm (18 ft-lb) • Stage 3: 35 Nm (26 ft-lb)
84 59 14	• Stage 1: 24 Nm (18 ft-lb) • Stage 2: 48 Nm (35 ft-lb) • Stage 3: 70 Nm (52 ft-lb)
84 60 11	• Stage 1: 70 Nm (52 ft-lb) • Stage 2: 154 Nm (113 ft-lb) • Stage 3: 230 Nm (170 ft-lb)

6.16 Pumps with MAS 801: Replace the PEM

For information about replacing the PEM, see the Service and Repair manual for the drive unit.

6.17 Torque values

All screws and nuts must be lubricated to achieve correct tightening torque. Screws that are screwed into stainless steel must have the threads coated with applicable lubricants to prevent seizing.

If there is a question regarding the tightening torques, then contact a sales or authorized service representative.

Screws and nuts

Table 35: Stainless steel, A2 and A4, torque Nm (lbf·ft)

Property class	M4	M5	M6	M8	M10	M12	M16	M20	M24	M30
50	1.0 (0.74)	2.0 (1.5)	3.0 (2.2)	8.0 (5.9)	15 (11)	27 (20)	65 (48)	127 (93.7)	220 (162)	434 (320)

Property class	M4	M5	M6	M8	M10	M12	M16	M20	M24	M30
70, 80	2.7 (2)	5.4 (4)	9.0 (6.6)	22 (16)	44 (32)	76 (56)	187 (138)	364 (268)	629 (464)	1240 (915)
100	4.1 (3)	8.1 (6)	14 (10)	34 (25)	66 (49)	115 (84.8)	248 (183)	481 (355)	—	—

Table 36: Steel, torque Nm (lbf·ft)

Property class	M4	M5	M6	M8	M10	M12	M16	M20	M24	M30
8.8	2.9 (2.1)	5.7 (4.2)	9.8 (7.2)	24 (18)	47 (35)	81 (60)	194 (143)	385 (285)	665 (490)	1310 (966.2)
10.9	4.0 (2.9)	8.1 (6)	14 (10)	33 (24)	65 (48)	114 (84)	277 (204)	541 (399)	935 (689)	1840 (1357)
12.9	4.9 (3.6)	9.7 (7.2)	17 (13)	40 (30)	79 (58)	136 (100)	333 (245)	649 (480)	1120 (825.1)	2210 (1630)

Table 37: Brass, torque Nm (lbf·ft)

M5	M8	M10
2.7 (2.0)	11 (8.1)	22 (16.2)

Hexagon screws with countersunk heads

For hexagon socket head screws with countersunk head, maximum torque for all property classes must be 80% of the values for property class 8.8.

Round nuts with set screws

Table 38: Set screw, torque Nm (lbf·ft)

The torque values are only valid for the set screw, and not for the round nut.

M8	M10
18 (13)	35 (26)

6.18 Tools

Beside ordinary tools, the following tools are required in order to perform the necessary maintenance of the pump.

All pumps

Part number	Denomination	Range of use	
83 95 42	Oil drainage pumps	Drainage pumps for emptying oil housing	
84 13 68	Hydraulic unit, 200 kN	Bearing removal	584 83 00

N3531

Part number	Denomination	Range of use
332 91 00	Stop spring removing tool	

Part number	Denomination	Range of use
399 41 00	Mounting tool unit (for shaft Ø75 and Ø90 mm)	Mounting the seal
576 83 01	Washer (for shaft Ø75, 7X5 and 7X6 drive units)	Mounting the locking assembly
576 83 02	Washer (for shaft Ø90 mm, (for 8X5, 905, 915 drive units)	Mounting the locking assembly
576 83 03	Washer (for shaft Ø110 mm, for 905 - 960 drive units)	Mounting the locking assembly
576 84 00	Puller screw	
584 81 00	Washer	
587 72 00	Impeller tool (for shaft Ø75 mm, 7X5 and 7X6 drive units and for shaft Ø90 mm, 8X5, and 905, 915 drive units)	
587 73 00	Impeller tool (for shaft Ø110, 905 - 960 drive units)	
587 94 00	Basic kit V	
660 48 00	Impeller tool (for shaft Ø110, 965 - 998 drive units)	Removing the impeller
660 49 00	Impeller tool (for shaft Ø110 , 965 - 998 drive units)	Mounting the locking assembly and the impeller

7 Troubleshooting

7.1 Electrical troubleshooting

DANGER: Electrical Hazard

Troubleshooting a live control panel exposes personnel to hazardous voltages. Electrical troubleshooting must be done by a qualified electrician.

