Operation & Maintenance Manual

OCSD Sludge Dewatering and Odor Control

Fountain Valley, CA

S/N: 3153.095-1480007, -1480091, -1480092, -1480093, -1480100, -1480101

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Submersible Sump Pumps - 15LPMP870,873,878,881 & 15MPMP980,983

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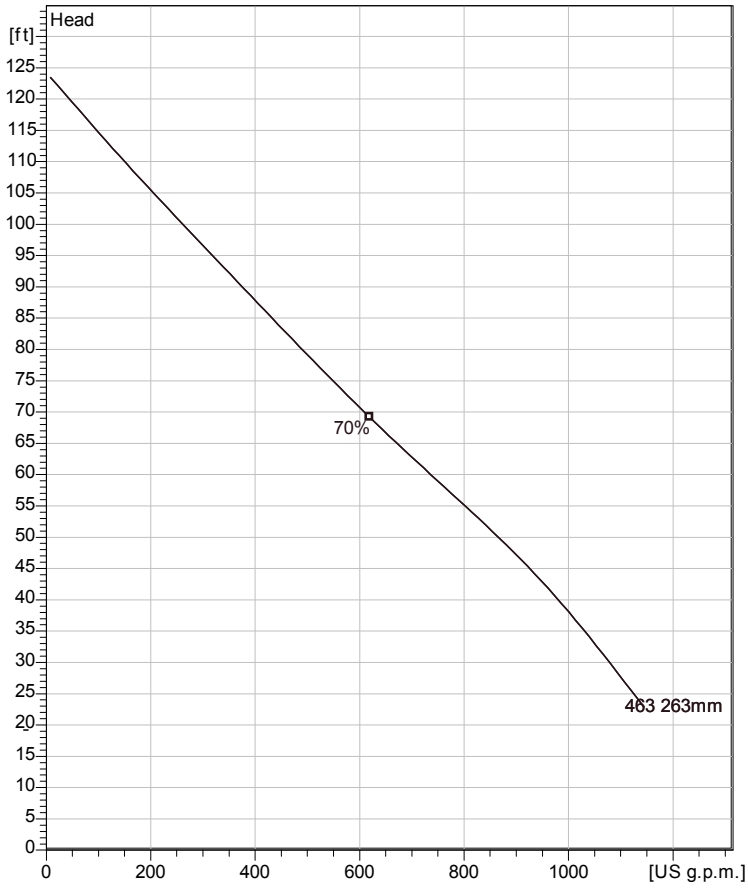
NP 3153 HT 3~ 463

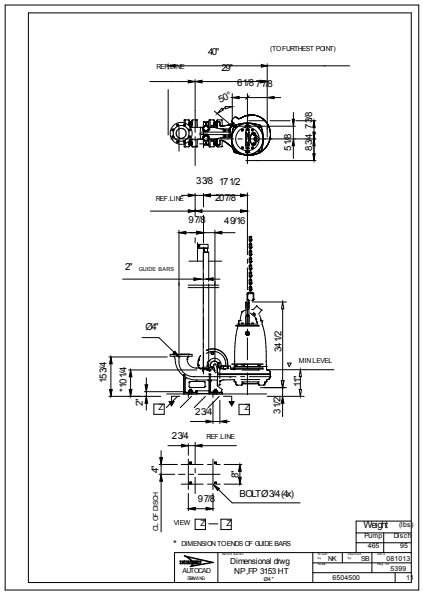
Technical specification



Curve according to: ISO 9906

Note: Picture might not correspond to the current configuration.

Installation: P - Semi permanent, Wet



General

Patented self cleaning semi-open channel impeller, ideal for pumping in most waste water applications. Possible to be upgraded with Guide-pin® for even better clogging resistance. Modular based design with high adaptation grade.

Impeller

Impeller material	Grey cast iron
Outlet width	3 15/16 inch
Inlet diameter	150 mm
Impeller diameter	263 mm
Number of blades	2
	0 inch

Motor

Motor #	N3153.181 21-18-4AA-W 20hp
Stator variant	5
Frequency	60 Hz
Rated voltage	460 V
Number of poles	4
Phases	3~
Rated power	20 hp
Rated current	26 A
Starting current	148 A
Rated speed	1755 rpm
Power factor	
1/1 Load	0.83
3/4 Load	0.77
1/2 Load	0.66
Efficiency	
1/1 Load	87.5 %
3/4 Load	89.0 %
1/2 Load	89.0 %

Configuration

Project	Project ID	Created by	Created on	Last update
Sludge Dewatering	& Odor Control		2013-04-05	

Technical Reference

Application limits

Data	Description
Liquid temperature	40°C (104°F) maximum For P- and S-installations without cooling jacket, the pump can be operated only when the sump level is at least 10 mm above the stator housing. Warm-liquid version (only with cooling jacket): 70°C (158°F) maximum Ex-approved pumps: 40°C (104°F) maximum
Liquid density	1100 kg/m³ (9.2 lb per US gal) maximum
pH of the pumped media (liquid)	5.5–14
Depth of immersion	20 m (65 ft) maximum
Other	For the specific weight, current, voltage, power ratings, and speed of the pump, see the data plate of the pump.

Motor data

Feature	Description
Motor type	• 3153.091/.095/.181/.185/.350/.390: Squirrel-cage induction motor • 3153.800/.810/.820/.830/.840/.850: Line-started, permanent-magnet synchronous motor
Frequency	50 or 60 Hz
Supply	3-phase
Starting method	• Direct on-line • Star-delta • Soft starter
Maximum starts per hour	30 evenly spaced starts per hour
Code compliance	IEC 60034-1
Rated output variation	±10%
Voltage variation without overheating	±10%, provided that it does not run continuously at full load
Voltage imbalance tolerance	2%
Stator insulation class	H (180°C [360°F])

TAB 2

APPROVED SUBMITTAL

N-3153.185/095 SPECS.

PUMP DESIGN CONFIGURATION (Wet pit installation)
The pump shall be supplied with a mating cast iron _____ inch discharge connection and be capable of delivering _____ GPM at _____ FT. TDH. The pump(s) shall be automatically and firmly connected to the discharge connection, guided by no less than two guide bars extending from the top of the station to the discharge connection. There shall be no need for personnel to enter the wet-well. Sealing of the pumping unit to the discharge connection shall be accomplished by a machined metal to metal watertight contact. **Sealing of the discharge interface with a diaphragm, O-ring or profile gasket will not be acceptable**. No portion of the pump shall bear directly on the sump floor. Each pump shall be fitted with _____ feet of _____ lifting chain or stainless steel cable. The working load of the lifting system shall be 50% greater than the pump unit weight.

PUMP CONSTRUCTION
Major pump components shall be of grey cast iron, ASTM A-48, Class 35B, with smooth surfaces devoid of blow holes or other irregularities. The lifting handle shall be of stainless steel. All exposed nuts or bolts shall be of stainless steel construction. All metal surfaces coming into contact with the pumpage, other than stainless steel or brass, shall be protected by a factory applied spray coating of acrylic dispersion zinc phosphate primer with a polyester resin paint finish on the exterior of the pump.

Sealing design shall incorporate **metal-to-metal contact** between machined surfaces. Critical mating surfaces where watertight sealing is required shall be machined and fitted with Nitrile O-rings. Fittings will be the result of controlled compression of rubber O-rings in two planes and O-ring contact of four sides without the requirement of a specific torque limit.

Rectangular cross sectioned gaskets requiring specific torque limits to achieve compression shall not be considered as adequate or equal. No secondary sealing compounds, elliptical O-rings, grease or other devices shall be used.

COOLING SYSTEM
(Non-cooling Jacket Equipped)
Each pump motor shall be sufficiently cooled by submergence in the pumped media.

(Cooling Jacket Equipped)
Each unit shall be provided with an integral motor cooling system. A stainless steel motor cooling jacket shall encircle the stator housing, providing for dissipation of motor heat regardless of the type of pump installation. An impeller, integral to the cooling system and driven by the pump shaft, shall provide the necessary circulation of the cooling liquid through the jacket. The cooling liquid shall pass about the stator housing in the closed loop system in turbulent flow providing for superior heat transfer. The cooling system shall have one fill port and one drain port integral to the cooling jacket. The cooling system shall provide for continuous pump operation in liquid or ambient temperatures of up to 104°F (40°C). Operational restrictions at temperatures below 104°F are not acceptable. Fans, blowers or auxiliary cooling systems that are mounted external to the pump motor are not acceptable.

CABLE ENTRY SEAL
The cable entry seal design shall preclude specific torque requirements to insure a watertight and submersible seal. The cable entry shall consist of dual cylindrical elastomer grommets, flanked by washers, all having a close tolerance fit against the cable outside diameter and the entry inside diameter. The grommets shall be compressed by the cable entry unit, thus providing a strain relief function. The assembly shall provide ease of changing the cable when necessary using the same entry seal. The cable entry junction chamber and motor shall be sealed from each other, which shall isolate the stator housing from foreign material gaining access through the pump top. Epoxies, silicones, or other secondary sealing systems shall not be considered equal.

MOTOR
The pump motor shall be a NEMA B design, induction type with a squirrel cage rotor, shell type design, housed in an air filled, watertight chamber. The stator windings shall be insulated with moisture resistant Class H insulation rated for 180°C (356°F). The stator shall be insulated by the trickle impregnation method using Class H monomer-free polyester resin resulting in a winding fill factor of at least 95%. The motor shall be inverter duty rated in accordance with NEMA MG1, Part 31.The stator shall be heat-shrink fitted into the cast iron stator housing. The use of multiple step dip and bake-type stator insulation process is not acceptable. The use of pins, bolts, screws or other fastening devices used to locate or hold the stator and that penetrate the stator housing are not acceptable. The motor shall be designed for continuous duty while handling pumped media of up to 104°F. The motor shall be capable of no less than 30 evenly spaced starts per hour. The rotor bars and short circuit rings shall be made of aluminum. Three thermal switches shall be embedded in the stator end coils, one per phase winding, to monitor the stator temperature. These thermal switches shall be used in conjunction with and supplemental to external motor overload protection and shall be connected to the motor control panel.
The junction chamber shall be sealed off from the stator housing and shall contain a terminal board for connection of power and pilot sensor cables using threaded compression type terminals. The use of wire nuts or crimp-type connectors is not acceptable. The motor and the pump shall be produced by the same manufacturer.

The motor service factor (combined effect of voltage, frequency and specific gravity) shall be 1.15. The motor shall have a voltage tolerance of +/- 10%. The motor shall be designed for continuous operation in up to a 40°C ambient and shall have a NEMA Class B maximum operating temperature rise of 80°C. A motor performance chart shall be provided upon request exhibiting curves for motor torque, current, power factor, input/output kW and efficiency. The chart shall also include data on motor starting and no-load characteristics.

Motor horsepower shall be sufficient so that the pump is non-overloading throughout its entire performance curve, from shut-off to run-out. The motor and cable shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 65 feet or greater.

BEARINGS
The integral pump/motor shaft shall rotate on two bearings. The motor bearings shall be sealed and permanently grease lubricated with high temperature grease. The upper motor bearing shall be a two row angular contact ball bearing to handle radial loads. The lower bearing shall be a two row angular contact ball bearing to handle the thrust and radial forces. The minimum L_{10} bearing life shall be 50,000 hours at any usable portion of the pump curve.

MECHANICAL SEALS
Each pump shall be provided with a positively driven dual, tandem mechanical shaft seal system consisting of two seal sets, each having an independent spring. The lower primary seal, located between the pump and seal chamber, shall contain one stationary and one positively driven rotating corrosion and abrasion resistant tungsten-carbide ring. The upper secondary seal, located between the seal chamber and the seal inspection chamber shall be a leakage-free seal. The upper seal shall contain one stationary and one positively driven rotating corrosion and abrasion resistant tungsten-carbide seal ring. The rotating seal ring shall have small back-swept grooves laser inscribed upon its face to act as a pump as it rotates, returning any fluid that should enter the dry motor chamber back into the lubricant chamber. All seal rings shall be individual solid sintered rings. Each seal interface shall be held in place by its own spring system. The seals shall not depend upon direction of rotation for sealing. Mounting of the lower seal on the impeller hub is not acceptable. Shaft seals without positively driven rotating members or conventional double mechanical seals containing either a common single or double spring acting between the upper and lower seal faces are not acceptable. The seal springs shall be isolated from the pumped media to prevent materials from packing around them, limiting their performance.

Each pump shall be provided with a lubricant chamber for the shaft sealing system. The lubricant chamber shall be designed to prevent overfilling and shall provide capacity for lubricant

expansion. The seal lubricant chamber shall have one drain and one inspection plug that are accessible from the exterior of the motor unit. The seal system shall not rely upon the pumped media for lubrication.

The area about the exterior of the lower mechanical seal in the cast iron housing shall have cast in an integral concentric spiral groove. This groove shall protect the seals by causing abrasive particulate entering the seal cavity to be forced out away from the seal due to centrifugal action.

A separate seal leakage chamber shall be provided so that any leakage that may occur past the upper, secondary mechanical seal will be captured prior to entry into the motor stator housing. Such seal leakage shall not contaminate the motor lower bearing. The leakage chamber shall be equipped with a float type switch that will signal if the chamber should reach 50% capacity.

PUMP SHAFT
The pump and motor shaft shall be a single piece unit. The pump shaft is an extension of the motor shaft. Shafts using mechanical couplings shall not be acceptable. The shaft shall be stainless steel – ASTM A479 S43100-T. Shaft sleeves will not be acceptable.

IMPELLER
The impeller shall be of Hard-Iron™ (ASTM A-532 (Alloy III A) 25% chrome cast iron), dynamically balanced, semi-open, multi-vane, back swept, screw-shaped, non-clog design. The impeller leading edges shall be mechanically self-cleaned automatically upon each rotation as they pass across a spiral groove located on the volute suction. The leading edges of the impeller shall be hardened to Rc 60 and shall be capable of handling solids, fibrous materials, heavy sludge and other matter normally found in wastewater. The screw shape of the impeller inlet shall provide an inducing effect for the handling of up to 5% sludge and rag-laden wastewater. The impeller to volute clearance shall be readily adjustable by the means of a single trim screw. The impeller shall be locked to the shaft, held by an impeller bolt and shall be coated with alkyd resin primer.

VOLUTE / SUCTION COVER
The pump volute shall be a single piece gray cast iron, ASTM A-48, Class 35B, non-concentric design with smooth passages of sufficient size to pass any solids that may enter the impeller. Minimum inlet and discharge size shall be as specified. The volute shall have a replaceable suction cover insert ring in which are cast spiral-shaped, sharp-edged groove(s). The spiral groove(s) shall provide trash release pathways and sharp edge(s) across which each impeller vane leading edge shall cross during rotation so to remain unobstructed. The insert ring shall be cast of Hard-Iron™ (ASTM A-532 (Alloy III A) 25% chrome cast iron) and provide effective sealing between the multi-vane semi-open impeller and the volute housing.

PROTECTION
Each pump motor stator shall incorporate three thermal switches, one per stator phase winding and be connected in series, to monitor the temperature of the motor. Should the thermal switches open, the motor shall stop and activate an alarm. A float switch shall be installed in the seal leakage chamber and will activate if leakage into the chamber reaches 50% chamber capacity, signaling the need to schedule an inspection.

The thermal switches and float switch shall be connected to a Mini CAS control and status monitoring unit. The Mini CAS unit shall be designed to be mounted in the pump control panel.

MODIFICATIONS

1. Explosion-proof Pumps (X).
2. Warm Liquid Applications (WL) available with standard motor.

Refer to the General Guide Specifications for additional information.

Designed and engineered for longer life

Flygt specially designs and manufactures N-pump components, such as the motor, seals and shaft, to optimize operation and prolong pump service life.

Motor

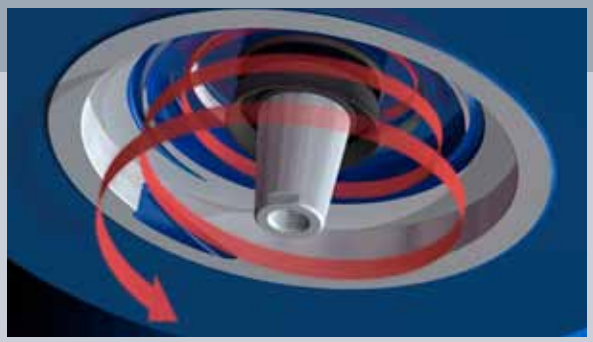
The Class H squirrel-cage induction motor delivers outstanding performance and superior heat transfer in submersible and dry installations. Heat losses are concentrated around the shrink-fitted stator, which is cooled by means of the surrounding water. The motor has a NEMA Class B maximum operating temperature rise of 80°C (176°F) to ensure long service life. Prepared for variable speed operation, all motors are capable of fully utilizing the available power.

Long-life seals

Durable tungsten carbide seals offer exceptional mechanical strength as well as superior sliding properties even when running dry. These low-friction seals withstand thousands of hours of high-pressure operation under extreme conditions without cracking, seizing up or showing signs of unacceptable wear.

Low shaft deflection

To minimize vibration, promote quiet operation and prolong seal and bearing life, all Flygt N-pumps feature a short shaft overhang to reduce shaft deflection.



Spin-out™ seal protection for pumps with cavities in the seal chamber

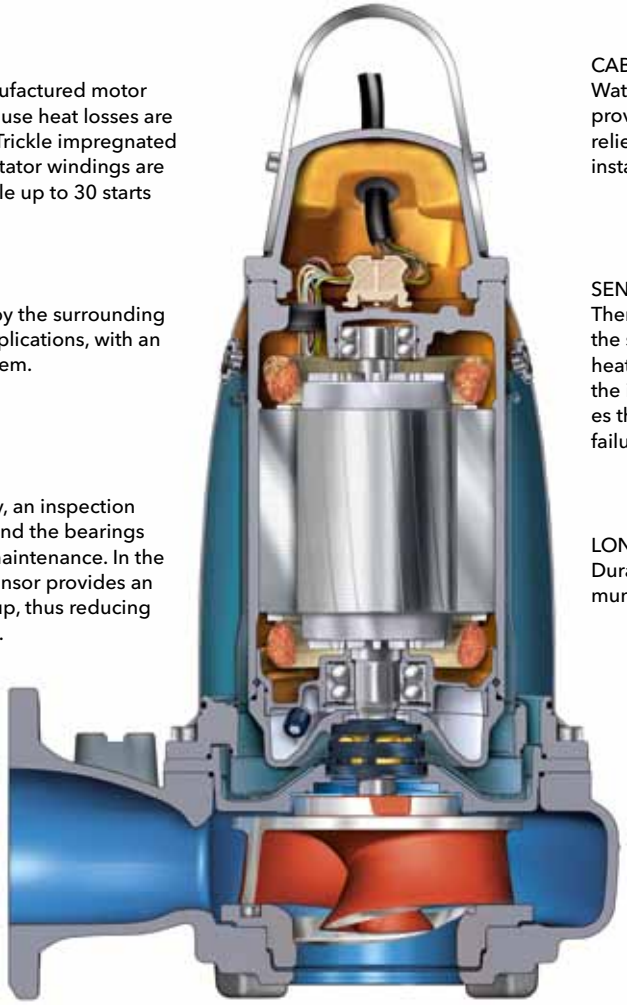
The patented Spin-out™ design expels abrasive particles from the seal chamber, providing protection against wear of the outer seal. As an integral part of the seal chamber, Spin-out™ is as simple as it is effective.

BETTER HEAT TRANSFER
Our specially designed and manufactured motor provides enhanced cooling because heat losses are concentrated around the stator. Trickle impregnated in resin (Class H insulation), the stator windings are rated at 180°C (355°F) and enable up to 30 starts per hour.

EFFICIENT COOLING
These pumps are cooled either by the surrounding liquid or, in more demanding applications, with an internal closed-loop cooling system.

INSPECTION CHAMBER
To increase operational reliability, an inspection chamber between the seal unit and the bearings enables rapid spot checks and maintenance. In the case of a seal failure, a built-in sensor provides an early warning of any fluid build-up, thus reducing the risk of expensive repair work.

COMPLIANCE
Each pump is tested and approved in accordance with national and international standards, including IEC 34-1 and CSA. Pumps are available in explosion-proof versions for use in hazardous environments, and are approved by the Factory Mutual, European Standard and IEC.



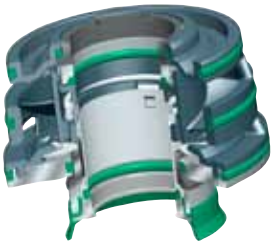
CABLE ENTRY
Water-resistant cable entry provides both sealing and strain relief functions to ensure a safe installation.

SENSORS
Thermal sensors embedded in the stator windings prevent overheating, and a leakage sensor in the inspection chamber minimizes the risk for bearing and stator failure.

LONG-LIFE BEARINGS
Durable bearings provide a minimum service life of 50,000 hours.

ENDURING SEALS
The Flygt Plug-in™ seal with the Active Seal™ system offers increased sealing reliability and zero leakage into the motor, thereby reducing the risk of bearing and stator failure.

Flygt Plug-in™ seal with Active Seal™ system



Inner seal with laser-cut spiral grooves.

The Flygt Plug-in™ seal is a seal unit that eliminates the risks associated with incorrect installation and careless handling. It comprises the Active Seal™
system in one easy-to-handle unit.