Follow these guidelines when troubleshooting:

- Disconnect and lock out the power supply except when conducting checks that require voltage.
- Make sure that no one is near the unit when the power supply is reconnected.
- When troubleshooting electrical equipment, use the following:
  - Universal instrument multimeter
  - Test lamp (continuity tester)
  - Wiring diagram

7.2 The pump does not start

DANGER: Crush Hazard

Moving parts can entangle or crush. Always disconnect and lock out power before servicing to prevent unexpected startup. Failure to do so could result in death or serious injury.

NOTICE:

Do NOT override the motor protection repeatedly if it has tripped. Doing so may result in equipment damage.

Cause	Remedy
An alarm signal has been triggered on the control panel.	Check that: • The impeller rotates freely. • The sensor indicators do not indicate an alarm. • The overload protection is not tripped. If the problem still persists: Contact a sales or authorized service representative.
The pump does not start automatically, but can be started manually.	Check that: • The start level regulator is functioning. Clean or replace if necessary. • All connections are intact. • The relay and contactor coils are intact. • The control switch (Man/Auto) makes contact in both positions. Check the control circuit and functions.

Cause	Remedy
The installation is not receiving voltage.	Check that: • The main power switch is on. • There is control voltage to the start equipment. • The fuses are intact. • There is voltage in all phases of the supply line. • All fuses have power and that they are securely fastened to the fuse holders. • The overload protection is not tripped. • The motor cable is not damaged.
The impeller is stuck.	Clean: • The impeller • The sump in order to prevent the impeller from clogging again.

Always state the serial number of the product, see *Product Description* on page 19.

7.3 The pump does not stop when a level sensor is used

DANGER: Crush Hazard

Moving parts can entangle or crush. Always disconnect and lock out power before servicing to prevent unexpected startup. Failure to do so could result in death or serious injury.

Cause	Remedy
The pump is unable to empty the sump to the stop level.	Check that: • There are no leaks from the piping and/or discharge connection. • The impeller is not clogged. • The non-return valve(s) are functioning properly. • The pump has adequate capacity. For information: Contact a sales or authorized service representative.
There is a malfunction in the level-sensing equipment.	• Clean the level regulators. • Check the functioning of the level regulators. • Check the contactor and the control circuit. • Replace all defective items.
The stop level is set too low.	Raise the stop level.

Always state the serial number of the product, see *Product Description* on page 19.

7.4 The pump starts-stops-starts in rapid sequence

Cause	Remedy
The pump starts due to back-flow which fills the sump to the start level again.	Check that: • The distance between the start and stop levels is sufficient. • The non-return valve(s) work(s) properly. • The length of the discharge pipe between the pump and the first non-return valve is sufficiently short.

Cause	Remedy
The self-holding function of the contactor malfunctions.	Check: • The contactor connections. • The voltage in the control circuit in relation to the rated voltages on the coil. • The functioning of the stop-level regulator. • Whether the voltage drop in the line at the starting surge causes the contactor's self-holding malfunction.

Always state the serial number of the product, see *Product Description* on page 19.

7.5 The pump runs but the motor protection trips

DANGER: Crush Hazard

Moving parts can entangle or crush. Always disconnect and lock out power before servicing to prevent unexpected startup. Failure to do so could result in death or serious injury.

NOTICE:

Do NOT override the motor protection repeatedly if it has tripped. Doing so may result in equipment damage.

Cause	Remedy
The motor protection is set too low.	Set the motor protection according to the data plate and if applicable the cable chart.
The impeller is difficult to rotate by hand.	• Clean the impeller. • Clean out the sump. • Check that the impeller is properly trimmed.
The drive unit is not receiving full voltage on all three phases.	• Check the fuses. Replace fuses that have tripped. • If the fuses are intact, then notify a certified electrician.
The phase currents vary, or they are too high.	Contact a sales or authorized service representative.
The insulation between the phases and ground in the stator is defective.	• Drive units up to 1 kV: See *Check the insulation, up to 1 kV drives or generators* on page 108. • Drive units 1.2–6.6 kV: See *Check the insulation, 1.2–6.6 kV drives* on page 108.
The density of the pumped fluid is too high.	Make sure that the maximum density is 1100 kg/m3 (9.2 lb/US gal) • Change the impeller, or • Change to a more suitable pump • Contact a sales or authorized service representative.
There is a malfunction in the overload protection.	Replace the overload protection.

Always state the serial number of the product, see *Product Description* on page 19.

7.6 The pump delivers too little or no water

DANGER: Crush Hazard

Moving parts can entangle or crush. Always disconnect and lock out power before servicing to prevent unexpected startup. Failure to do so could result in death or serious injury.

NOTICE:

Do NOT override the motor protection repeatedly if it has tripped. Doing so may result in equipment damage.

Cause	Remedy
The impeller rotates in the wrong direction.	If it is a 3-phase pump, then transpose two phase leads.
One or more of the valves are set in the wrong positions.	• Reset the valves that are set in the wrong position. • Replace the valves, if necessary. • Check that all valves are correctly installed according to media flow. • Check that all valves open correctly.
The impeller is difficult to rotate by hand.	• Clean the impeller. • Clean out the sump. • Check that the impeller is properly trimmed.
The pipes are obstructed.	Clean out the pipes to ensure a free flow.
The pipes and joints leak.	Find the leaks and seal them.
There are signs of wear on the impeller, pump, and casing.	Replace the worn parts.
The liquid level is too low.	• Check that the level sensor is set correctly. • Depending on the installation type, add a means for priming the pump, such as a foot valve.

Always state the serial number of the product, see *Product Description* on page 19.

8 Technical Reference

8.1 Application limits

Data	Description
Liquid temperature	Maximum 40°C (104°F)
pH of the pumped media	5.5–14
Liquid density	1100 kg/m³ (9.2 lb for each US gal) maximum
Depth of immersion	Maximum 20 m (65 ft)

8.2 Drive units overview

The following table shows the range of drive units for large submersible pumps. Not all drive units can be used for a particular pump. For drive unit-hydraulic unit compatibility, see the compatibility charts.

Drive units	Not Explosion-proof	Explosion-proof	HE Motor	Voltage Range		Cooling System				Connection House	
				LV, up to 1 kV	MV, 1.2–6.6 kV	External	Integrated	Direct	Internal Closed-loop	Small	Large
605, 665	X			X		X	X	X		X	
615, 675		X		X		X	X	X		X	
705, 735, 765	X			X		X	X	X		X	X
706, 736, 766	X		X	X				X	X	X	X
715, 745, 775		X		X		X	X	X		X	X
716, 746, 776		X	X	X				X	X	X	X
805, 835, 865	X			X		X	X	X			X
885	X			X				X			X
806, 836, 866	X		X	X				X	X		X
886	X		X	X				X			X
815, 845, 875		X		X (2)		X	X	X			X
895		X		X				X			X
816, 846, 876		X	X	X (2)				X	X		X
896		X	X	X (2)				X			X
863, 883	X				X			X	X		X
873, 893		X			X (1)			X	X		X
905, 935, 965	X			X		X	X	X			X
915, 945, 975		X		X		X	X	X			X
906, 936, 966	X		X	X				X	X		X
916, 946, 976		X	X	X				X	X		X
950, 985, 988	X				X	X	X	X			X
960, 995, 998		X			X	X	X	X			X

Drive units	Not Explosion-proof	Explosion-proof	HE Motor	Voltage Range		Cooling System				Connection House	
				LV, up to 1 kV	MV, 1.2–6.6 kV	External	Integrated	Direct	Internal Closed-loop	Small	Large
951, 986, 987	X		X		X			X	X		X
961, 996, 997		X	X		X			X	X		X
(1) FM: 2.3–4.16 kV (2) FM: Up to 600 V											

8.3 Pt100 resistance

This table shows the relationship between temperature (°C) and resistance (ohms).