The Active Seal™ system is a patented zero-leakage double-seal system that actively prevents liquid from entering the motor cavity, thereby reducing the risk for bearing and stator failure. It comprises a unique inner seal that acts as a micro-pump and an outer seal that prevents leakage of pumped media into the buffer chamber.

Laser-cut grooves on the inner seal create a hydrodynamic pumping effect that prevents any leakage from entering the motor.

This translates into enhanced sealing reliability, reduced downtime and fewer unscheduled maintenance checks. In addition, regular service inspections can be prolonged in many applications.

1. Introduction

Calculating hydraulic, dynamic and electrical forces and assessing the environment in which the product will work is a very complex process. Through years of field experience and experimentation in research laboratories, Flygt has developed computerized methods for calculating forces and the outcome of the forces applied to the rotating system of a pump or mixer. This is essential for the design of the rotating system including shaft, rotor, seals and impeller/propeller, and for the selection of bearings with adequate bearing life.

Bearings are one of the key components that determine the service interval for rotating machinery; they can even limit the life of the machine. Therefore, knowledge and understanding of bearings are important to both designers and users. In selecting the bearing to be used, one must consider a variety of factors:

- Loads, maximum and minimum, static and dynamic.
- Speed and running pattern.
- Stiffness.
- Temperature levels and gradients, heat conduction.
- Lubrication: viscosity, stiffness, durability.
- Degree of contamination. Shielding.
- Mounting.
- Maintenance.
- Lifetime and service time.

A bearing selection or analysis is futile without rotor dynamic data from the shaft and other rotating parts. A correctly dimensioned shaft is fundamental and there are many criteria that need to be fulfilled:

- Magnetic behaviour, especially for 2-pole motors.
- Fatigue durability.
- Limited deflection for impeller, seal and rotor positions.
- No natural frequencies of the rotating system close to rotational speed.
- Low impact on the surroundings regarding vibration.
- Limited angular displacement at bearing positions.
- Temperature conduction to ensure suitable bearing temperature.

Some of the items above improve with a larger shaft and some with a smaller shaft.

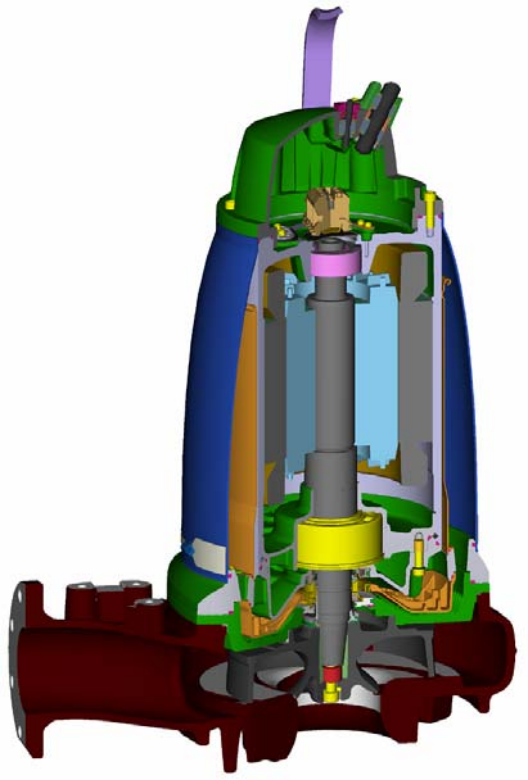


Figure 1. A midrange sewage pump showing the typical layout of a Flygt product.

To ensure the long life of a product, many factors have to be taken into account. A poor installation with unfavorable inlet conditions, unfavorable duty points, bad anchoring, etc., can cause structural disturbances that may be detrimental. Natural frequencies in the structure from poorly designed support of the pump, pipes or valves often cause high vibration levels. Those matters are not covered in this booklet; see Reference 1 for additional information.

This booklet describes some of the knowledge and experience that Flygt has acquired, including precautions to observe when designing and analysing the shaft and bearings.

2. Causes of failure

In order to properly dimension the rotating system, potential causes or modes of failure have to be determined. Most failures are due to unpredictable factors. The cure for these failures is to create a robust design that can cope with the unknown. Predictable failures or lifetimes can be calculated, although many parameters will vary and statistical considerations have to be taken into account.

2.1 Shaft

The shaft is designed to have an infinite life. This will be the case unless the shaft is overloaded or damaged.

2.1.1 Fatigue crack

The cause of a broken shaft is usually fatigue. A crack may start at a stress concentration at a keyway or a sharp radius, or in rare cases, from a material impurity. Flaws in the surface of a shaft, such as scratches, indents or corrosion, may also be the starting point of a fatigue crack. Loads that drive a crack are normally torsion loads from direct online starts or bending loads from the hydraulic end.

2.1.2 Plastic deformation

Plastic deformation can only occur in extreme load cases when debris is squeezed into a radial clearance that results in large deformations.

2.1.3 Shaft defects

Shaft defects that have gone unnoticed during factory checks for unbalance as well as the check during testing are very rare. On site, however, it is important to prevent damage from corrosion, indents etc., by proper handling.

2.2 Joint

A poorly designed joint between the shaft and impeller can be detrimental for the system during both installation (high mounting forces, impacts) and operation.

2.2.1 Loose connection

A loose connection can cause impacts that generate high loads and damage to the shaft and/or impeller. It is essential to tighten the bolt(s) correctly with the proper torque and lubricate with appropriate lubricant. With conical joints, lubrication is of great importance to the conical sleeve or the conical part of the impeller as it rises on the shaft and creates the necessary pressure to enable the holding force.

2.2.2 Misaligned connection

This is normally hard to achieve, but it may occur with incorrect mounting.

2.3 Bearing

A roller bearing does not last forever. Sooner or later fatigue, wear, or lubricant deterioration will ultimately destroy the bearing's ability to function properly. Causes of bearing failure are listed below in order of likelihood.

2.3.1 Penetrating fluid or particles

Cleanliness is essential for good performance. Particles generate high stresses in the bearing components and create premature fatigue failure. Particles also generate wear that shortens life. Particles, especially light alloy particles like zinc, may act as catalysts for the grease and create premature aging. Consequently, Nilos rings must not be used!

If a fluid enters the bearing, contact with the rolling elements will cause the fluid to act as a jet and force the grease out from the raceway. If the fluid is oil with just a tiny amount of water (0.1%), the bearing's lifetime is ruined even if it is flooded with that oil. Furthermore, the fluid may also cause corrosion.

2.3.2 High temperature or gradient

High temperatures due to inadequate cooling or too much generated heat can be identified (if the bearing is not totally ruined) by darkened grease and a feeling of carbon particles dissolved in oil. If synthetic oil is used, it may have polymerized and created a lacquer layer on the surface, mainly seen in oil lubrication. A bearing that has been overfilled with grease may also overheat.

If the temperature is just slightly higher than allowed, the signs are not so obvious. However, the lifetime will be reduced due to lower viscosity and faster degradation of the lubricant. Cages with plastic material will also age faster at increased temperatures. The normal temperature limit for a Flygt product is 90°C, but peak temperatures up to 120°C are allowed.

If too much heat is generated, perhaps from overload but having adequate cooling, then the gradient over the bearing can be too high, generating a preload that can destroy the bearing. A correct internal bearing clearance is vital.

2.3.3 Incorrect mounting

Improper mounting in the field causes a high amount of bearing failures. Precautions that must be taken include:

- Keep everything clean and protected from corrosion during mounting and storage.
- Do not overheat. The max temperature is 150°C for very short periods. The bearing is stabilized to a certain temperature and temperatures above this may alter the

internal structure of the material, although it takes some time. The cage may also be damaged if subjected to overheating.

- Use suitable tools. Avoid mounting in a way that the mounting force goes through the rolling element which may cause indentations and destroy the bearing.
- Use the correct grease or oil and do not overfill. Bearing lifetime is calculated with a specific lubricant. Note that different greases or oils should not be mixed as the result may be disastrous.
- Use the correct bearing as specified by Flygt. Standard bearings may have improper lubricants, clearances, angles or be unsuitable in other ways.
- Always follow the Flygt guidelines.

2.3.4 Shock loads from handling

Shock load may be transmitted from mounting of other parts, i.e. impeller, or during transport and installation.

2.3.5 Vibration at standstill

During operation, the bearing can withstand rather high vibration. Normally 25 mm/s rms does not have a significant effect on the lifetime. The grease though may be "shaken" away depending on installation and grease type. At standstill, the allowable levels are much lower as false brinelling may occur at levels as low as 7 mm/s rms. Poor installation of piping, stands, etc., may cause harmful vibration levels in stations with more than one pump.

2.3.6 Low load with stiff grease

Surfing occurs when the rolling elements ride irregularly (not spinning) in the unloaded zone and are forced to spin in the loaded zone, and thereby create a skid mark in the rolling surface. Preloaded bearings by weight or springs can overcome this. Oversized bearings have higher risk of surfing.

2.3.7 Electrical current

Large electric motors and motors driven by low quality frequency drives may suffer from stray current. Other equipment such as welding machines may also create stray current. Some of Flygt's larger motors have a ceramic coating on the outer ring of the bearing to avoid this problem. The current does not always ruin the surfaces; however, the grease can be destroyed in a short period of time and create a failure.

2.3.8 Fatigue

The calculated lifetime of a bearing, defined as the time to the first sign of pitting or scaling (not a total failure), is dependent on the number of revolutions, the load and the lubrication. Initial fatigue damage, in the form of small cracks, results from cyclic shear stresses that are highest just below the surface. The cracks then propagate up to the surface. As the rolling elements pass over these cracks, small fragments will finally break off (scaling). The calculated lifetime varies in a statistically known probability according to the Weibull distribution gathered from many tests.

2.3.9 Defective bearing, housing or shaft

Defective bearings are extremely rare nowadays. Shafts and the bearing housings from the factory are also very rarely out of tolerance, and it is even more unlikely that they will be shipped to a customer. It is very important that the mounting is correct so that uneven tightening of bolts does not ruin the tolerance.

2.4 Failure detection

Depending on the customer's philosophy regarding service and maintenance, there are several ways to act on a failure indication. The simplest approach is to operate until total disaster. Another approach is to perform preventive maintenance at recommended intervals to (hopefully) avoid any failure. The most advanced approach is to use sensors and analyzing tools to spot early signs of faults and act when needed. Listed below are possible indications:

- **Noise**. You can hear severe damage. You can amplify the noise by placing a screwdriver or a wooden rod in contact with the machine and your ear. Be aware though, that all bearings create some noise, especially during start up while the clearance is still at its nominal value. When the machine is warm, the noise is normally lowered.
- **Vibration**. Vibrations caused by loose parts contain many frequencies and can be hard to separate from the noise of cavitation and debris in pumped media. Vibration caused by a defective bearing can only be detected with sophisticated tools, and even then it is difficult to identify if you do not have the vibration pattern of a good operating condition with the actual bearing for comparison. Condition monitoring (with acoustic emission, see-technique, etc.) is a good tool if you are able to measure the vibration close to the bearing and if you set up individual limits for different running conditions. Vibration from a damaged bearing close to failure or a loose part may be spotted by simpler vibration measure devices. This can be used to stop the machine before total breakdown.
- **Temperature**. Temperature measurements are unable to detect defective bearings. In some

cases you may see a temperature rise just before breakdown. In rare cases, trend measurements of temperatures may sometimes give information that indicates a malfunction due to increased heat generation in the bearing.

3. Geometry Modelling

Simplified geometrical models of the rotating system are needed to perform the calculations. Only the mechanical model is discussed here. Heat transfer models, structural models involving the entire pump and connected items, and electrical models are not mentioned in this booklet.

3.1 Shaft

The geometry of the total shaft is made of pipe segments with or without a hole. No asymmetrical parts are allowed. Each segment has its modulus of elasticity and density. Each segment can also have an extra added mass and diametrical moment of inertia to simulate mass with no stiffness. Figure (3.1) shows a modelled shaft with concentrated and distributed load marked.

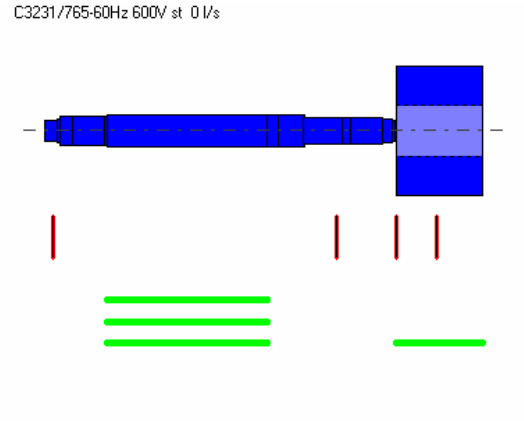


Figure 3.1. A shaft model as seen in program AXEL with marked loads.

3.2 Rotor

The rotor has to be modelled as a shaft part as above. The mass and inertia of a rotor can easily be calculated or measured. The stiffness of the rotor is more difficult to get. To measure the stiffness, it is important to have deflections in the region of an actual rotor. Deflections that are too small, like the ones you get by pounding on the rotor with a hammer and then measuring the frequency response with an accelerometer, will result in a stiffness that is too high. From extensive measurements at Flygt (rotors from 2 kg to 2000 kg), equation (3.2) gives the stiffness equivalent diameter *de*.

$$de = d \cdot \left(1 + \frac{Eer}{Ea} \left(\frac{Eesp}{Eer} \cdot \left(\frac{dy}{d} \right)^4 + \left(1 - \frac{Eesp}{Eer} \right) \cdot \left(\frac{di}{d} \right)^4 - 1 \right) \right)^{.25}$$

de = stiffness equivalent diameter (3.2)
d = shaft diameter
di = rotor core diameter
dy = rotor diameter
Ea = shaft modulus
Eer = equivalent core modulus
Eesp = equivalent slot modulus

This is calculated in the Flygt program ROTOR.

3.3 Impeller/Propeller

The stiffness of the impeller is easier to model since it is so stiff that it is accurate enough just to assign a high value here. The mass and inertia are normally taken from the cad part and the lack of symmetry is normally of less importance.

3.4 Bearing

In most cases, it is adequate to model the bearing as a stiff support in Flygt products. If the bearing housing is radially weak or the bearing stiffness is of importance, this can be simulated by a spring with suitable stiffness. In the case of a bearing that can take some bending and the shaft angle is more than about 4 angular minutes, this technique is to be used. The stiffness of a bearing is load dependent. Therefore, in linear analysis some runs are necessary to achieve the correct stiffness. See Figure (3.3).

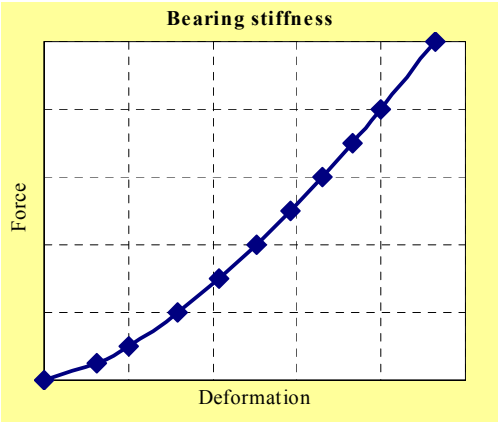


Figure 3.3. The non-linear behavior of a typical ball bearing.

4. Loads

Different loads act on the rotating system and there is a lot of work and experience involved in achieving accurate forces. Moreover, without accurate forces sophisticated rotor dynamic

analyses are of little value and lifetime calculations are futile.

4.1 Hydraulic forces

The calculation of hydraulic forces is part of a package containing an extensive set of computer programs used in the design and calculation of the hydraulic components. The programs have been verified by extensive testing in Flygt's RD&E laboratories. See Reference 3. To investigate further details of flow pattern, using CFD software is helpful, as described in Reference 4.

4.1.1 Radial pumps

The axial force from an impeller is normally directed towards the inlet as the pressure is lower there than on the back of the impeller, especially for open impellers. Sometimes large flows may create axial forces that shift direction, a situation to be avoided since it may have a harmful influence on the bearings.

Radial forces caused by the impeller and volute are at their minimum at nominal flow since the pressure distribution and internal flow are most favorable there. See Figure (4.1.1). Since these forces are the dominating ones in many cases, it is very important to ensure that the duty point is satisfactory. The frequency of the dynamic force is determined by the number of vanes. Single vane impellers create large dynamic forces.

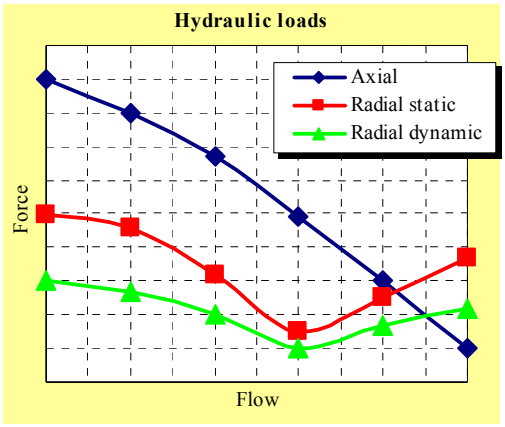


Figure 4.1.1. The radial hydraulic forces from the impeller reach a minimum at nominal flow.

4.1.2 Axial pumps and mixers

For mixers and axial pumps without volutes, the radial forces are smaller and normally neglected. The axial force or thrust, may cause a bending moment if there is a skewed inflow. Equations (4.1.2) give:

$$Mb = F \cdot A \cdot \frac{kd}{2} \text{ if} > 2 \text{ blades}$$
$$Mb = F \cdot A \cdot kd \text{ if 2 blades} \qquad (4.1.2)$$
$$A \approx \frac{D}{3} \text{ for a large propeller}$$

Mb = bending moment
F = thrust
A = radius to axial force on blade
Kd = skew factor
D = propeller diameter

A skew factor of 1 indicates that one blade has twice the normal force in one position and no force in another. A normal value to use for mixers is 1/3.

4.2 Motor forces

The value of the magnetic effects in the motor as well as torque and speed data during start are obtained from software handling motor calculations and from Flygt's RD&E laboratories.

4.2.1 Axial

The axial force from skewed rotor bars is normally negligible compared to other forces.

4.2.2 Radial

The magnetic field surrounding the rotor in the motor produces a radial force if any eccentricity is present. The magnetic force is expressed as:

$$F = dmp \cdot C \cdot \varepsilon \cdot f(\varepsilon)$$
$$\varepsilon = \frac{e+u}{Lg} \qquad (4.2.2)$$
$$C = K \cdot L \cdot D$$

F = force
dmp = damping
C = unbalanced pull
ε = relative eccentricity
$f(\varepsilon)$ = non-linear part
e = eccentricity
u = deflection
Lg = air gap
K = factor including magnetic flux parameters
L = length of rotor
D = rotor diameter

The non-linear behavior causes the force to be very large at high eccentricities. If ε is less than 0.3, the non-linear part is negligible, and if it is less than 0.5, it is small. The value K can be estimated as 0.2 MPa for 2-pole motors, and as 0.4 MPa in all other cases. The damping value is normally smaller than 0.3. The air gap to use is the magnetic gap that at small eccentricities is equal to the physical gap. However, at high magnetic flux, as at high

eccentricities and small physical gaps, the magnetic gap is larger.
The magnetic force is divided into two parts: One is dependent on eccentricity (e) and the other depends on the displacement, like a spring but with force and displacement in the same direction. That is, if the air gap is smaller on one side than on the other, the magnetic flow will pull the rotor in the direction of the smallest gap. The Flygt program ROTOR handles this calculation.
To get both the static and the rotating eccentricity, many tolerances have to be added together. To get a representative value of the eccentricity in both ends of the rotor, the tolerances with their maximum values are added to form a quadratic sum. This is done with the Flygt program EXCENT.

4.2.3 Torque

The dimensioning torque for a typical Flygt product comes from direct-on-line start. Figure (4.2.3) shows torque curves from a start.

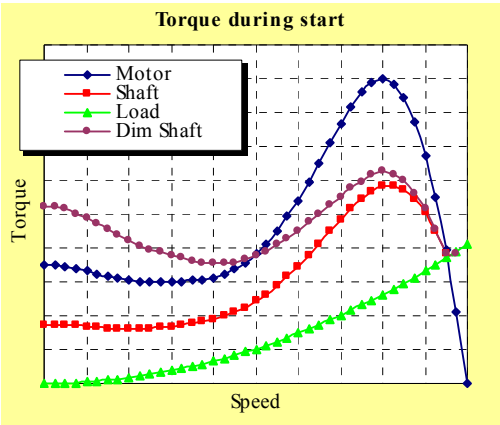


Figure 4.2.3. The torque curves during direct on line start.

The motor curve and the shaft curve are the nominal ones; the actual curve has disturbances of an electrical nature that give high peaks during the start sequence. The dimensional shaft curve has been modified to cope with this. The load curve is quadratic which is normal for a pump curve. Equation (4.2.3) shows how the nominal shaft curve can be calculated:

$$M_a = M_l + \frac{i^2 \cdot J_l}{J_m + i^2 \cdot J_l} \cdot (M_m - M_l) \qquad (4.2.3)$$

M_a = shaft torque
M_l = torque of load
i = gear ratio (if any)
J_l = polar inertia of load
J_m = polar inertia of motor

This is done for each speed during start and the highest value of the dimensional shaft curve is used. The Flygt program MOMENT is used for this.

4.3 Mass forces

If the rotating system is exposed to high vibration levels, then mass forces are to be added. If the vibration levels emerge from the rotating system, then the mass forces may cause lower reactions, all depending on the dynamic behaviour of the entire installation with housing, anchoring, piping, etc. These phenomena are not covered here.

4.3.1 Weight

The static force from the weight is comparably low and is beneficial for the bearing in order to ensure a minimum load.

4.3.2 Unbalance

The unbalance of the rotor and impeller causes radial forces when the machine is rotating. The maximum allowed unbalance is used in the calculation. The force is calculated as:

$$F = Ub \cdot \omega^2 \qquad (4.3.2)$$

F = force
Ub = unbalance
ω = rotational speed

This force is distributed over the length of the part, and if it acts in two planes (dynamic balancing), the values are added to form a vector sum.
The unbalance value is normally according to ISO 1940 G6.3, but higher values are permitted for components if the product in another design contains rotating components of larger mass or inertia. Higher values can also occur if the rotating parts have a minor effect on the product or its surroundings. The allowed unbalance value is divided between two planes if motivated by the geometry of the part.

4.4 Thermal influence

A thermal analysis provides the temperature distribution needed to get the elongation of the shaft and the temperature and temperature gradient over the bearings. Elongation is used for the calculation of the axial spring force of axially preloaded bearings or the required tolerance for the expansion. Bearing temperatures are required for the calculation of correct fit and clearance, as well as the lifetime calculation. The thermal condition may even require a larger size of the bearing due to the heat transfer capabilities rather than the load carrying capabilities. Thermal calculations are made using the Flygt program HEATS SP that is

described in Reference 2 and the outcome is shown in Figure (4.4).

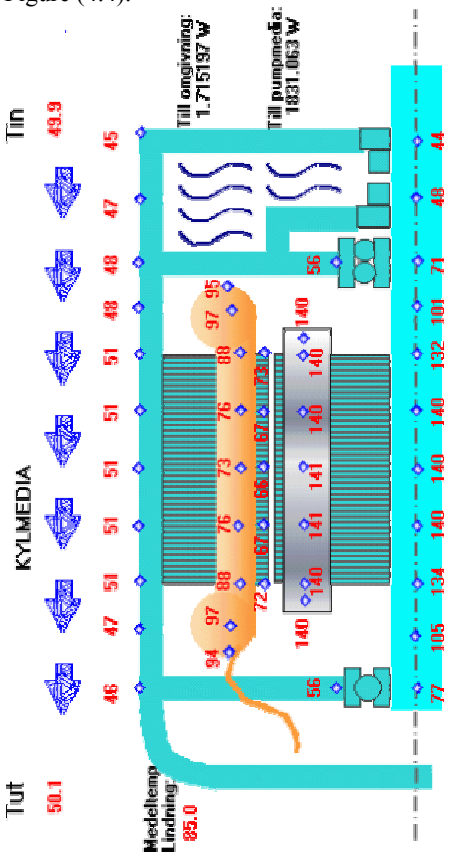


Figure 4.4. An example of the temperature distribution of a Flygt motor.

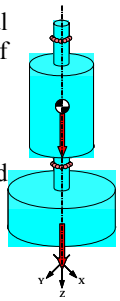
5. Load cases

From the calculated forces, one can define load cases that represent different types of analyses. In this section, the forces are collected and applied to get a base for further calculation. This is a generalized description; there may be more forces not mentioned here from such things as gears, for example.

5.1 Axial

Normally there are no dynamic axial forces of importance. Forces of importance are:

- Axial hydraulic force or thrust.
- Weight (if vertical)
- Spring forces from preloaded bearings.



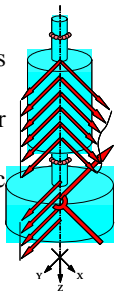
5.2 Radial

There are three main types of radial loads: Static, rotating with shaft, and rotating with blade pass frequency. To be accurate, the last force is not truly rotating, but for the purpose of shaft analysis it is a sufficient approximation. Several of these loads differ from one unit to another and their direction is undeterminable. To cope with this variability, we use maximum values (of tolerances, for example) and add them to form a quadratic sum. In addition, they should be combined to give a representative picture of a typical load case. The general procedure at Flygt is to have 90° between two consecutive loads and always between the two major ones, as shown in the figures. This technique ensures that most units have lower load levels than the calculated ones, and it also gives a standardized way of handling the unknown factors.

5.2.1 Static

Forces of importance (their directions are shown in the picture):

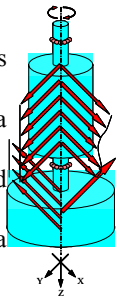
- Hydraulic force from volute or torque from propeller.
- Magnetic pull from an eccentric rotor.
- Magnetic "spring".
- Weight (if horizontal)



5.2.2 Rotating

Forces of importance (their directions are shown in the picture):

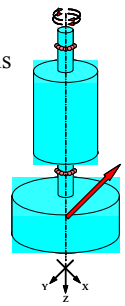
- Hydraulic force from impeller (if a single vane impeller).
- Unbalance from rotor and impeller/propeller.
- Magnetic pull from eccentricity by a bent rotor or play in bearings etc.
- Magnetic "spring".



5.2.3 Blade pass

Forces of importance (their directions are shown in the picture):

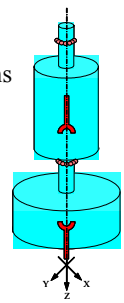
- Hydraulic force of impeller.
- Magnetic "spring".



5.3 Torsion

Forces of importance (their directions are shown in the picture):

- Motor torque.



- Polar inertia during acceleration.
- Hydraulic torque.

6. Shaft calculations

To handle the radial loads and rotor dynamics, we normally use a software package, AXEL, developed at Flygt. The program uses a finite difference method. In the calculation, the symmetrical shaft is split into increments. The variables (displacement, angular displacement, moment and shear force) at one side of each increment are expressed in terms of the same variables on the other side of the increment in conjunction with an incremental transfer matrix. Loads of different types and bearings have their own transfer matrices in which the increment size is zero. All matrices are multiplied to obtain a total transfer matrix. This process is repeated successively; that is, the matrix is updated for each increment and each load. The matrix can then be assembled in accordance with the boundary conditions at the end of the shaft (if internal boundaries, then sub matrices have to be saved for later use). The remaining boundary variables are solved, and then all unknown variables in between the boundaries can be evaluated by means of the same technique based on the updated transfer matrix (using the saved sub matrices if internal boundary conditions exist). Natural frequencies are found when the determinant of the total matrix shift sign while stepping the frequencies. Since natural frequencies are load independent and no damping is involved, the matrices are somewhat simpler. The torsion natural frequencies are also handled by this software. For calculation of deflections, stresses, etc., each load case, with its rotational speed, has to be calculated with the actual shaft rotation. Only in the load case that rotates with shaft speed are both load and shaft rotation equal.
Axial and torsion calculations are comparatively simpler and can consequently be made with simpler tools.

6.1 Natural frequencies

It is essential to avoid natural frequencies that coincide with the frequencies of disturbance forces since the dynamic deformations are amplified dramatically close to a natural frequency. The influences of the damping set the limit close to natural frequencies and are of limited importance elsewhere, as shown in Figure (6.1) of the response function.

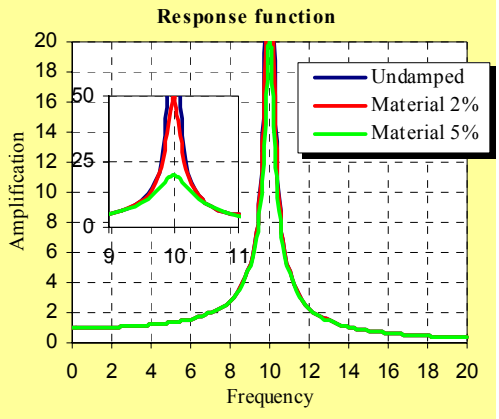


Figure 6.1. The response functions around a single critical frequency for different damping. Max value for 2% damping is 50 and for 5% 20.

Damping values for steel are around 1%, and the damping for the entire rotating system at normal displacement is higher, roughly up to 5%. With pumps there is also some viscous damping (reaction force linear to velocity). The relation is expressed in Equation (6.1).

$$\Phi = \frac{1}{\sqrt{\left(1-\frac{\omega^2}{\omega_{cr}{}^2}\right)^2+\eta^2}} \qquad (6.1)$$

$$c = \eta \cdot \frac{K}{\omega}$$

Φ = amplification
ω = frequency
ω_{cr} = critical frequency
η = material damping
c = viscous damping
K = Static stiffness at position of damping

The peak is flattened in a real application due to non-linearity and the picture is more complex due to the influence of other mode shapes and frequencies.

6.1.1 Axial

Axial natural frequencies are normally very high and of no practical interest.

6.1.2 Bending

Bending natural frequencies are hard to calculate by hand, and furthermore these are of most interest as they normally are the lowest ones. In the program AXEL, a frequency range is scanned and the selected amount of the lowest natural frequencies is calculated. Flygt products have at least a margin of 30% between the rotational speed and the first natural frequency of the rotating

system. The presented natural frequencies are calculated with load and shaft rotating with equal speed.

6.1.3 Torsion

Torsion frequencies are calculated with the AXEL program, but as a rough check of the first mode Equation (6.1.2) may be used

$$\omega_{kr} = \sqrt{\frac{G \cdot K}{L} \cdot \left(\frac{1}{J_M} + \frac{1}{J_L} \right)} \qquad (6.1.2)$$
$$G = \frac{E}{2 \cdot (1 + \nu)}$$

ω_{cr} = critical frequency, torsion
K = torsion stiffness
L = length
G = torsion modulus
E = modulus of elasticity
ν = Poissons ratio
J_m = inertia motor
J_l = inertia load (impeller)

6.2 Reactions

To correctly design and dimension the boundary to the rotating system (bearings, housings, etc.) the reactions are needed.

6.2.1 Axial

The axial reaction is mainly static during run and is carried by the main bearing arrangement and its housing, except for spring preload if any. The load is the sum of forces from Section (5.1).

6.2.2 Radial

The radial reactions are a bit more complex as well as the load case shown in Section (5.2). Each radial load case has to be calculated and the reactions then have to be totalled. For bearing calculation, the static load case should be added to the sum of magnitudes for the dynamic load cases in the special way described in Section (7.1).

6.2.3 Torsion

Torsional reactions are taken by the stator and its housing, and the load is shown in Figure (4.2.3) with the addition of the electrical disturbances during start.

6.2.4 Global reactions

The rotating system is one of the major causes of reactions that are taken by the structure holding the pump or mixer. The axial reactions are those from axial loads from thrust or inlet conditions and disturbances and weight. The radial reactions from unbalances and unbalances caused by rotating displacement can be achieved from an unbalance calculation by the AXEL program. The program gives the unbalance data at start position of the shaft and they can be used to calculate forces acting on the base or as a part in estimating vibration levels. To get the forces from unbalance data, equation (6.2.4) can be used

$$F_x = \omega^2 \cdot Ub_x$$
$$z_x = \frac{DUb_{xz}}{Ub_x} \qquad (6.2.4)$$

F_x,F_y = forces in x and y direction
z_x,z_y = position of forces
ω = rotational speed
Ub_x,Ub_y = unbalance
DUb_{xz},DUb_{yz} = moment unbalance

More reactions that are global emerge from the created flow and pressure from the hydraulic end. The rotation reactions are those mentioned in the previous section and they give a start jerk that has to be considered. In this section, the focus on the rotating system is a bit vague and only the matters closely connected to the shaft calculation are covered with some depth.

6.3 Displacement

Even if a shaft can cope with rather large deflections, other components such as seals may fail if the deflections or angular deformations are too large.

6.3.1 Axial

The axial displacement is calculated according to Equation (6.3.1)

$$\delta = \int_L \left(\frac{F \cdot dL}{A \cdot E} + \alpha \cdot dL \cdot \Delta T \right) \qquad (6.3.1)$$

δ = displacement
F = force
L = length
E = modulus of elasticity
A = cross section area
α = thermal expansion coefficient
ΔT = temperature change

The integration or sum of parts with different temperatures, geometries or loads goes from the axial boundary condition that is normally fixed at the main bearing and axially free elsewhere. The axial displacement shall not cause any rotating part to interfere with the surroundings or be large enough to create problems for support bearings, seals, etc.
Parts of different geometry or load may be calculated separately and added together.

6.3.2 Radial

Radial deflection is calculated by the AXEL program. With two dynamic load cases, the deflection, if plotted for some position on the shaft, can look a bit odd as shown in Figure (6.3.2.1).

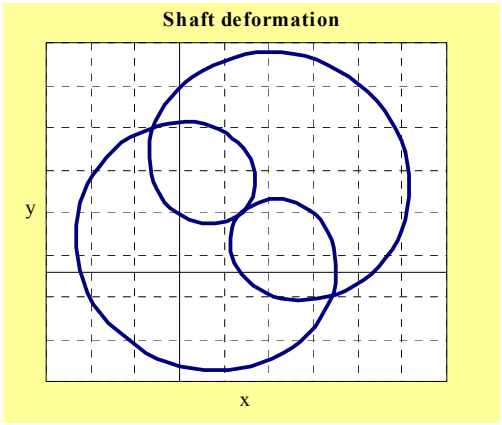


Figure 6.3.2.1. The deformation pattern of static, rotational and blade pass (3 blades) load cases with equal amplitudes and equal phase.

The detailed pattern is of less importance, and furthermore the phase is normally unknown. To cope with this, the amplitude of one of the two dynamic load cases is added to the amplitude of the other to form a maximum dynamic deflection. An example from AXEL is shown in Figures (6.3.2.2) to (6.3.2.4)

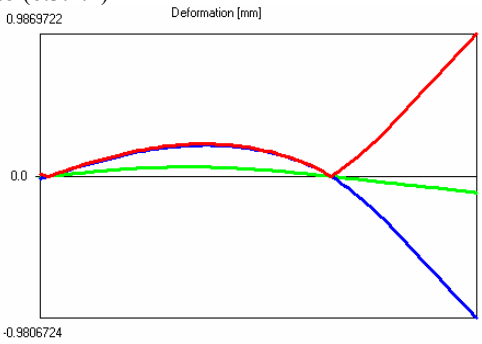


Figure 6.3.2.2. The deformation of the static run at one duty point. Red is magnitude and green and blue are x and y-data. Data from start to end of shaft.

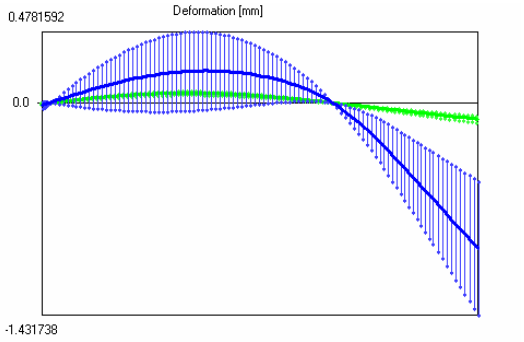


Figure 6.3.2.3. The deformation of the static run with the sum of the two dynamic runs superimposed at one duty point. Data from start to end of shaft.

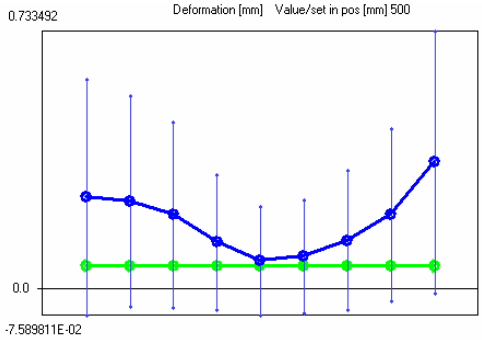


Figure 6.3.2.4. The deformation of the static run with the sum of the two dynamic runs superimposed in one position of shaft and at different duty points.

6.3.3 Torsion

Torsion displacement is of small practical interest in normal pumps with their relatively short shafts. If calculated, the Equation (6.3.3) gives:

$$\varphi = \frac{M_t \cdot L}{G \cdot K} \qquad G = \frac{E}{2 \cdot (1 + \nu)} \tag{6.3.3}$$

φ = angular motion
K = torsional stiffness
L = length
G = torsion modulus
E = modulus of elasticity
ν = Poissons ratio
M_t = torque

6.4 Stresses

The static and dynamic stresses of the shaft are needed to design the shaft accurately with respect to plastic deformation and fatigue.

6.4.1 Bending and Axial

The axial stress is calculated according to equation (6.4.1.1) and is normally comparatively small.

$$\sigma_d = \frac{F}{A} \qquad (6.4.1.1)$$

σ_d = axial stress
F = force
A = cross section area

The bending stress is calculated by AXEL and here the rotating loads are static relative to the shaft. To calculate the dynamic part, the static run and the blade pass run have to be added. The sum is created by adding the magnitude of the blade pass run to the static run. Note that this technique is only valid for calculation of maximum values and values to use for infinite life calculations. To get stresses to use in order to estimate crack propagation as a function of time, the load cases cannot be added in this way. An example from AXEL is shown in Figures (6.4.1.1) to (6.4.1.3)

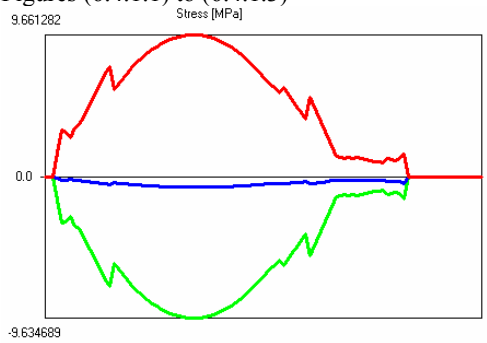


Figure 6.4.1.1. The bending stress of the rotating run in one duty point. Red is magnitude and green and blue are x and y-data. Data from start to end of shaft.

In the data shown in Figure (6.4.1.1), the magnitude of axial stress in the different positions of the shaft are to be added to form the maximum normal stress.

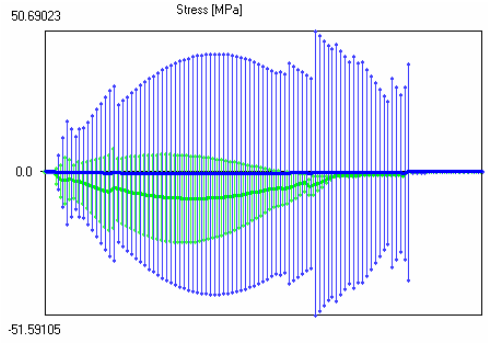


Figure 6.4.1.2. The bending stress of the rotating run with the sum of the static and blade pass runs superimposed in one duty point. x and y data only. Data from start to end of shaft.

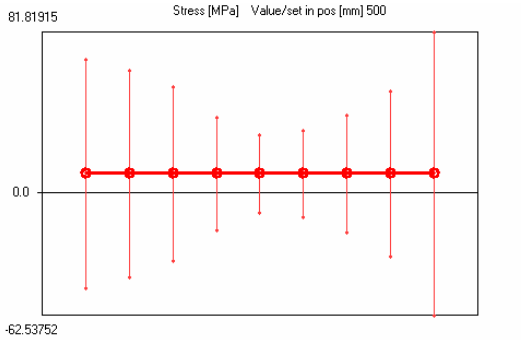


Figure 6.4.1.3. The bending stress of the rotating run with the sum of the static and blade pass runs superimposed in one position of shaft and in different duty points. Magnitude only.

All stresses shown and mentioned so far are nominal, that is, without the influence of stress concentration factors from sharp corners, keyways, etc. To get maximum tensile stresses, the concentration factors are needed as shown in Equation (6.4.1.2).

$$\sigma_1 = \sigma_d \cdot K_d + (\sigma_{b\,\mathrm{stat}} + \sigma_{b\,\mathrm{rot}} + \sigma_{b\,\mathrm{bp}}) \cdot K_b$$

σ_1 = max tensile stress (6.4.1.2)
σ_d = axial stress
$\sigma_{b\,\mathrm{stat}}$ = static bending stress
$\sigma_{b\,\mathrm{rot}}$ = rotating bending stress
$\sigma_{b\,\mathrm{bp}}$ = bending stress from blade pass
K_d = stress concentration, axial
K_b = stress concentration, bending

Stress concentration factors give high local stresses that may yield the shaft material locally, normally without harm. More harmful is their ability to form a starting point for a crack. Stress concentrations are normally lower than 3. If higher than 5, then fracture mechanics are more appropriate. Stress concentration factors can be found in many publications or can be determined with finite element analysis.

6.4.2 Torsion

The shear stress from torsion is calculated from Equation (6.4.2).

$$\tau_v = \frac{M_v}{W} \qquad (6.4.2)$$
$$\tau_1 = \tau_v \cdot K_v$$

τ_1= max shear stress
τ_v = shear stress
M = torque
W = section modulus
K_v = stress concentration, shear

The stress concentrations for torsion are normally lower than for bending.

6.4.3 Combination of stresses

To get an effective stress value to compare with material data, the von Mise stress criteria is best suited for shaft materials.

$$\sigma_e = \sqrt{\sigma^2 + 3 \cdot \tau^2} \qquad (6.4.3)$$

σ_e = von Mise stress
σ = tensile stress
τ = shear stress

6.5 Fatigue analysis

The method presented here is based on the construction of an idealized and linearized Haigh diagram, together with a Wöhler diagram (linearized as the logarithmic amplitude stress versus logarithmic number of cycles). Picture (6.5) shows this in a 3-D graph.