T, °C	R, ohms	T, °C	R, ohms	T, °C	R, ohms	T, °C	R, ohms	T, °C	R, ohms
0	100.00	33	112.83	66	125.54	99	138.12	132	150.57
1	100.39	34	113.22	67	125.92	100	138.50	133	150.95
2	100.78	35	113.61	68	126.31	101	138.88	134	151.33
3	101.17	36	113.99	69	126.69	102	139.26	135	151.70
4	101.56	37	114.38	70	127.07	103	139.64	136	152.08
5	101.95	38	114.77	71	127.45	104	140.02	137	152.45
6	102.34	39	115.15	72	127.84	105	140.39	138	152.83
7	102.73	40	115.54	73	128.22	106	140.77	139	153.20
8	103.12	41	115.93	74	128.60	107	141.15	140	153.58
9	103.51	42	116.31	75	128.98	108	141.53	141	153.95
10	103.90	43	116.70	76	129.37	109	141.91	142	154.32
11	104.29	44	117.08	77	129.75	110	142.29	143	154.70
12	104.68	45	117.47	78	130.13	111	142.66	144	155.07
13	105.07	46	117.85	79	130.51	112	143.04	145	155.45
14	105.46	47	118.24	80	130.89	113	143.42	146	155.82
15	105.85	48	118.62	81	131.27	114	143.80	147	156.19
16	106.24	49	119.01	82	131.66	115	144.17	148	156.57
17	106.63	50	119.40	83	132.04	116	144.55	149	156.94
18	107.02	51	119.78	84	132.42	117	144.93	150	157.31
19	107.40	52	120.16	85	132.80	118	145.31	151	157.69
20	107.79	53	120.55	86	133.18	119	145.68	152	158.06
21	108.18	54	120.93	87	133.56	120	146.06	153	158.43
22	108.57	55	121.32	88	133.94	121	146.44	154	158.81
23	108.96	56	121.70	89	134.32	122	146.81	155	159.18
24	109.35	57	122.09	90	134.70	123	147.19	156	159.55
25	109.73	58	122.47	91	135.08	124	147.57	157	159.93
26	110.12	59	122.86	92	135.46	125	147.94	158	160.30
27	110.51	60	123.24	93	135.84	126	148.32	159	160.67
28	110.90	61	123.62	94	136.22	127	148.70	160	161.04

T, °C	R, ohms		T, °C	R, ohms		T, °C	R, ohms		T, °C	R, ohms		T, °C	R, ohms
29	111.28		62	124.01		95	136.60		128	149.07			
30	111.67		63	124.39		96	136.98		129	149.45			
31	111.94		64	124.77		97	137.36		130	149.82			
32	112.45		65	125.16		98	137.74		131	150.20			

8.4 Cable bending radius, weight and diameter

Control cables

Table 39: SUBCAB™ control cables

This table shows the minimum bending radius, weight, and outer diameter for SUBCAB control cables.

Cable	Minimum bending radius in mm	Weight in kg/m	Outer diameter, minimum-maximum in mm
12x1.5 mm^2	190	0.53	Ø 18.2–21.2
24x1.5 mm^2	250	0.90	Ø 24.9–28.9
S12x1.5 mm^2	300	0.78	Ø 29.9–31.0
S24x1.5 mm^2	350	1.59	Ø 33.0–37.0