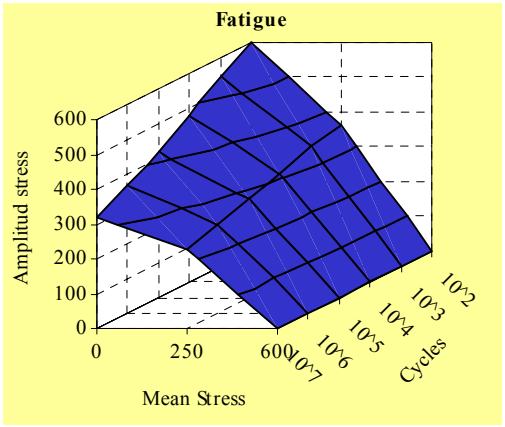


Figure 6.5. The combined and linearized Haigh and Wöhler diagram.

The linearization is essentially not a practical limitation since fatigue data do not normally have the highest degree of accuracy. The calculations are handled by the Flygt program FATIGUE.

6.5.1 Material

To create a Haigh diagram, the fatigue data of the material is needed, either from material specification or from tests. The parameters are:

- σ_b ultimate stress.
- σ_s yield stress.
- σ_u fatigue stress limit, alternate load at 10^{Nm} cycles.
- σ_{up} fatigue stress limit (amplitude) pulsating load at 10^{Nm} cycles.
- A_n Neuber radius.

If data does not exist, it may be estimated in a variety of ways such as from tables or from rules of thumb.

6.5.2 Reductions

If the fatigue data is taken from a test specimen, and not the statistically accurate tests of the actual component, then reductions have to be made. Reductions are made with three factors: C_l, C_d and C_s due to load, dimension and surface. If there is a stress concentration, the reductions are made with the help of a stress concentrations factor K_t and fatigue factor K_f and the dimension factor is then of less importance. The factors are described in more detail below:

C_l. Reduction due to load. If fatigue data and load case do not match, this factor is used. For example, if torsion load and material data for bending do not match, then C_l is 0.58 (and $\sigma_{up}=\sigma_u$). If tensile load and data for bending do not match, then C_l=0.85.

C_d. Reduction due to size. Normally close to 1. Statistically the risk of fatigue failure is larger the bigger the stressed volume is. See explanation of K_f in Equation (6.5.2.3). If no stress concentration and maximum stress is used, then Equation (6.5.2.1) may be used.

$$C_d = \frac{1 + \sqrt{\frac{2 \cdot A_n}{d}}}{1 + \sqrt{\frac{2 \cdot A_n}{10}}} \qquad (6.5.2.1)$$

d = characteristic size [mm]

C_d is 1 according to (6.5.2.1) if the size is equal to the size of the test specimen, normally 10 mm.

C_s. Reduction due to surface quality. A bad surface has more and worse starting points for a fatigue crack. Different machining and surface treatments give different C_s values, as well as the environment that the surface is exposed to. C_s may be larger than 1 from surface treatments. One example is to induce compressive stress into the surface by roller burnishing or shot peening. If a little crack of size A_n or smaller exists, then Equation (6.5.2.2) with crack depth a gives:

$$C_s = \frac{1}{\sqrt{1 + \frac{2 \cdot a}{A_n}}} \qquad (6.5.2.2)$$

The fatigue factor K_f can be determined in different ways. If the stress concentration factor K_t is given and nominal stress is used, then Equation (6.5.2.3) may be used and C_d is 1 (may be smaller if stressed volume is large).

$$K_f = 1 + q \cdot (K_t - 1)$$

$$q = \frac{1}{1 + \sqrt{\frac{A_n}{K_r}}} \qquad (6.5.2.3)$$

q = notch sensitivity factor
K_r = notch radius

If the stress distribution is known by FEA for example, the Equation (6.5.2.4) can give the fatigue factor.

$$K_f = \frac{1}{A_n} \cdot \int_0^{An} \frac{\sigma_{(r)}}{\sigma_0} dr \qquad (6.5.2.4)$$

σ_0 = max stress
$\sigma_{(r)}$ = stress perpendicular to path of crack propagation

That is, mean stress to the depth of A_n divided by max stress. Here K_f is smaller than 1 and max stress is given as load. C_d is 1 (may be smaller if stressed volume is large).

6.5.3 Haigh diagram

In the Haigh diagram in Figure (6.5.3), five different curves can be seen.

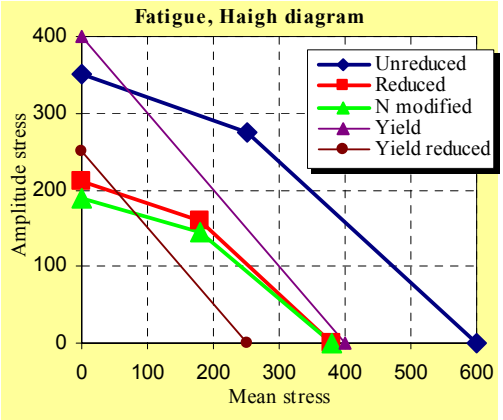


Figure 6.5.3. Haigh diagram

Curve 1, the unreduced curve is drawn from three points shown in Equation (6.5.3.1).

$$(0, \sigma_u)$$
$$(\sigma_{up}, \sigma_{up}) \qquad (6.5.3.1)$$
$$(\sigma_b, 0)$$

Curve 2, the reduced curve due to load, dimension, surface and stress concentrations are drawn from three points shown in Equation (6.5.3.2).

$$(0, \sigma_u \cdot C_l \cdot C_d \cdot C_s / K_f)$$
$$(\sigma_{up} \cdot C_l / K_t, \sigma_{up} \cdot C_l \cdot C_d \cdot C_s / K_f) \qquad (6.5.3.2)$$
$$(\sigma_b \cdot C_l / K_t, 0)$$

Curve 3, the curve modified due to number of cycles 10^N that differ from 10^{Nm} is drawn from three points shown in Equation (6.5.3.3).

$$(0, \sigma_f \cdot C_l / K_t \cdot \exp\left(\frac{N}{Nm} \cdot \log\left(\frac{\sigma_u \cdot C_l \cdot C_d \cdot C_s / K_f}{\sigma_f \cdot C_l / K_t}\right)\right)$$
$$(\sigma_{up} \cdot C_l / K_t, (\sigma_f - \sigma_{up}) \cdot C_l / K_t \cdot \exp\left(\frac{N}{Nm} \cdot \log\left(\frac{\sigma_{up} \cdot C_l \cdot C_d \cdot C_s / K_f}{(\sigma_f - \sigma_{up}) \cdot C_l / K_t}\right)\right)$$
$$(\sigma_b \cdot C_l / K_t, 0)$$
$$\sigma_f = \sigma_b \cdot \frac{1}{1 - \Psi} \qquad (6.5.3.3)$$

σ_f = true ultimate stress
ψ = reduction of area at rupture

An alternative to the true ultimate stress is to use the ordinary ultimate stress at 100 cycles. This is used in the FATIGUE program. Another alternative is to use the factor 0.9 at 1000 cycles.

Curve 4, the unreduced yield curve is drawn from two points shown in Equation (6.5.3.4).

$$(0, \sigma_s)$$
$$(\sigma_s, 0) \qquad (6.5.3.4)$$

Curve 5, the reduced yield curve (local yield) is drawn from two points shown in Equation (6.5.3.5).

$$(0, \sigma_s \cdot C_l / K_t)$$
$$(\sigma_s \cdot C_l / K_t, 0) \qquad (6.5.3.5)$$

6.5.4 Interpretation

The actual stress plotted in the HAIGH diagram should be in the area of the lower left corner, limited by the curves. For a ductile material with the mean stress lower than twice the yield stress and larger than the reduced yield curve, the actual mean stress may be moved left to the reduced yield curve. The safety factor is normally expressed as the ratio of the distance to the limiting curve and the distance to the actual stress point. If nothing explicit is mentioned, the vertical distances are used.

7. Bearing calculations

The aim of bearing calculations is to estimate how long a bearing will last within a specified probability. In the theoretical calculation, failure is defined as the first sign of pitting, not when the whole bearing breaks down.

7.1 Time equivalent load

Since there are both dynamic and static radial reactions that act on a bearing, it is necessary to form a time equivalent load to use. First, the dynamic parts are added. The magnitude of blade pass reaction is added to the rotating reaction to form the dynamic part. Then the static and dynamic parts are added as shown in Equation (7.1.1), also included in AXEL.

$$F = f_m \cdot \left(F_{stat} + F_{dyn}\right)$$
$$f_m = \frac{3}{4} \cdot \left(\frac{\mathrm{Max}(F_{stat}, F_{dyn})}{\left(F_{stat} + F_{dyn}\right)} - 0.5 \right)^2 \qquad (7.1.1)$$

F = time equivalent force
f_m = calculation factor
F_{stat}, F_{dyn} = static and dynamic force

At Flygt, the bearing lifetime is calculated assuming full load and a continuously running machine. If different loads are involved during a run pattern, then Equation (7.1.2) is appropriate.

$$F = \left(\frac{\sum F_i^3 \cdot U_i}{\sum U_i} \right)^{1/3} \qquad (7.1.2)$$

F = time equivalent force
F_i = force i
U_i = time fraction of force i

7.2 Equivalent load

The relationship between axial and radial forces on a bearing affects the distribution of loads on the different rolling elements. For example, a purely axial load is to be shared by all rolling elements, but a purely radial one acts on fewer rolling elements and is more unevenly distributed. Conditions like clearance and mounting also affect this load. Normally, simple formulas from the bearing manufacturer, as in Equation (7.2), can be used although this is normally handled by bearing calculation programs. See Figure (7.3.1).

$$P = X \cdot F_r + Y \cdot F_y \qquad (7.2)$$

P = equivalent dynamic load
X, Y = constants for different bearing types and different load cases
F_r, F_y = radial and axial force

7.3 ISO standard 281

The ISO standard for bearing calculation has been modified in some steps since the Equation (7.3.1) was introduced in 1962. The basis for that formula was the work of Weibull, a theory of statistical endurance of metallic materials in 1936, and the work of Lundeberg and Palmgren, who calculated the stresses in the volume affected by the Herzian pressure in 1947. In 1977, the factors for reliability, material and lubrication (a_1, a_2 and a_3) were added to enhance the calculation. The latest enhancements are the introduction of fatigue load limit and influence of contamination that form the factor a_m to be used in lifetime calculations. This work by mainly Ioannidis has introduced two improvements: a fatigue stress limit and more accurate calculations of the stressed volume with local stresses, thereby including influence of surface error and contamination. Reference 5 gives the details and Reference 6 gives a "popular" version.

7.3.1 Basic formula

The formula for nominal life at 10% probability of failure is:

$$L_{10} = \left(\frac{C}{P} \right)^p$$
$$L_{10h} = \frac{10^6}{60 \cdot n} \cdot L_{10} \qquad (7.3.1)$$

L_{10} = nominal life in rev·10^6
L_{10h} = nominal lifetime in hours
P = equivalent dynamic load
C = dynamic load rating
p = exponent; 3 for ball bearings and 10/3 for roller bearings
n = rotational speed, rev/min

The value of C is provided by the bearing manufacturer and achieved through a lot of testing.

A normal calculation from the SKF online catalogue is shown in Figure (7.3.1).

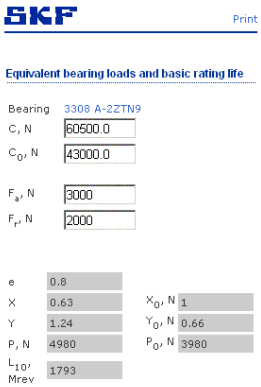


Figure 7.3.1. An online calculation from SKF.

7.3.2 Reliability

The reliability factor is 1 for 90% reliability and it should be lowered for higher reliability: Figure (7.3.2) gives values that follow a Weibull distribution with a Weibull slope of 1.5 as adopted by ISO.

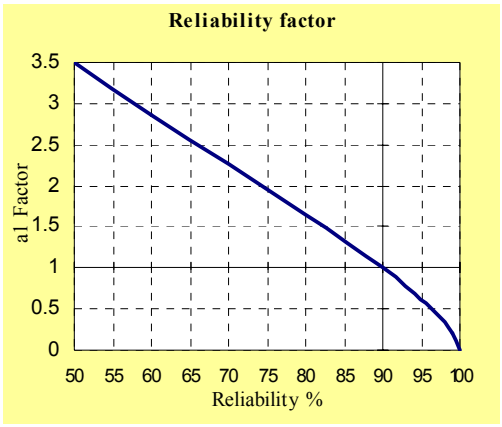


Figure 7.3.2. Reliability factor a_1. $L_n=a_1 \cdot L_{10}$

The lifetime with altered probability is shown in equation (7.3.2).

$$L_{nh} = a_1 \cdot L_{10h} \qquad (7.3.2)$$

L_{10h} = nominal lifetime in hours
L_{nh} = nominal lifetime with altered reliability n according to a_1
a_1 = reliability factor

7.3.3 Viscosity

The required lubricant has to have sufficient viscosity in order to separate the rolling surfaces and distribute the pressure to achieve acceptable stress levels. The diagram in Figure (7.3.3.1) gives the required viscosity as a function of bearing size and speed.

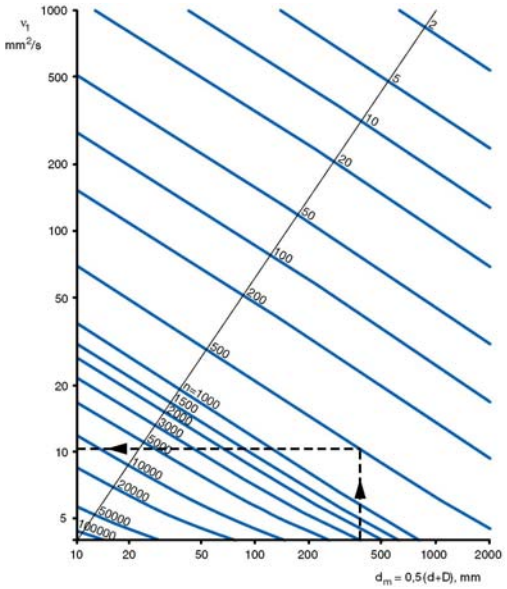


Figure 7.3.3.1. Required viscosity ν_1 as a function of speed and mean diameter of the bearing. (SKF)

The viscosity is highly temperature dependent and the viscosity at the running temperature is needed. The viscosity of the grease is normally given at 40°C and with a normal viscosity index the use of diagrams, as in Figure (7.3.3.2), can provide the correct figure.

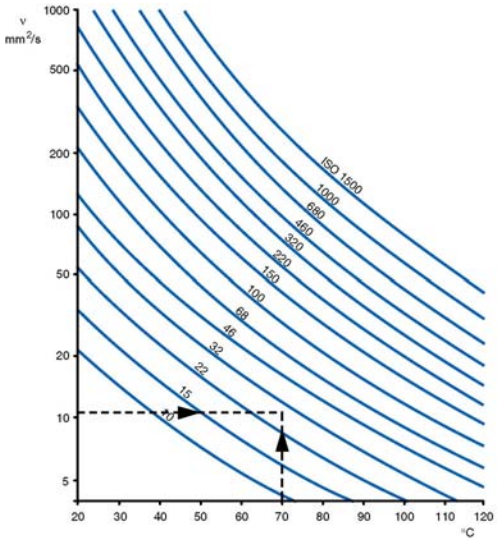


Figure 7.3.3.2. Viscosity - temperature relation for different ISO grade i.e. viscosities.

If the grease also has data for another temperature, normally 100°C, the viscosity at a given

temperature can be calculated as shown in Equation (7.3.3.1) with a log to log linearization.

$$\begin{aligned} xf(T) &= \log(T_0 + T) \\ yf(\nu) &= \log\left(\log\left(\nu^2\right)\right) \\ a &= \frac{yf(\nu_{T2}) - yf(\nu_{T1})}{xf(T2) - xf(T1)} \\ b &= yf(\nu_{T1}) - a \cdot xf(T1) \\ yf(\nu_T) &= a \cdot xf(T) + b \end{aligned} \qquad (7.3.3.1)$$

$T1, T2, T3$ = temperatures in °C with ...
$\nu_T, \nu_{T1}, \nu_{T2}$ = ... corresponding viscosity
T_0 = 273.15

With the required viscosity and the actual viscosity, the viscosity relationship in Equation (7.3.3.2) can be obtained for further use in lifetime calculation.

$$\kappa = \frac{\nu}{\nu_1} \qquad (7.3.3.2)$$

κ = viscosity ratio
ν_1 = required viscosity
ν = actual viscosity

7.3.4 Contamination & fatigue load limit

The contamination degree is tricky to estimate. The guideline from SKF is shown in Table (7.3.4). The pre-greased bearings in Flygt's products with their well protected surroundings have a contamination factor of 0.7. If not pre-greased, this value is 0.5.

Condition	η_c
Very clean Debris size of the order of the lubricant thickness	1
Clean Bearings greased for life and sealed	0.8 - 0.9
Normal Greased for life and shielded	0.5 - 0.8
Contaminated Bearing without seals; particles from surroundings	0.5 - 0.1
Heavily contaminated Intruding fluids and particles, extreme contamination	0

Table 7.3.4. Contamination factor η_c

When loads, lubricant and environmental considerations have been calculated, there is time to get the adjustment factor to obtain the calculated lifetime of a bearing according to Equation (7.3.4).

$$\begin{aligned} L_{10mh} &= a_m \cdot L_{10h} \\ a_m &= f\left(\kappa, \eta_c \cdot \frac{P_u}{P}\right) \end{aligned} \qquad (7.3.4)$$

L_{10mh} = lifetime in hours
L_{10h} = nominal lifetime in hours
a_m = adjustment factor
κ = viscosity ratio
η_c = contamination factor
P = equivalent dynamic load
P_u = fatigue load limit

The adjustment factor is achieved from diagrams, such as the one shown in Figure (7.3.4.1), for different bearing types. The fatigue load limit is provided by the bearing manufacturer.

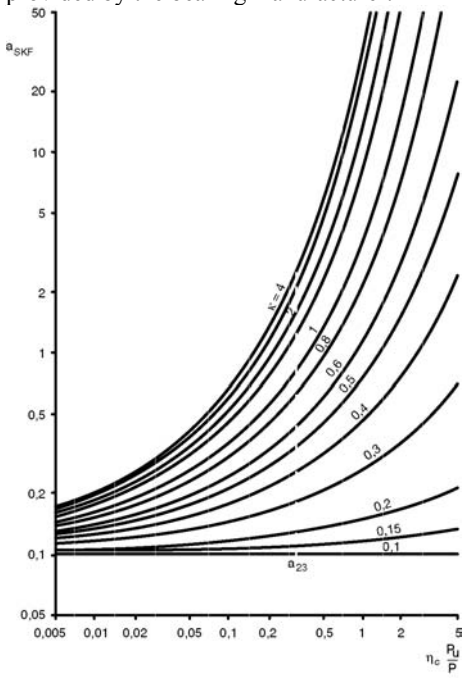


Figure 7.3.4.1. Adjustment factor a_m from SKF. Variables described in Equation (7.3.4)

The calculation can be made by hand with the help of diagrams, but it is much easier to use the online program available, shown in Figure (7.3.4.2).

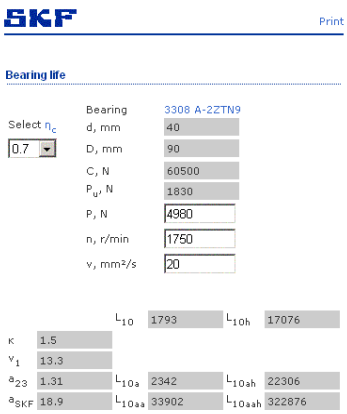


Figure 7.3.4.2. An online calculation from SKF.

7.4 Lubrication life

The preceding information naturally depends on proper lubrication which itself has a specific lifetime. The lifetime of grease lubrication may be far shorter than the lifetime of a bearing. Some rules together with the diagram in Figure (7.4) (SKF) provide a rough estimation of the lifetime of the lubrication. The rules in short (t_f is lifetime in operating hours):

- If 90% reliability instead of 99%: $t_f = t_f \cdot 2$
- For vertical mounting: $t_f = t_f/2$
- For every 15°C above 70°C: $t_f = t_f/2$
- For lower temperatures maximum: $t_f = t_f \cdot 2$
- For synthetic grease above 70°C: $t_f = t_f \cdot 4$
- For synthetic grease below 70°C: $t_f = t_f \cdot 3$

Environment: If water or dirt can penetrate the bearing, the predicted lifetime should be lowered dramatically. If, on the other hand, the environment is extremely clean and no exchange with the outer world takes place, the lifetime can be prolonged ($t_f = t_f \cdot 2$).

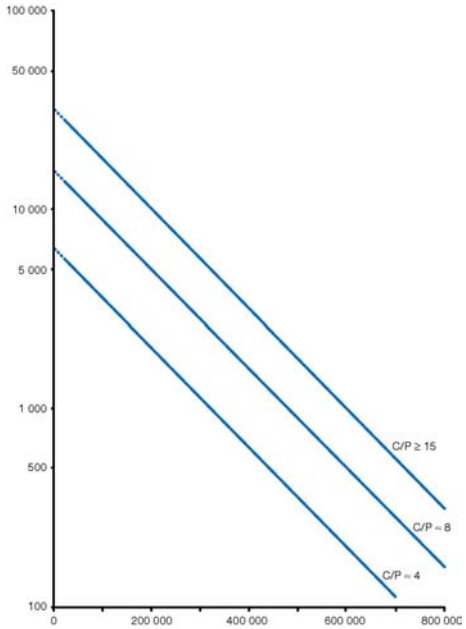


Figure 7.4. Time to relubrication (SKF) The y-axis is operating hours and the x-axis is the product of speed [RPM], bearing mean diameter [mm] and a factor 1 for normal ball bearings and 1,5 for normal roller bearings without axial load.

7.5 Practical life

The calculated lifetime, although correctly done, is just one part in estimating the practical life of a bearing. Moderately loaded bearings may work for a long time even though signs of fatigue have appeared. Matters like wear and all the causes of failure mentioned in Section 2.3 shall also be considered. A calculated lifetime that is too long can even shorten the practical life of a bearing. The goal for a Flygt bearing to meet is:

ITT Flygt's bearings shall guarantee a service interval of 50 000 hours and be seen "as trouble free as a bolt".

In product development, we may also use x-ray diffraction to analyze bearings exposed to real loads in a field test. The analysis gives information

of loading and remaining lifetime and thereby enhances lifetime estimations.

7.5.1 Wear

Particles do not only create high stresses in the bearing and lower the calculated lifetime, they may also cause wear, another reason for cleanliness of bearings and their lubrication. The wear rate depends mainly on the particle concentration, particle size, particle hardness and sliding.

7.5.2 Lubrication

Lubrication properties are of great importance and Flygt continuously tries to get the best lubrication for our products. One should note that grease is perishable and one test Flygt performs to compare different grease in this respect is a heat test at 140°C. This test and others, as well as tests from lubricant and bearing suppliers, give the basis from which we predict lubricant lifetime.

8. Safety factors

To determine the appropriate safety factor to use, there are many considerations to take into account; type of failure, accuracy in calculations, acceptance level of failure, etc. This can be structured as a set of factors that can be multiplied to form a safety factor as shown below:

- Demands 1. Factor for failure probability is 1 if less serious (failure probability of 10^{-3}), 1.1 if serious (failure probability of 10^{-4}) and 1.2 if very serious (failure probability of 10^{-5}).
- Demands 2. Factor for control of calculation, material, manufacturing and use is 1 if rigorous control, 1.05 if normal, and 1.1 if low degree of control.
- Load. Factor for load is 1 if maximum values, loads with limitations, or fixed load with no variations are used. For other conditions, an estimation of the load probability has to be made.
- Resistance 1. Factor for material is 1 if guaranteed minimum values or probability of lower values are less than 10^{-3}. 1.1 to 1.3 if normal distribution and average values of ultimate stress, yield stress and crack propagation values. 1.3 to 1.7 if normal distribution and average values of fatigue data for infinite life.
- Resistance 2. Factor for calculation method is 1 if worst case calculation. 1.1 to 1.2 if handbook formulas or FEA. It is larger than 1.2 if less accurate methods are used.
- Resistance 3. Factor for criteria is 1 if plastic deformation or non-brittle failure, if brittle failures and one-directional stress, if fatigue and infinite life or if fatigue and constant amplitude at one-directional stress. 1.1 if brittle failure and multi-directional stress, if fatigue and limited life or if fatigue and multi-directional stress. 2 if fatigue and several different load cases. Time independent deformation gives a factor of 1, time dependent deformations 1.1 to 2.

The figures above are given as guidance. If the probability distribution of the factors above is known then a more sophisticated analysis may be performed. This is normally not the case, however. The final safety factor is formed by multiplying the two demand factors, the load factor and the three resistance factors.

If a component is tested, like bearings, then the values obtained from tests are the ones to use. This type of endurance test is normally not possible to perform, especially not for components produced in a low number.

9. Conclusions

When analyzing a rotating system, there are many calculations involved and assumptions to be made. This publication shows how Flygt performs this and what methods Flygt considers to be the most suitable. In order to compare predictions of bearing life, safety levels of different failures, etc., it is necessary to know how they have been derived.

The amount of data needed (and generated) to obtain results from one duty point of one combination of drive unit and hydraulic part is huge. For the entire pump curve, even more is needed. Consequently, it is impossible to analyze all combinations of all impellers/propellers, volutes, drive units and running conditions.

What finally counts is the performance of the product, not a good figure of some kind. Especially since there are a lot of failure conditions that are unpredictable by calculations. Nevertheless, accurate analyses are necessary to compare different designs and to create a robust product that fulfills the customer’s demands.

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Shaft and bearing calculation chart

Project name:	**OCSD P1-101 Project**
Product:	**NP3153.095-463HT, 20HP, 1750RPM**
Calcs performed for a duty range of:	**300-750 GPM (AOR)**
Bearing life:	**Upper bearing (radial) L10aa = > 50 000 h** **Lwr. bearing (radial/axial) L10aa = > 50 000 h**

Bearing life calculations made in accordance with SKF adjusted rating life, new theory, L10aa.
Hydraulic and electrical forces are related to the specified duty range and in accordance with the specific product and version.
Adjustment factor for contamination is 0.5 (normal).
Viscosity of lubricant at 40° C is 95.0 mm2/s.
(Refer to appendix 1 for bearing life methodology and additional details.)

The shaft, hub coupling and seals are calculated and checked in accordance with Flygt-Xylem standards. Refer to the attached appendix for the methodology for each individual parameter.

Critical speed

First natural frequency due to bending and torsion is more than 30% away from exciting frequencies at actual speed.

Torsional and combined stresses

Maximum allowed stress limits are calculated for static and dynamic load cases and compared with the σ reduction curve in a Haigh fatigue diagram. A minimum 15% margin is required. A minimum of 1 X 10^7 load change was used (indefinite life time).

Maximum allowable combined stress, in accordance to v. Mises is;

$$\sqrt{\sigma N^2 + \sigma B^2 + 3 \times \tau^2} = 80 \mathrm{N/mm^2}$$

Shaft deflection

Valid for Flygt standard M0344.2321.00 (ASTM/AISI 431 Martensitic Stainless Steel)

Maximum shaft deflection, at the seal position during normal duty, is less than 0.1 mm.

Date: MARCH 18, 2014

Approved: **Xylem Water Solutions- Flygt Products**

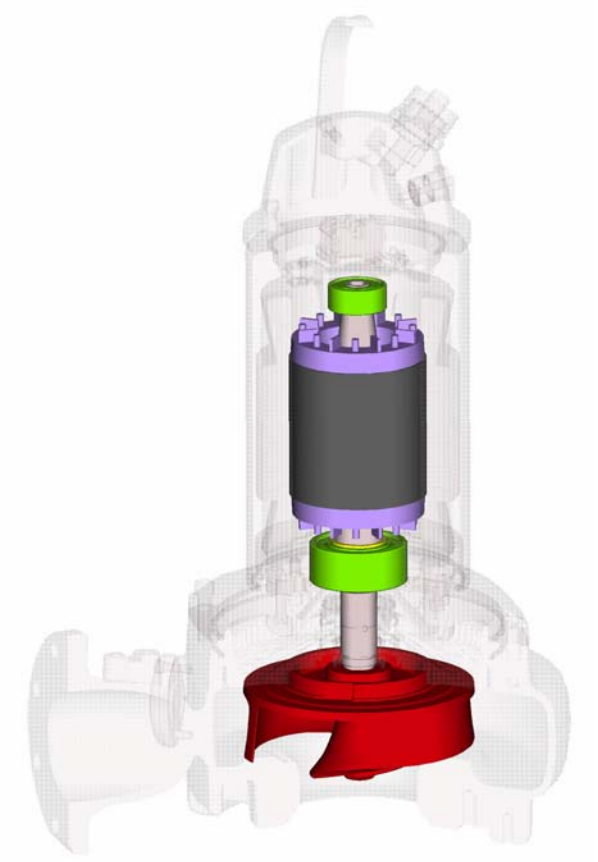
Signature: _____

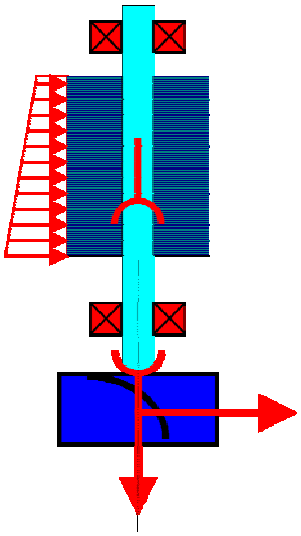
David Troyer
Applications Engineer

Shaft and Bearing Calculations

Gert Hallgren
ITT Flygt AB

Abstract. Years of field experience and laboratory testing, together with advanced calculations, form the basis for development of Flygt methods and computer programs used to analyze and dimension the rotating system of a pump or mixer. Bearings are one of the key components that determine service intervals for Flygt pumps and mixers. Therefore, knowledge and understanding of the variety of factors that influence a bearing's lifetime is of utmost importance. A correctly dimensioned shaft is fundamental to ensuring smooth and trouble free running with no disturbances from natural frequencies, large deflections or fatigue failures. Knowledge of unpredictable causes of failure such as penetrating fluid in the bearing or assembly damage to the shaft, are also an important part in the design of a sturdy and reliable product. Proven models of geometry as well as load cases that cover the unpredictable directions of tolerances and related forces are necessary. The amount of data needed (and generated) in shaft and bearing calculations is huge. Consequently, it is impossible to analyze all combinations of impellers/propellers, volutes, drive units and running conditions. What *is* important is the performance of the product and our ability to create a robust product that fulfills the customer's demands. Other important issues that are not addressed in this publication, but which are vital to creating well designed systems, are proper installation with favorable inlet conditions, favorable duty points, secure anchoring, etc.





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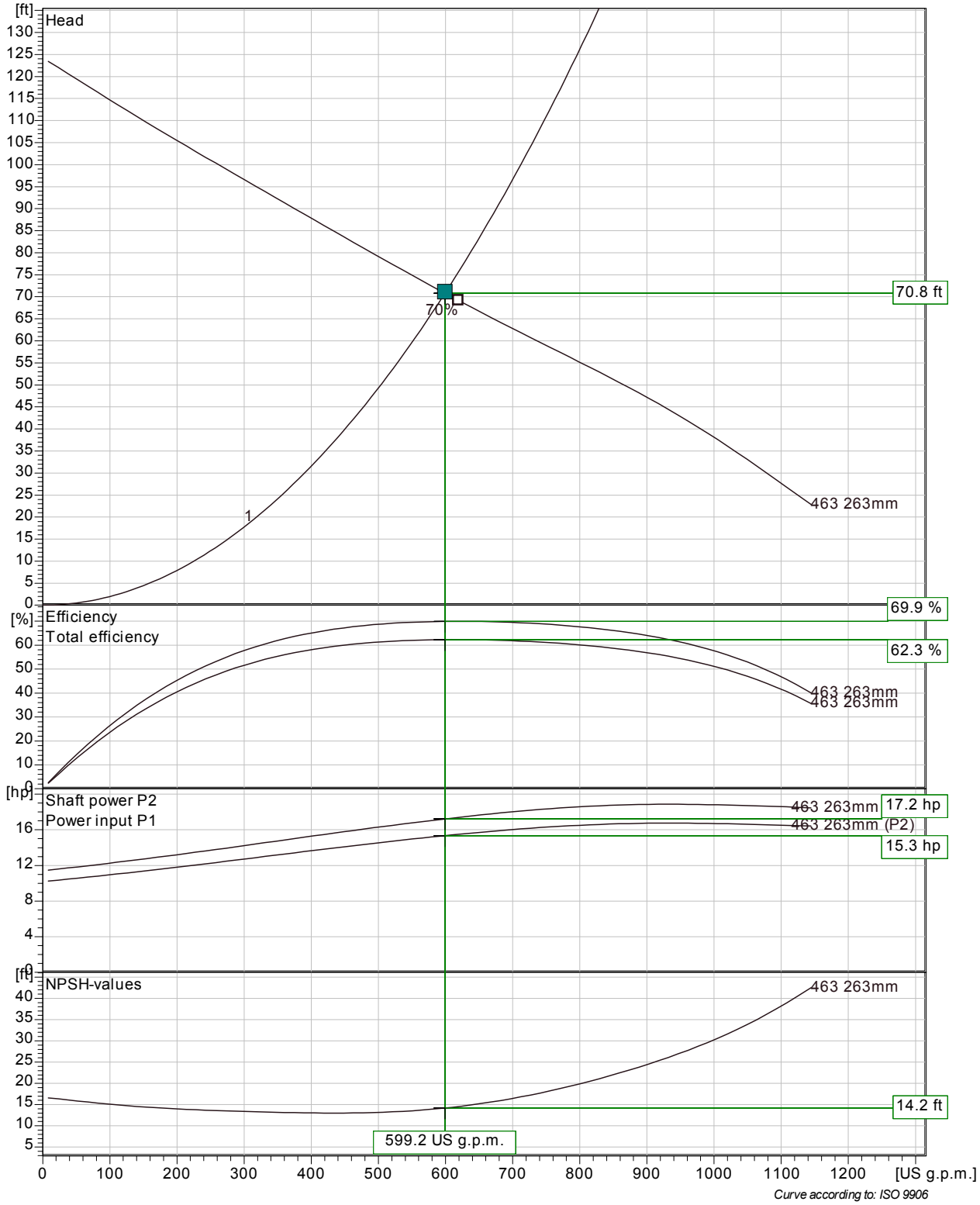
Duty Analysis



Pumps running /System	Individual pump			Total					
	Flow	Head	Shaft power	Flow	Head	Shaft power	Hyd eff.	Specific energy	NPSHre
1	599 US g.p.m.	70.8 ft	15.3 hp	599 US g.p.m.	70.8 ft	15.3 hp	69.9 %	357 kWh/US MG	14.2 ft

Project	Project ID	Created by	Created on	Last update
Sludge Dewatering & Odor Control			2013-04-05	

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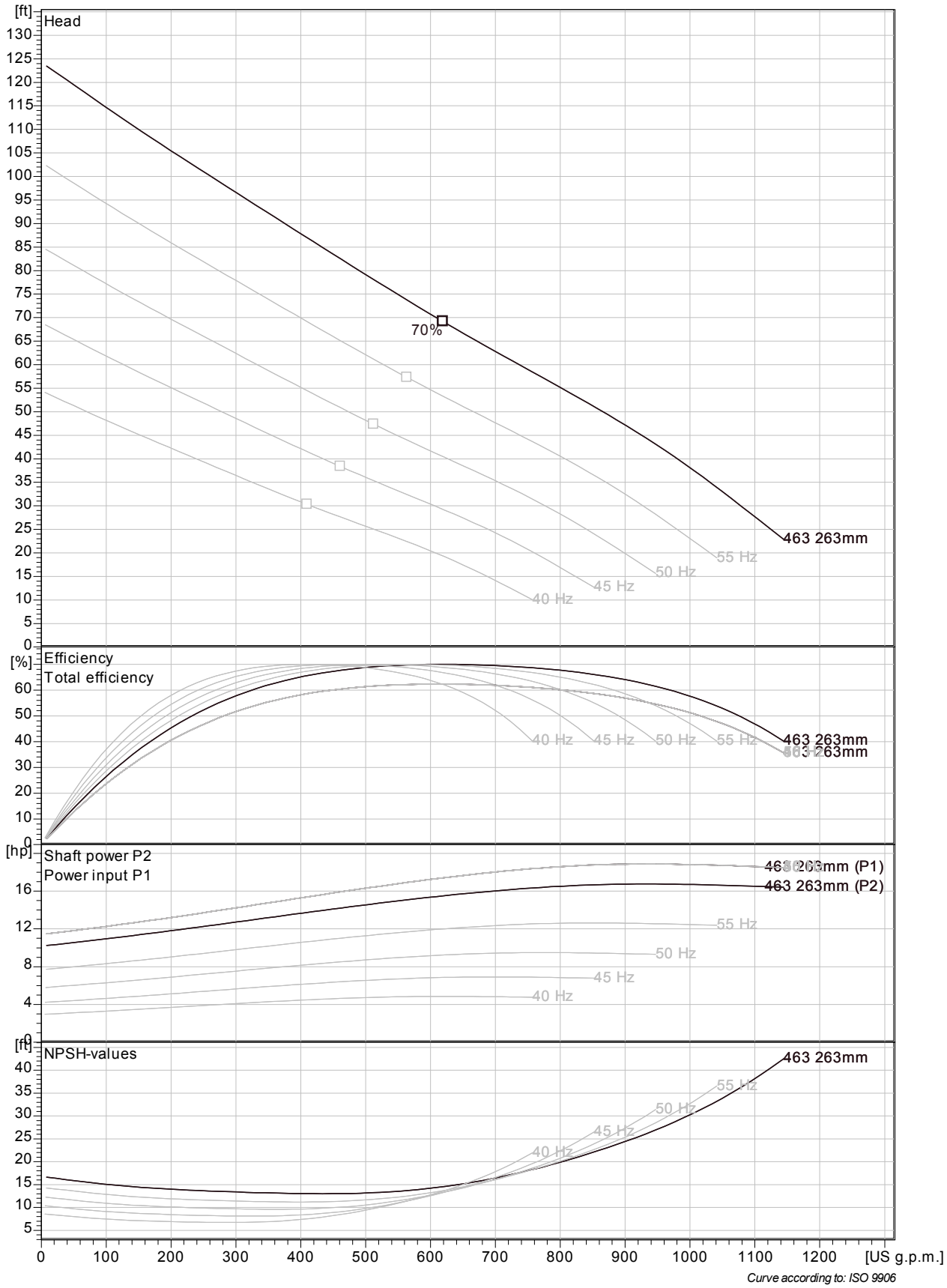
VFD Curve

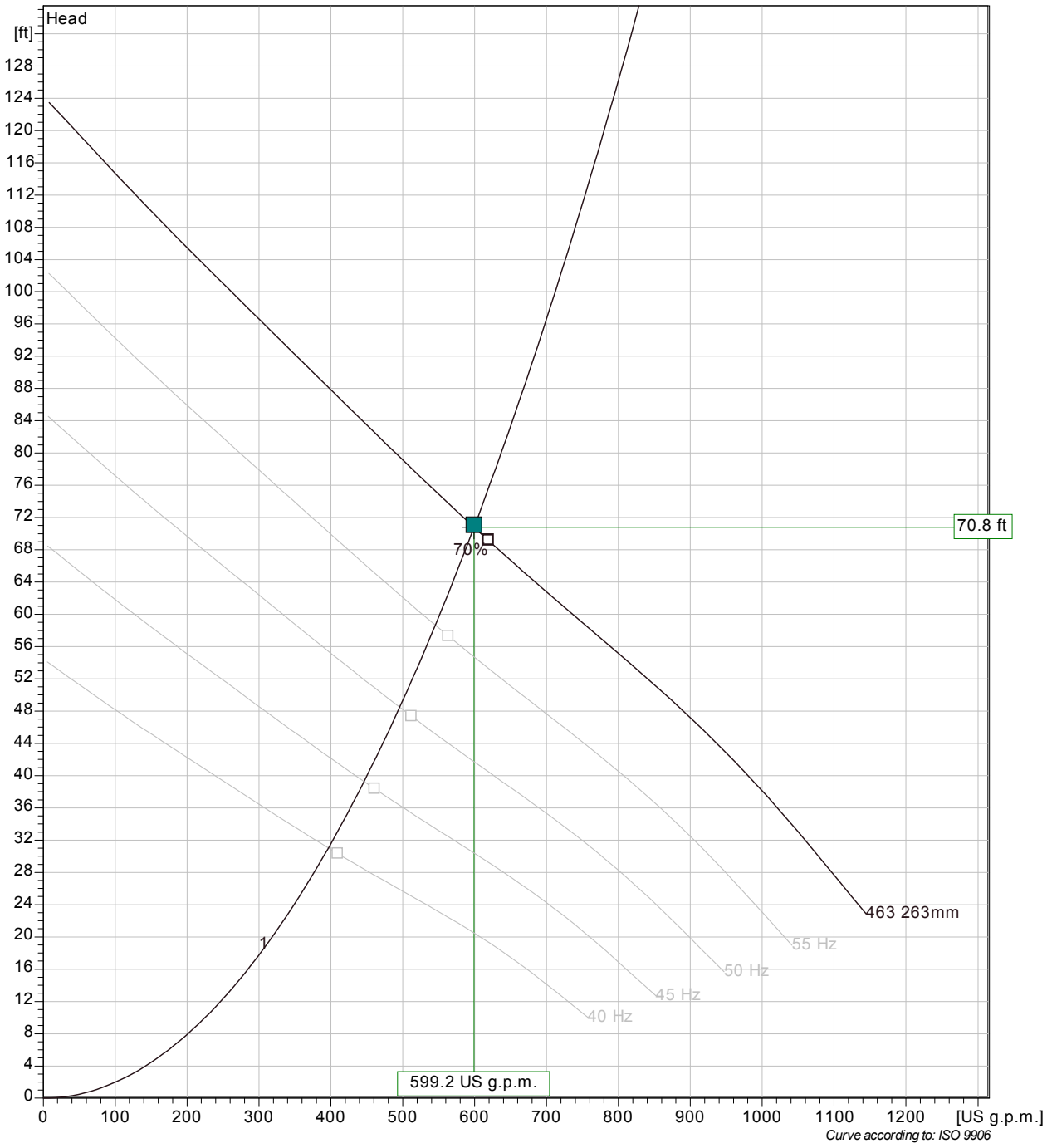


Curve according to: ISO 9906

Project	Project ID	Created by	Created on	Last update
Sludge Dewatering	& Odor Control		2013-04-05	

NP 3153 HT 3~ 463

VFD Analysis



	Individual pump				Total					
Pumps running /System	Frequency	Flow	Head	Shaft power	Flow	Head	Shaft power	Hyd eff.	Specific energy	NPSHre
1	60 Hz	599 US g.p.m.	70.8 ft	15.3 hp	599 US g.p.m.	70.8 ft	15.3 hp	69.9 %	357 kWh/US MG	14.2 ft
1	55 Hz	545 US g.p.m.	58.7 ft	11.6 hp	545 US g.p.m.	58.7 ft	11.6 hp	69.9 %	295 kWh/US MG	12.2 ft
1	50 Hz	496 US g.p.m.	48.5 ft	8.7 hp	496 US g.p.m.	48.5 ft	8.7 hp	69.9 %	245 kWh/US MG	10.5 ft
1	45 Hz	446 US g.p.m.	39.3 ft	6.34 hp	446 US g.p.m.	39.3 ft	6.34 hp	69.9 %	203 kWh/US MG	8.86 ft
1	40 Hz	397 US g.p.m.	31 ft	4.45 hp	397 US g.p.m.	31 ft	4.45 hp	69.9 %	166 kWh/US MG	7.34 ft

Project	Project ID	Created by	Created on	Last update
Sludge Dewatering & Odor Control			2013-04-05	

TAB 3

INSTALLATION, OPERATION AND MAINTENANCE

Installation,
Operation, and
Maintenance Manual

Flygt 3153

FLYGT
a xylem brand

Table of Contents

Introduction and Safety

Introduction

Purpose of this manual

The purpose of this manual is to provide necessary information for:

- Installation
- Operation
- Maintenance

CAUTION:

Read this manual carefully before installing and using the product. Improper use of the product can cause personal injury and damage to property, and may void the warranty.