Power cables with power cores and control element

Table 40: Screened SUBCAB

Cable	Minimum bending radius in mm	Weight in kg/m	Outer diameter, minimum-maximum in mm
S3x16 + 3x16/3 + S(4x0.5)	240	1.1	Ø 24–26
S3x25 + 3x16/3 + S(4x0.5)	290	1.4	Ø 29–31
S3x35 + 3x16/3 + S(4x0.5)	320	2.0	Ø 32–34
S3x50 + 3x25/3 + S(4x0.5)	380	3.0	Ø 38–40
S3x70 + 3x35/3 +2 S(2x0.5)	420	3.5	Ø 42–44
S3x95 + 3x50/3 + 2S(2x0.5)	440	4.6	Ø 44–47
S3x120 + 3x70/3 + 2S(2x0.5)	500	5.5	Ø 50–52
S6x95 + 95 + S(4x0.5)	570	7.6	Ø 57–60

Table 41: SUBCAB

Cable	Minimum bending radius in mm	Weight in kg/m	Outer diameter, minimum-maximum in mm
4 G 16 + S(2x0.5)	260	1.13	Ø 26–28
4 G 25 + S(2x0.5)	320	1.7	Ø 32–34
4 G 35 + S(2x0.5)	350	2.24	Ø 35–37
3x50 + 2G35/2 + S(2x0.5)	350	2.6	Ø 35–37
3x70 + 2G35/2 + S(2x0.5)	380	3.3	Ø 38–41
3x95 + 2G50/2 + S(2x0.5)	470	4.5	Ø 47–50
3x120 + 2G70/2 + S(2x0.5)	540	5.7	Ø 54–56

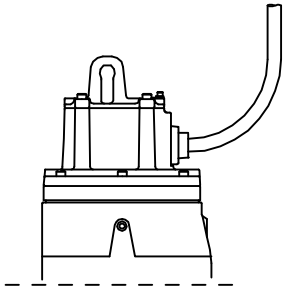
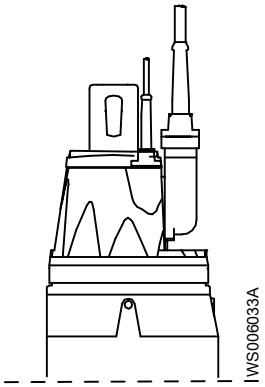
Medium voltage power cables, 1.2–15 kV

Table 42: (N)TSCGEWOEUS 1.2–15 kV

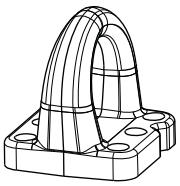
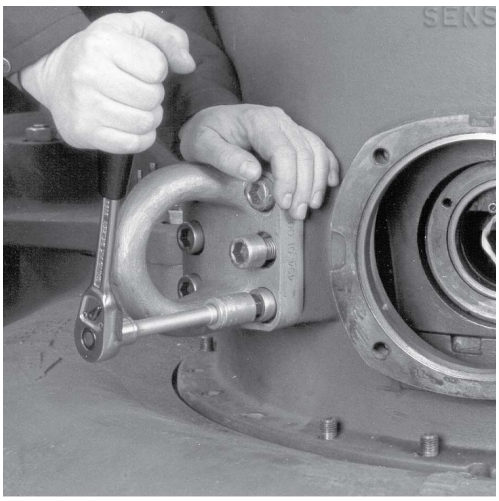
This table shows the minimum bending radius, weight, and outer diameter for (N)TSCGEWOEUS 1.2–15 kV cables.

Cable	Minimum bending radius in mm	Weight in kg/m	Outer diameter, minimum-maximum in mm
3x25+3x25/3	410	2.51	Ø 41–44
3x50+3x25/3	460	3.47	Ø 46–49

8.5 Large and small connection housing (junction box)

Small connection housing	Large connection housing
 WS006034A Drive unit series: • 600-series • 700-series	 WS006033A Drive unit series: • 700-series • 800-series • 900-series

8.6 Lifting eye bracket

 WS011502B Part number: • 1 bracket: 584 61 00 • 2 brackets: 584 61 01	 WS002323B

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2) a leading global water technology company.

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xylem
Let’s Solve Water

Xylem Water Solutions Global Services AB 556782-9253
361 80 Emmaboda
Sweden
Tel: +46-471-24 70 00
Fax: +46-471-24 74 01
http://tpi.xyleminc.com
www.xylemwatersolutions.com/contacts/

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The original instruction is in English. All non-English instructions are translations of the original instruction.

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