NOTICE:

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

Safety

WARNING:

- The operator must be aware of safety precautions to prevent physical injury.
- Any pressure-containing device can explode, rupture, or discharge its contents if it is over-pressurized. Take all necessary measures to avoid over-pressurization.
- 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. 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 an Xylem representative before proceeding.
- This manual clearly identifies accepted methods for disassembling units. These methods must be adhered to. Trapped liquid can rapidly expand and result in a violent explosion and injury. Never apply heat to impellers, propellers, or their retaining devices to aid in their removal.
- Do not change the service application without the approval of an authorized Xylem representative.

CAUTION:

You must observe the instructions contained in this manual. Failure to do so could result in physical injury, damage, or delays.

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
- 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
NOTICE:	• A potential situation which, if not avoided, could result in undesirable conditions • A practice not related to personal injury

Hazard categories

Hazard categories can either fall under hazard levels or let specific symbols replace the ordinary hazard level symbols.

Electrical hazards are indicated by the following specific symbol:

Electrical Hazard:

These are examples of other categories that can occur. They fall under the ordinary hazard levels and may use complementing symbols:

- Crush hazard
- Cutting hazard
- Arc flash hazard

Magnetic hazard

Magnetic hazards are indicated by a specific symbol that replaces the typical hazard level symbols:

CAUTION:

Environmental safety

The work area

Always keep the station clean to avoid and/or discover emissions.

Waste and emissions regulations

Observe these safety regulations regarding waste and emissions:

- Appropriately dispose of all waste.
- Handle and dispose of the processed liquid in compliance with applicable environmental regulations.
- Clean up all spills in accordance with safety and environmental procedures.
- Report all environmental emissions to the appropriate authorities.

WARNING:

Do NOT send the product to the Xylem manufacturer if it has been contaminated by any nuclear radiation. Inform Xylem so that accurate actions can take place.

Electrical installation

For electrical installation recycling requirements, consult your local electric utility.

Recycling guidelines

Always recycle according to these guidelines:

1. Follow local laws and regulations regarding recycling if the unit or parts are accepted by an authorized recycling company.
2. If the first guideline is not applicable, then return the unit or parts to your Xylem representative.

User safety

General safety rules

These safety rules apply:

- Always keep the work area clean.
- Pay attention to the risks presented by gas and vapors in the work area.
- Avoid all electrical dangers. Pay attention to the risks of electric shock or arc flash hazards.
- Always bear in mind the risk of drowning, electrical accidents, and burn injuries.

Safety equipment

Use safety equipment according to the company regulations. Use this safety equipment within the work area:

- Hard hat
- Safety goggles, preferably with side shields
- Protective shoes
- Protective gloves
- Gas mask
- Hearing protection
- First-aid kit
- Safety devices

NOTICE:

Never operate a unit unless safety devices are installed. Also see specific information about safety devices in other chapters of this manual.

Electrical connections

Electrical connections must be made by certified electricians in compliance with all international, national, state, and local regulations. For more information about requirements, see sections dealing specifically with electrical connections.

Hazardous liquids

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 work with biologically hazardous liquids are vaccinated against diseases to which they may be exposed.
- Observe strict personal cleanliness.

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.

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.
- You must fully submerge the Ex-approved product during normal 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.
- Make sure that thermal contacts are connected to a protection circuit according to the approval classification of the product, and that they are in use.
- 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 authorized Xylem representative.
- Only use parts that are provided by an authorized Xylem representative.

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 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. Condition-monitoring devices include but are not limited to the following:

- Level indicators
- Temperature detectors

Product warranty

Coverage

Xylem undertakes to remedy defects in products from Xylem under these conditions:

- The faults are due to defects in design, materials, or workmanship.
- The faults are reported to an Xylem representative within the warranty period.
- The product is used only under the conditions described in this manual.
- The monitoring equipment incorporated in the product is correctly connected and in use.
- All service and repair work is done by Xylem-authorized personnel.
- Genuine Xylem parts are used.
- Only Ex-approved spare parts and accessories authorized by Xylem are used in Ex-approved products.

Limitations

The warranty does not cover defects caused by these situations:

- Deficient maintenance
- Improper installation
- Modifications or changes to the product and installation made without consulting Xylem
- Incorrectly executed repair work
- Normal wear and tear

Xylem assumes no liability for these situations:

- Bodily injuries
- Material damages
- Economic losses

Warranty claim

Xylem products are high-quality products with expected reliable operation and long life. However, should the need arise for a warranty claim, then contact your Xylem representative.

Spare parts

Xylem guarantees that spare parts will be available for 15 years after the manufacture of this product has been discontinued.

Transportation and Storage

Inspect the delivery

Inspect the package

1. Inspect the package for damaged or missing items upon delivery.
2. Note any damaged or missing items on the receipt and freight bill.
3. File a claim with the shipping company if anything is out of order.
   If the product has been picked up at a distributor, make a claim directly to the distributor.

Inspect the unit

1. Remove packing materials from the product.
   Dispose of all packing materials in accordance with local regulations.
2. Inspect the product to determine if any parts have been damaged or are missing.
3. If applicable, unfasten the product by removing any screws, bolts, or straps.
   For your personal safety, be careful when you handle nails and straps.
4. Contact your sales representative if anything is out of order.

Transportation guidelines

Precautions

WARNING:
- Stay clear of suspended loads.
- Observe accident prevention regulations in force.

Position and fastening

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

Lifting

WARNING:
- Crush hazard. The unit and the components can be heavy. Use proper lifting methods and wear steel-toed shoes at all times.
- Lift and handle the product carefully, using suitable lifting equipment.
- The product must be securely harnessed for lifting and handling. Use eyebolts or lifting lugs if available.
- Always lift the unit by its lifting handle. Never lift the unit by the motor cable or by the hose.
- Do not attach sling ropes to shaft ends.

Lifting equipment

Lifting equipment is always required when handling the unit. It must fulfill the following requirements:

- The minimum height (contact Xylem for information) between the lifting hook and the floor must be sufficient to lift the unit.
- 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 securely anchored and in good condition.
- The lifting equipment must support weight of the entire assembly and must only be used by authorized personnel.
- 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.

NOTICE:

Oversized lifting equipment could cause damage if the unit should stick when being lifted.

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 (–58°F) to +60°C (+140°F).

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.

Units equipped with an internal 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.

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 water. Change if needed.

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.
- 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 more than 6 months, the following apply:

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

Product Description

Pump design

The pump is submersible, and driven by an electric motor.

For a list of pump version and corresponding motor type, see *Motor data* (page 67).

Intended use

The product is intended for moving wastewater, sludge, raw and clean water. Always follow the limits that are given in *Application limits* (page 67). If there is a question regarding the intended use of the equipment, please contact an Xylem representative before proceeding.

WARNING:

In explosive or flammable environments, only use Ex- or MSHA-approved pumps.

NOTICE:

Do NOT use the pump in highly corrosive liquids.

Spare parts

- Modifications to the unit or installation should 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 your Xylem representative.

Pressure class

LT	Low head
MT	Medium head
HT	High head
SH	Super high head

Parts

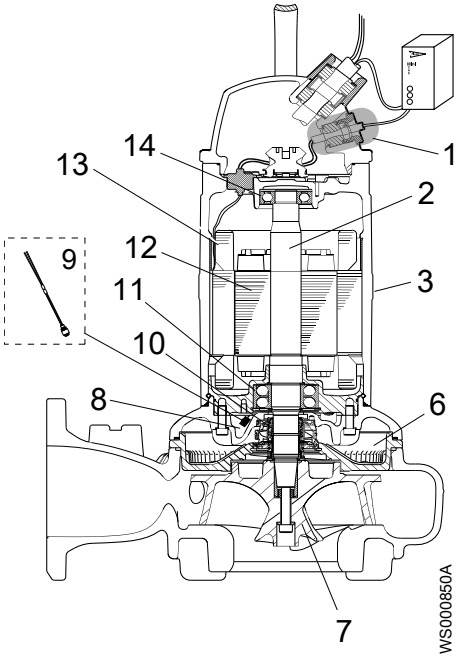


Figure 1: Without cooling jacket

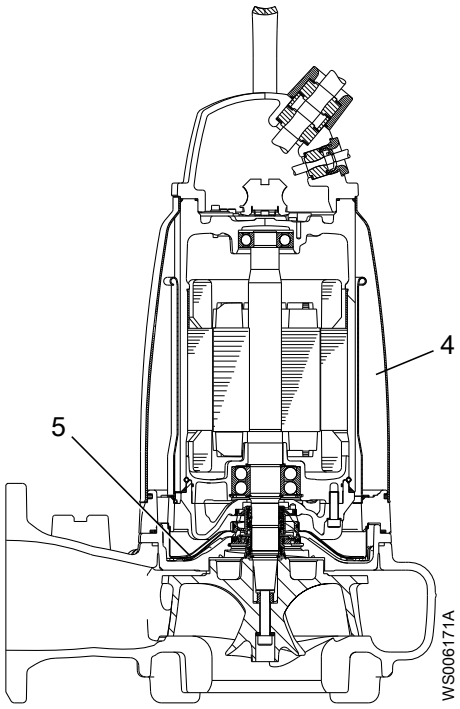


Figure 2: With cooling jacket

Position	Part	Description
1	Monitoring sensor	Optional sensor. For information about sensors, see *Monitoring equipment* (page 14).
2	Shaft	Stainless steel, with an integrated rotor
3	Cooling without jacket	The pump is cooled by the ambient liquid.
4	Cooling with jacket	The motor is cooled by a closed loop system. An integrated coolant pump circulates the coolant whenever the pump is operated.
5	Flow diffuser	Provides heat transfer from the coolant to the pumped fluid.
6	Seal housing	Includes a coolant that lubricates and cools the seals; the housing acts as a buffer between the pumped fluid and the electric motor
7	Impeller	N-impeller, a semi-open, two-vane impeller
8	Inspection chamber	Equipped with an FLS10 leakage sensor to prevent damages to the motor
9	FLS10	For information about FLS10, see *Monitoring equipment* (page 14).

10	Mechanical seals	Made of one of the following alternatives:
		• Alternative 1
		  • Inner seal: corrosion-resistant cemented carbide WCCR/WCCR
		  • Outer seal: corrosion-resistant cemented carbide WCCR/WCCR
		• Alternative 2
		  • Inner seal: corrosion-resistant cemented carbide/Aluminum oxide WCCR/Al_2O_3
		  • Outer seal: silicon carbide RSiC/RSiC

11	Main bearings	Consisting of a two-row angular contact ball bearing
12	Motor	For information about the motor, see *Motor data* (page 67).

Position	Part	Description
13	Thermal contact/ Thermistors	For information about the thermal contact and thermistors, see *Monitoring equipment* (page 14).
14	Support bearing	Consisting of a two-row ball bearing

Monitoring equipment

The following applies to the monitoring equipment of the pump:

- The stator incorporates three thermal contacts connected in series that activate the alarm and stops the pump at overtemperature
- The thermal contacts open at 140°C (285°F).
- Ex-approved pumps must have thermal contacts connected to the control panel.
- The sensors must be connected to either the MiniCAS II monitoring equipment or an equivalent equipment.
- The monitoring equipment must be of a design that makes automatic restart impossible.
- The pump is supplied with an inspection sensor FLS 10 for sensing the presence of any liquid in the inspection chamber.
- Information in the junction box shows if the pump is equipped with optional sensors.

Optional sensors

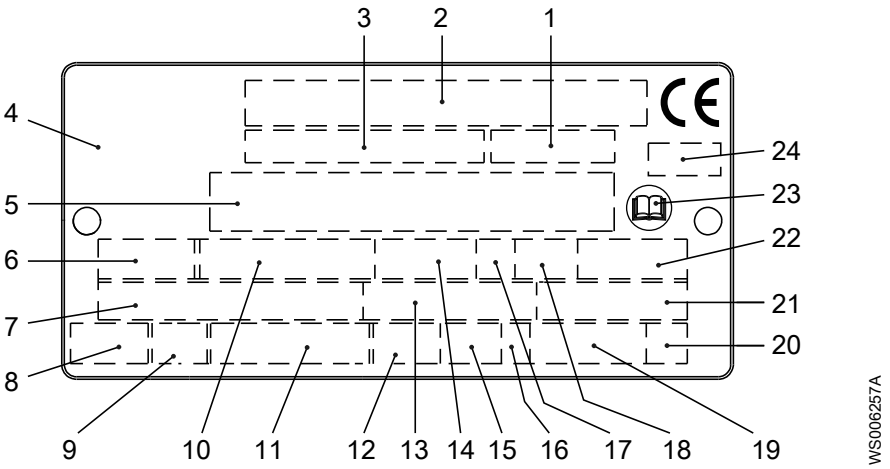
Thermistor Thermistors are optional sensors for measuring the temperature. They are connected in series in the stator and activate the alarm at overtemperature. Thermistors are not applicable to Ex-approved pumps.

NOTICE:

Thermistor must never be exposed to voltages higher than 2.5 V. If the voltage exceeds this value, for example when the control circuit is tested, the thermistors will be destroyed.

The data plate

The data plate is a metal label located on the main body of the products. The data plate lists key product specifications. Specially approved products also have an approval plate.



1. Curve code/Propeller code
2. Serial number, see *Product denomination* (page 17)
3. Product number

4. Country of origin
5. Additional information
6. Phase; type of current; frequency
7. Rated voltage
8. Thermal protection
9. Thermal class
10. Rated shaft power
11. International standard
12. Degree of protection
13. Rated current
14. Rated speed
15. Maximum submergence
16. Direction of rotation: L=left, R=right
17. Duty class
18. Duty factor
19. Product weight
20. Locked rotor code letter
21. Power factor
22. Maximum ambient temperature
23. Read installation manual
24. Notified body. Only for EN-approved Ex-products

Figure 3: The data plate

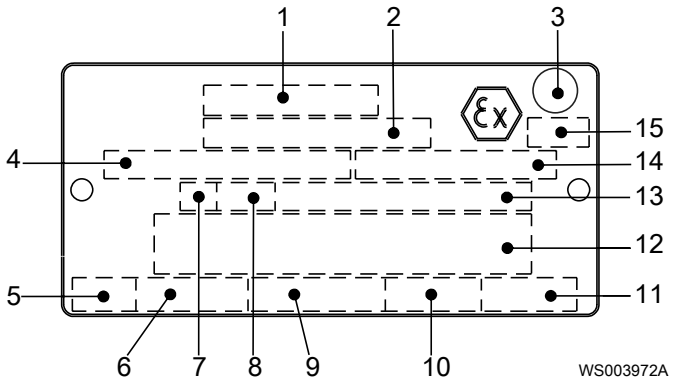
Approvals

Product approvals for hazardous locations

Pump	Approval
• 3153.091 • 3153.095 • 3153.390 • 3153.810 • 3153.830 • 3153.850	European Norm (EN) • ATEX Directive • EN 60079-0, EN 60079-1, EN 1127-1 •  I M2 Ex d I •  II 2 G Ex d IIB T3
	EN approval for cable entry: • Certificate number: INERIS 02ATEX9008 U •  II 2 G Ex d IIC or I M2 Ex d I
	IEC • IECEx scheme • IEC 60079–0, IEC 60079–1 • Ex d I • Ex d IIB T3
	Factory Mutural (FM) • 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

EN approval plate

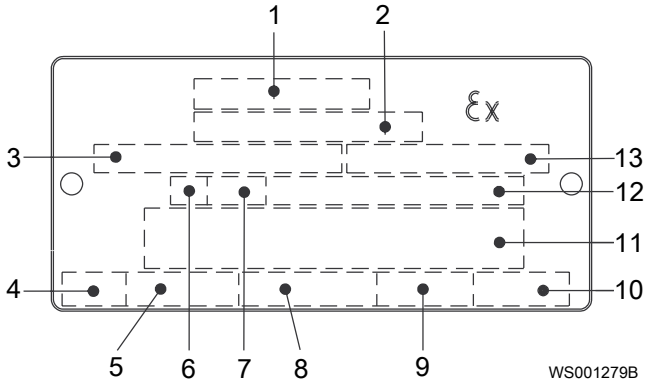
This illustration describes the EN approval plate and the information contained in its fields.



1. Approval
2. Approval authority + approval number
3. Approval for Class I
4. Approved drive unit
5. Stall time
6. Starting current/Rated current
7. Duty class
8. Duty factor
9. Input power
10. Rated speed
11. Controller
12. Additional information
13. Maximum ambient temperature
14. Serial number
15. ATEX marking

IEC approval plate

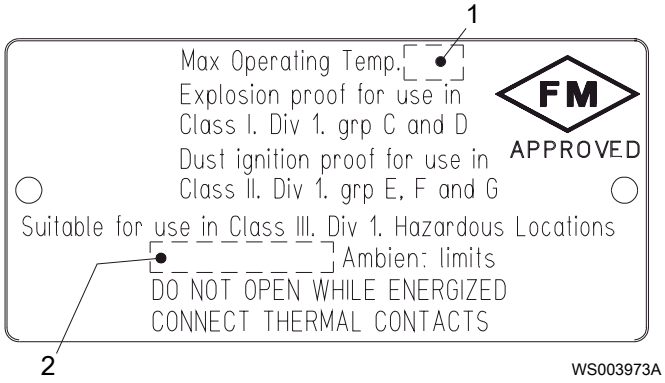
This illustration describes the IEC approval plate and the information contained in its fields. International Norm; not for EU member countries.



1. Approval
2. Approval authority + approval number
3. Approved for drive unit
4. Stall time
5. Starting current/Rated current
6. Duty class
7. Duty factor
8. Input power
9. Rated speed
10. Controller
11. Additional information
12. Max. ambient temperature
13. Serial number

FM approval plate

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



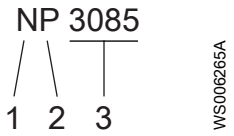
1. Temperature class
2. Maximum ambient temperature

Product denomination

Sales denomination

The sales denomination consists of the four-digit sales code and two letters that indicate the hydraulic end and type of installation.

This is an example of a sales denomination, and an explanation of its parts.

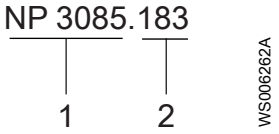


1. Hydraulic part
2. Installation type
3. Sales code

Product code

The product code consists of nine characters divided into two parts.

This is an example of a product code, and an explanation of its parts.

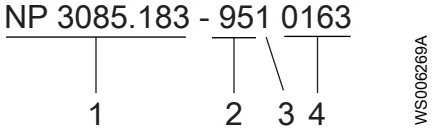


1. Sales denomination
2. Version

Serial number

The serial number is used for identification of an individual product, and is divided into four parts.

This is an example of a serial number, and an explanation of its parts.



1. Product code
2. Production year
3. Production cycle
4. Running number

Installation

Install the pump

WARNING:

- Electrical shock hazard. Check that the cable and cable entry have not been damaged during transport before installing the pump.
- Note that special rules apply to installation in explosive atmospheres.
- Make sure that the unit cannot roll or fall over and injure people or damage property.
- Do not install CSA-approved products in locations that are classified as hazardous in the national electric code, ANSI/NFPA 70-2005.
- Do not install the starter equipment in an explosive zone unless it is explosion-proof rated.

WARNING:

A permanent-magnet motor generates voltage when the shaft is rotating. Ensure that the shaft can not rotate before performing any electrical installation.

NOTICE:

- Do not run the pump dry.
- Never force piping to make a connection with a pump.
- Always remove all debris and waste material from the sump, inlet piping, and discharge connection, before you install the pump.

These requirements apply:

- Use the pump dimensional drawing in order to ensure proper installation.
- In S-, T-, and Z-installations the pump must be equipped with cooling jacket
- Provide a suitable barrier around the work area, for example, a guard rail.
- Check the explosion risk before you weld or use electric hand tools.
- Always check the impeller rotation before lowering the pump into the pumped liquid.
- If the unit has a permanent magnet motor, ensure that you have read and understood all safety instructions regarding permanent magnet motors.

Authority regulation

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

Fasteners

WARNING:

- Only use fasteners of the proper size and material.
- Replace all corroded fasteners.
- Make sure that all fasteners are properly tightened and that there are no missing fasteners.

Install 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. These requirements and instructions only apply when the installation is made according to the dimensional drawing.

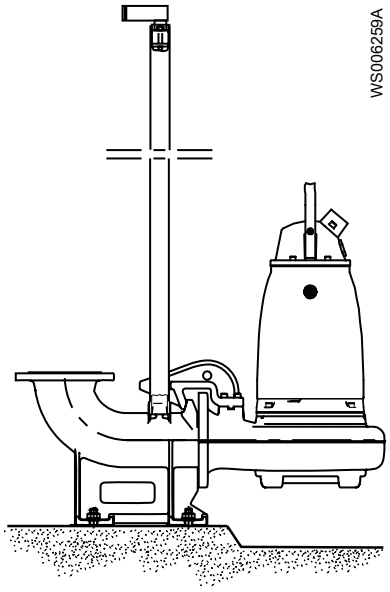


Figure 4: P-installation

These items are required:

- Guide bars
- Guide bar bracket for attaching 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 for holding 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 for connecting the pump to the discharge line

  The discharge connection has a flange which fits the pump casing flange and a bracket for attaching the guide equipment.
- Fasteners for the discharge connection
- Anchor bolts

1. Run a cable between the sump and the stator and monitoring equipment.

   Make sure that the cable is neither sharply bent, nor pinched.
2. Install the access frame:

   a) Place the access frame in position and align it horizontally.

   b) Grout the frame in place.
3. Grout the anchor bolts in place.

   Be careful when you align and position the discharge connection in relation to the access frame.
4. Place the discharge connection in position, and tighten the nuts.
5. Install the guide bars:

   a) Secure the guide bars in the bracket.

   b) Check that the guide bars are placed vertically. Use a level or a plumb line.
6. Connect the discharge pipe to the discharge connection.

7. Prepare for the level regulator:
   a) Bolt the cable holder to the access frame.
   b) Attach the level regulator cable to the cable holder and adjust the height of the level regulator.
   c) Protect bolts and nuts with a corrosion-preventive compound.
8. Lower the pump along the guide bars.
9. Secure the motor cable:
   a) Fasten the permanent lifting device to the pump and to the access frame. For example, you can use a stainless-steel lifting chain with shackles.
   b) Fasten the cable to the cable holder.

      Make sure that the cable cannot be sucked into the pump inlet or that it is neither sharply bent, or pinched. Support straps are required for deep installations.
   c) Connect the motor cable and the starter and monitoring equipment according to the separate instructions.

      Make sure that the impeller rotation is correct. For more information, see *Check the impeller rotation* (page 33).

Clean all debris from the sump before starting the pump.

Install 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.

These requirements and instructions only apply when the installation is made according to the dimensional drawing. For information about the different installation types, see Parts List.

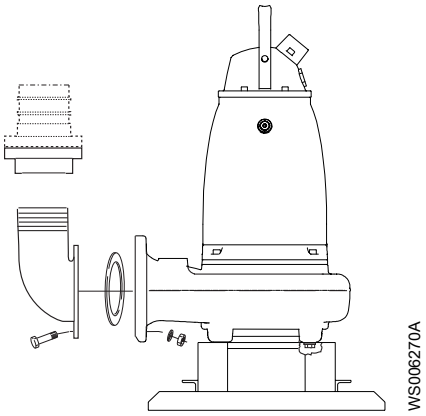


Figure 5: S-installation

1. Run the cable so that it has no sharp bends. Make sure that it is not pinched, and cannot be sucked into the pump inlet.
2. Connect the discharge line.
3. Lower the pump into the sump.
4. Place the pump on the base and make sure it cannot fall over or sink.

   Alternatively, the pump can be suspended with a lifting chain just above the sump bottom. Make sure that the pump cannot rotate at startup or during operation.
5. Connect the motor cable and the starter and monitoring equipment according to the separate instructions.

   Make sure that the impeller rotation is correct. For more information, see *Check the impeller rotation* (page 33).

Install with T/Z-installation

In the T-installation, the pump is installed in a vertical position in a dry well next to the wet sump. These requirements and instructions only apply when the installation is made according to the dimensional drawing.

In the Z-installation, the pump is installed in a horizontal position on a support stand in a dry well next to the wet sump, and a bell-mouth is connected to the inlet pipe. These requirements and instructions are for Z-installations that comply to the dimensional drawing.

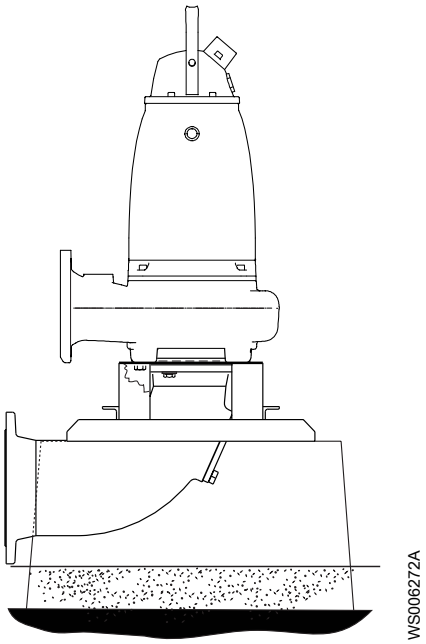


Figure 6: T-installation

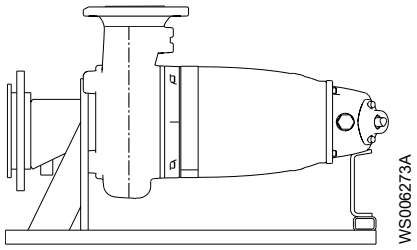


Figure 7: Z-installation

These items are required:

- Support stand and anchor bolts for anchoring the pump to a base
- Inlet elbow for connecting the suction line and discharge line
- Shut-off valves that allow you to remove the pump from service
- Air vent on the discharge side between the pump and the check valve
- Level regulators or other control equipment for start, stop, and alarm

NOTICE:

The risk of freezing is particularly high in T- or Z-installations.

1. Fasten the pump:
   a) Use the anchor bolts to bolt the support stand to the concrete base.
   b) Bolt the pump to the support stand and the suction connection.
2. Make sure that the pump is vertical for the T-installation or horizontal for the Z-installation.
3. Connect the suction line and discharge line.
4. Connect the motor cable and the starter and monitoring equipment according to the separate instructions.

   Make sure that the impeller rotation is correct. For more information, see *Check the impeller rotation* (page 33).
5. Make sure that the weight of the pump does not put strain on the piping.

Make the electrical connections

General precautions

Electrical Hazard:

- A certified electrician must supervise all electrical work. Comply with all local codes and regulations.
- 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.
- Leakage into the electrical parts can cause damaged equipment or a blown fuse. Keep the end of the motor cable above the liquid level.
- Make sure that all unused conductors are insulated.
- 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.
- A permanent-magnet motor generates voltage when the shaft is rotating. Ensure that the shaft can not rotate before performing any electrical installation.

WARNING:

Do not install the starter equipment in an explosive zone unless it is explosion-proof rated.

CAUTION:

If the pump is equipped with automatic level control and/or internal contactor, there is a risk of sudden restart.

Requirements

These general requirements apply for electrical installation:

- The supply authority must be notified before installing the pump if it will be connected to the public mains. When the pump is connected to the public power supply, it may 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 the connected voltage is specified by a yellow sticker close to the cable entry.
- The fuses and circuit breakers must have the proper rating, and the pump overload protection (motor protection breaker) must be connected and set to the rated current according to the data plate and if applicable the cable chart. The starting current in direct-on-line start can be up to six times higher than the rated current.
- The fuse rating and the cables must be in accordance with the local rules and regulations.
- If intermittent operation is prescribed, then the pump must be provided with monitoring equipment supporting such operation.
- If stated on the data plate, then the motor is convertible between different voltages.
- The thermal contacts/thermistors must be in use.
- For FM-approved pumps, FLS must be connected and in use in order to meet approval requirements.

Cables

These are the requirements to follow when you install cables:

- The cables must be in good condition, not have any sharp bends, and not be pinched.
- The sheathing must not be damaged and must not have indentations or be embossed (with markings, etc.) at the cable entry.
- The cable entry seal sleeve and washers must conform to the outside diameter of the cable.
- The minimum bending radius must not be below the accepted value.
- If using a cable which has been used before, a short piece must be peeled off when refitting it so that the cable entry seal sleeve does not close around the cable at the same point again. If the outer sheath of the cable is damaged, then replace the cable. Contact an Xylem service shop.
- The voltage drop in long cables must be taken into account. The drive unit's rated voltage is the voltage measured at the cable connection point in the pump.
- The screened cable must be used according to the European CE requirements if a Variable Frequency Drive (VFD) is used. For more information, contact your Xylem representative (VFD-supplier).

Earthing (Grounding)

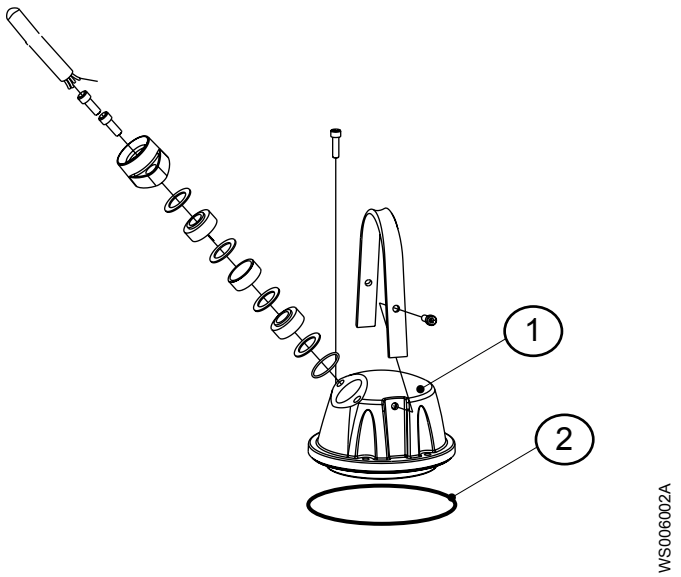
Electrical Hazard:

- You must earth (ground) all electrical equipment. This applies to the pump equipment, the driver, and any monitoring equipment. Test the earth (ground) lead to verify that it is connected correctly.
- If the motor cable is jerked loose by mistake, the earth (ground) conductor should be the last conductor to come loose from its terminal. Make sure that the earth (ground) conductor is longer than the phase conductors. This applies to both ends of the motor cable.
- Risk of electrical shock or burn. You must connect an additional earth- (ground-) fault protection device to the earthed (grounded) connectors if persons are likely to come into physical contact with the pump or pumped liquids.

Connect the motor cable to the pump

CAUTION:

Leakage into the electrical parts can cause damaged equipment or a blown fuse. Keep the end of the motor cable above the liquid level.



1. Entrance cover
2. O-ring

For more information about the cable entry, see the Parts list.

1. Remove the entrance cover and the O-ring from the stator housing.
   This provides access to the terminal board.
2. Check the data plate to see which connections are required for the power supply.
3. Arrange the connections on the terminal board in accordance with the required power supply.
   Links (jumper strips) are not used with the Y/D start.
4. Connect the mains leads (L1, L2, L3, and earth (ground)) according to applicable cable chart.
   The earth (ground) lead must be 100 mm (4.0 in.) longer than the phase leads in the junction box of the unit.
5. Make sure that the pump is correctly connected to earth (ground).
6. Connect the control leads to the applicable terminal board.
7. Make sure that any thermal contacts incorporated in the pump are properly connected to the terminal board.
8. Install the entrance cover and the O-ring on the stator housing.
9. Fasten the screws on the entrance flange so that the cable insertion assembly bottoms out.

Connect the motor cable to the starter and monitoring equipment

WARNING:
Do not install the starter equipment in an explosive zone unless it is explosion-proof rated.

NOTICE:

- Either thermal contacts or thermistors are incorporated in the pump.
- Thermal contacts must never be exposed to voltages higher than 250 V, breaking current maximum 4 A. It is recommended that they are connected to 24 V over separate fuses to protect other automatic equipment.

1. If thermal contacts are included in the pump installation, connect the T1 and T2 control conductors to the MiniCAS II monitoring equipment.

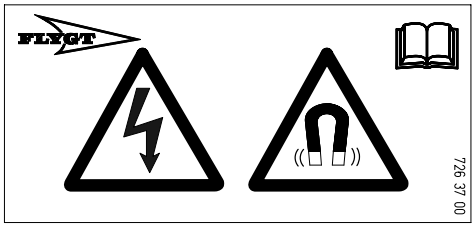
   NOTICE:

   Ex-approved products must always have the thermal contacts connected irrespective of the ambient temperature.

2. If thermistors are included in the pump installation, and screened or auxiliary cable is used, then connect T1(1) and T2(2) to thermistor relay or MAS 711, and T3(3) and T4 (4) to MiniCAS II or MAS 711.
3. Connect the mains leads (L1, L2, L3, and earth [ground]) to the starter equipment.

   For information about the phase sequence and the color codes of the leads, see *Cable charts* (page 25).
4. Ensure that the warning label is attached to the cable end. In case the label is missing, attach the spare label to the cable end.

   The label is delivered with the pump.



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5. Check the functionality of the monitoring equipment:
   a) Check that the signals and the tripping function work properly.
   b) Check that the relays, lamps, fuses, and connections are intact.

   Replace any defective equipment.

Cable charts

Description

This topic contains general connection information. It also provides cable charts that show connection alternatives for use with different cables and power supply.

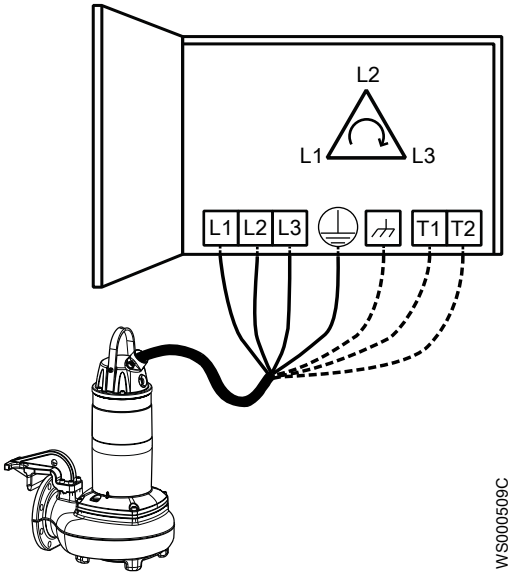
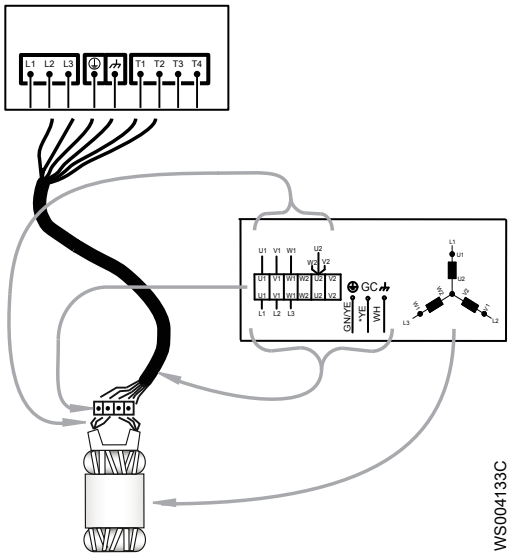


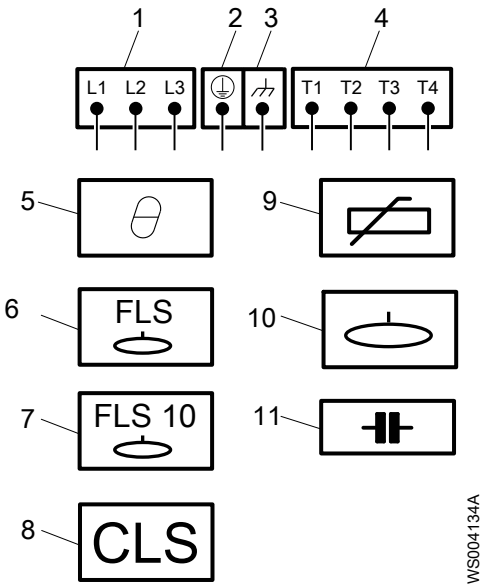
Figure 8: Phase sequence

Connection locations

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



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



1. Starter equipment and mains leads (L1, L2, L3)
2. Earth (ground)
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

Colors and markings of leads

Motor Connection

COLOR STANDARD

BN = Brown
BK = Black
WH = White
OG = Orange
GN = Green
GN/YE = Green-Yellow
RD = Red
GY = Grey
BU = Blue
YE = Yellow

STATOR LEADS

U1,U5 = RD
U2 = GN
V1,V5 = BN
V2 = BU
W1,W5 = YE
W2 = BK
T1,T2 = WH or YE

*SUBCAB AWG
* * Ground conductor is stranded around core
GC=Ground check

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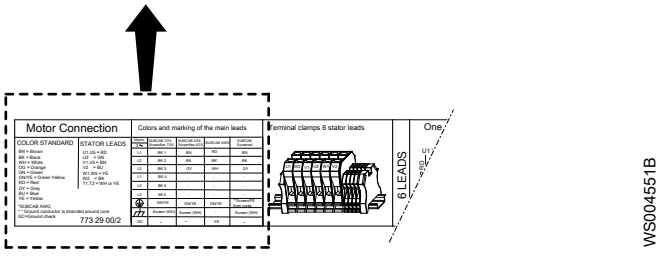
Colors and marking of the main leads

Mains 3 ~	SUBCAB 7GX Screenflex 7GX	SUBCAB 4GX Screenflex 4GX	SUBCAB AWG	SUBCAB Screened
L1	BK 1	BN	RD	BN
L2	BK 2	BK	BK	BK
L3	BK 3	GY	WH	GY
L1	BK 4	-	-	-
L2	BK 5	-	-	-
L3	BK 6	-	-	-
⏚	GN/YE	GN/YE	GN/YE	**Screen/PE from cores
⏚	Screen (WH)	Screen (WH)	-	Screen (WH)
GC	-	-	YE	-



Color code standard

Code	Description
BN	Brown
BK	Black
WH	White
OG	Orange
GN	Green
GNYE	Green-Yellow

Code	Description
RD	Red
GY	Grey
BU	Blue
YE	Yellow

Motor connection

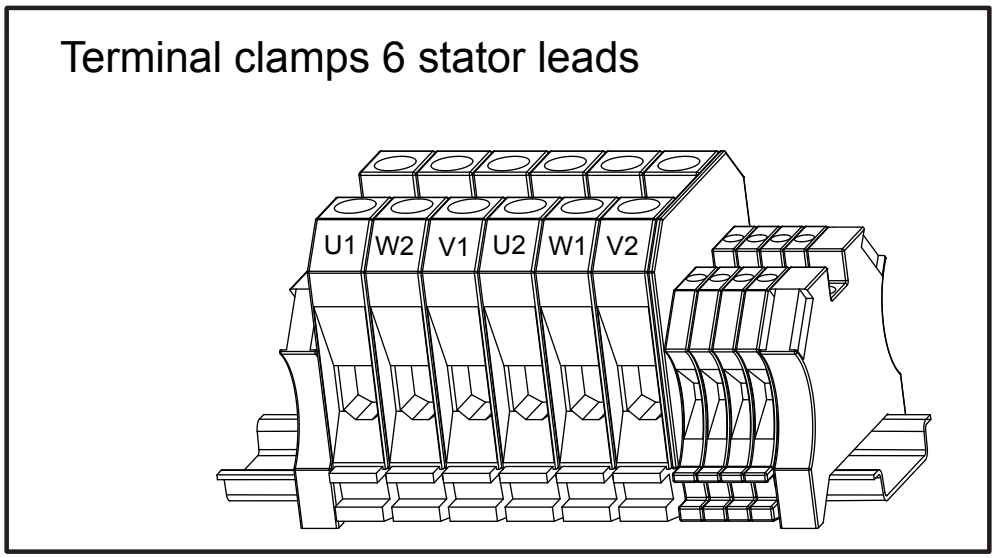


Figure 9: Terminal clamps, 6 stator leads

Connections included

- *6-leads connection* (page 28)
- *9-leads connection* (page 29)
- *Screened cable connection* (page 30)

6-leads connection

If a separate control cable is used, then the control cores in the motor cable are never used.

One cable (left) and two cables (right) Y-connection.

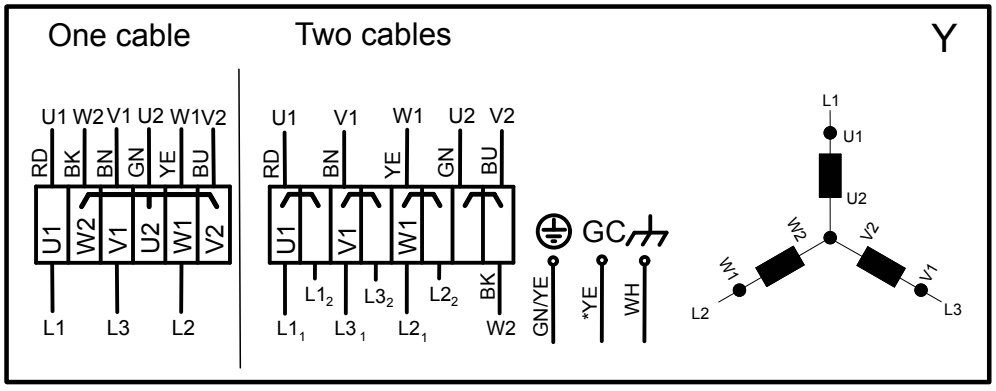


Figure 10: Y-connection

One cable (left) and two cables (right) D-connection.

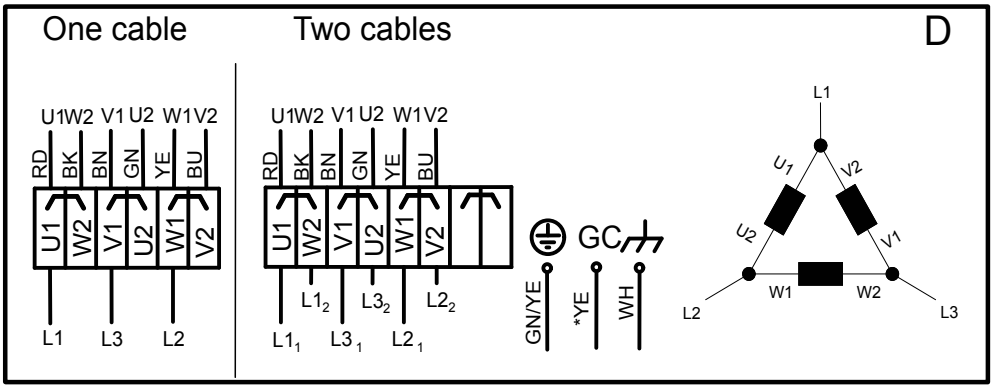


Figure 11: D-connection

One cable (left) and two cables (right)Y/ D-connection.

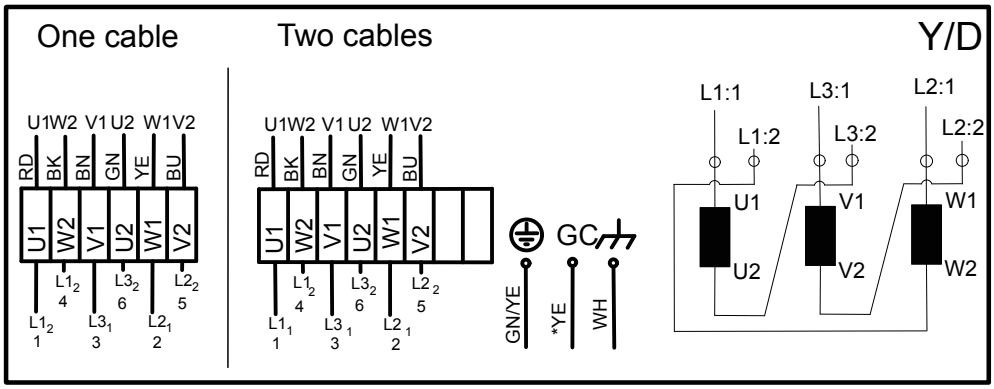


Figure 12: Y/D-connection

Y and D-connection, only applicable to 70 mm^2 terminal clamp.

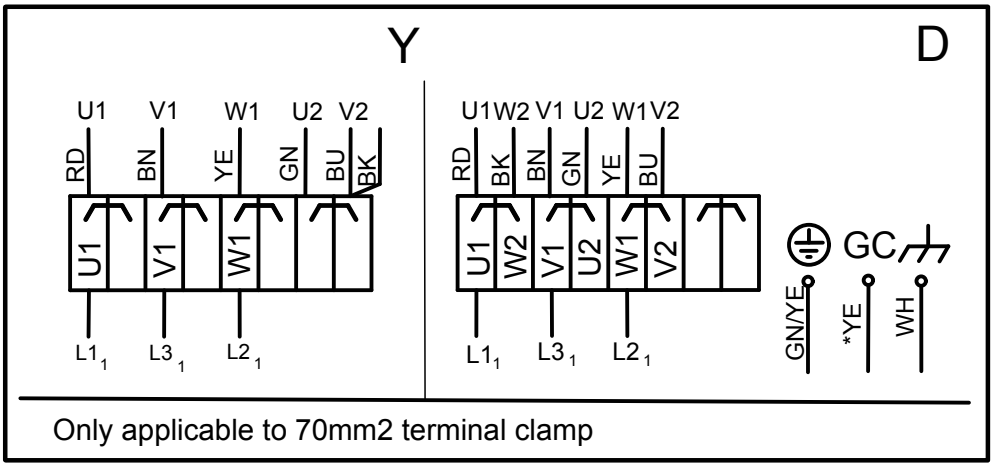


Figure 13: Y or D-connection

9-leads connection

If a separate control cable is used, then the control cores in the motor cable are never used.

One cable (left) and two cables (right) Y-parallel connection.

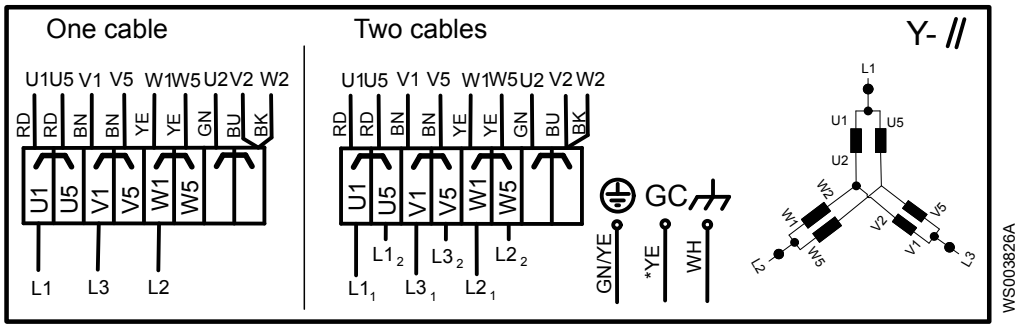


Figure 14: Y-parallel connection

One cable (left) and two cables (right) Y-serial connection.

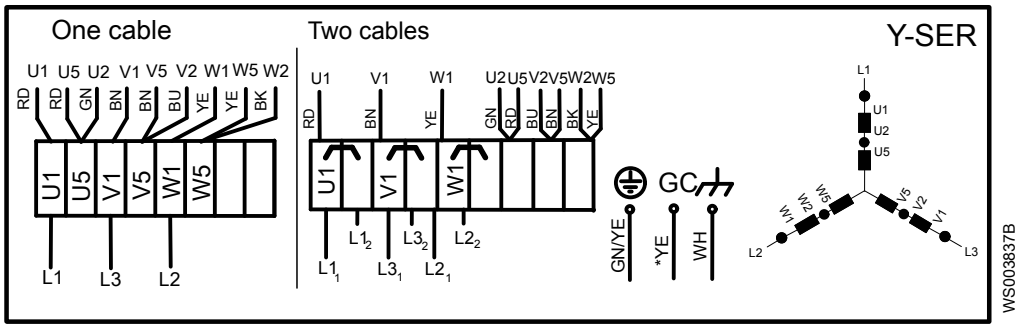


Figure 15: Y-serial connection

Screened cable connection

Cable without separate ground conductor. Screen as ground conductor.

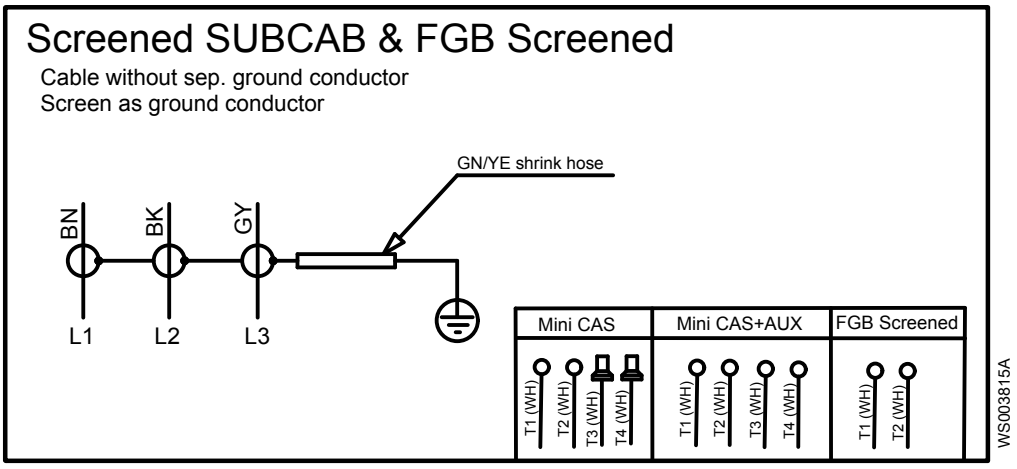


Figure 16: Screened SUBCAB and FGB Screened

* For screened SUBCAB T3 and T4 shall also be twisted separately.

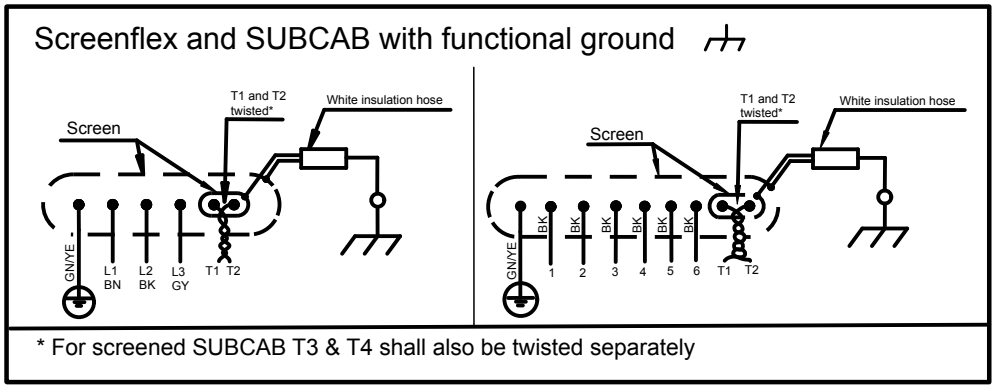


Figure 17: Screenflex and SUBCAB with functional ground

Sensor-connection

Connection to the pump

Color and marking of control leads

Control	SUBCAB 4GX/7G and Screenflex	SUBCAB AWG	SUBCAB Screened
T1	WH T1	OG	WH T1
T2	WH T2	BU	WH T2
T3	-	-	WH T3
T4	-	-	WH T4

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Figure 18: Color and marking of control leads

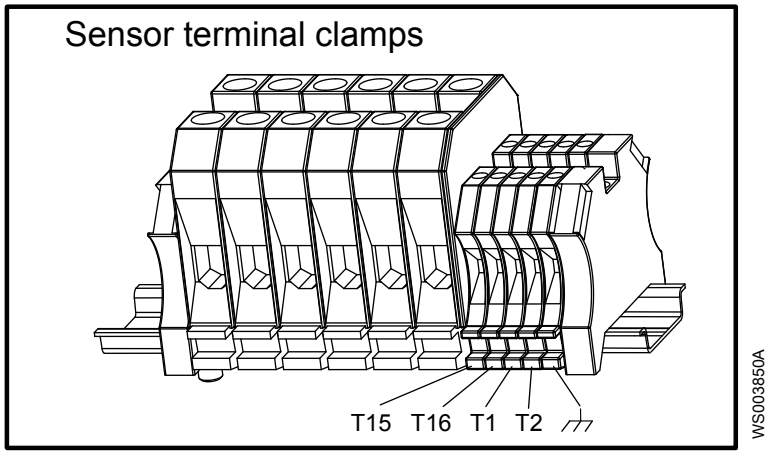
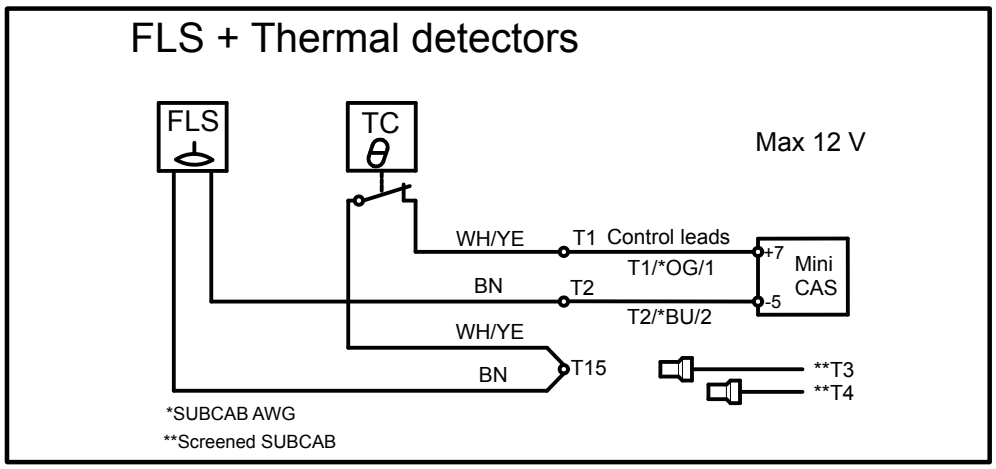


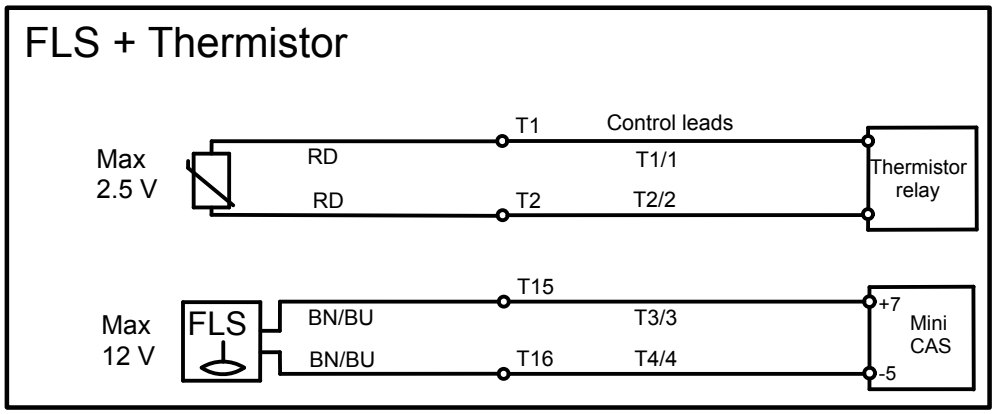
Figure 19: Sensor terminal clamps

FLS 10 and Thermal detectors



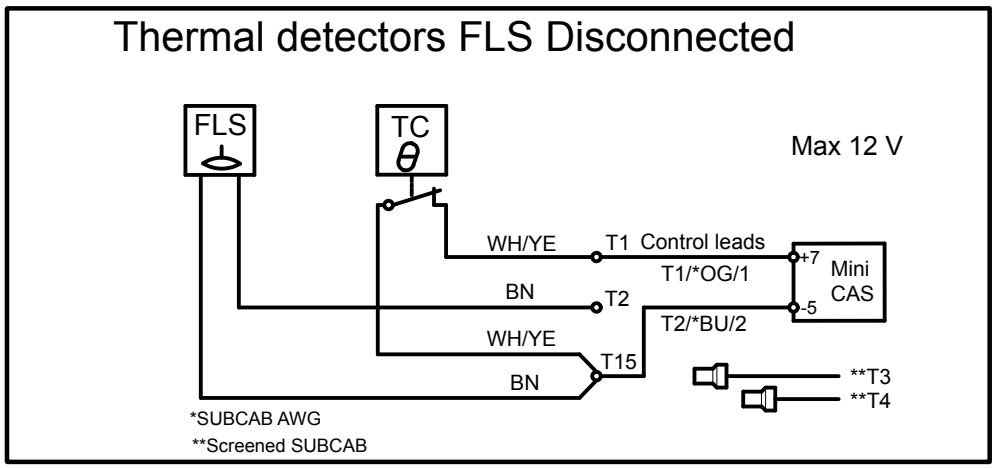
∞ Ohm	Overtemperature
1200 Ohm	OK
430 Ohm	Leakage

FLS 10 and Thermistor



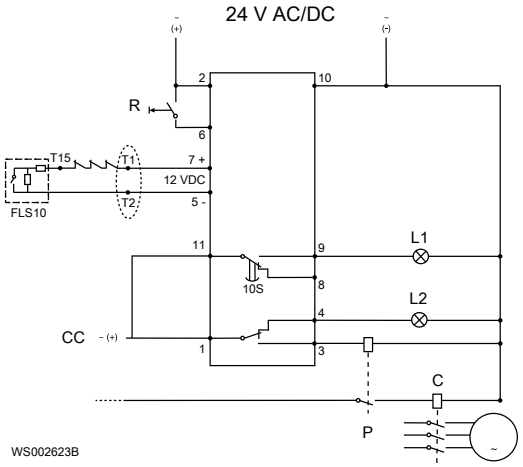
T=25°C (77°F)	R ≤ 100 Ohm
T=135°C (275°F) (T_{REF} -5°C (23°F))	R ≤ 550 Ohm
T=145°C (293°F) (T_{REF} +5°C (41°F))	R ≤ 1330 Ohm

Thermal detectors, FLS disconnected



Connection to the monitoring equipment

MiniCAS II

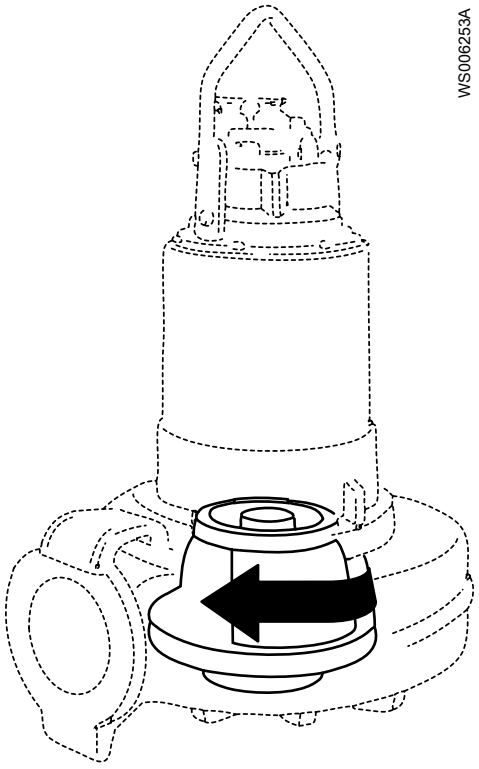


C Pump contactor
CC Control circuit
L1 Caution light (leakage)
L2 Caution light (stator over-temperature)
P Pump main supply
R Reset switch

Check the impeller rotation

WARNING:
The starting jerk can be powerful.

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



The correct direction of impeller rotation is clockwise when you look at the pump from above.

4. If the impeller rotates in the wrong direction, transpose two phase leads (3-phase) and do this procedure again.

Operation

Precautions

WARNING:

- Never operate the pump without safety devices installed.
- Never operate the pump with the discharge valve closed.
- Make sure you have a clear path of retreat.
- Never work alone.

CAUTION:

If the pump is equipped with automatic level control and/or internal contactor, there is a risk of sudden restart.

Distance to wet areas

Electrical Hazard:

Risk of electrical shock. Make sure no one gets closer than 20 m (65 ft.) to the unit when being in contact with the pumped or mixed liquid.

Noise level

NOTICE:

The noise level of the product is lower than 70 dB. However, the noise level of 70 dB may be exceeded in some installations and at certain operating points on the performance curve. Make sure that you understand the noise level requirements in the environment where the pump is installed. Failure to do so may result in hearing loss or violation of local laws.

Start the pump

Electrical Hazard:

A permanent-magnet motor generates voltage when the shaft is rotating. Ensure that the shaft can not rotate before performing any electrical installation.

WARNING:

- If you need to work on the pump, make sure that it is isolated from the power supply and cannot be energized.
- Make sure that the unit cannot roll or fall over and injure people or damage property.
- In some installations, the pump and the surrounding liquid may be hot. Bear in mind the risk of burn injuries.
- Make sure nobody is close to the unit when it is started. The unit will jerk in the opposite direction of the impeller rotation.

NOTICE:

Make sure that the rotation of the impeller is correct. For more information, see Check the impeller rotation.

1. Remove the fuses or open the circuit breaker, and check that the impeller can be rotated freely.
2. Conduct insulation test phase to ground. To pass, the value must exceed 5 megohms.
3. Check that the monitoring equipment works.
4. Start the pump.

Maintenance

Precautions

WARNING:

- Always follow safety guidelines when working on the product. See *Introduction and Safety* (page 3).
- Disconnect and lock out electrical power before installing or servicing the pump.
- Make sure that the unit cannot roll or fall over and injure people or damage property.
- Rinse the unit thoroughly with clean water before working on the unit.
- Rinse the components in water after dismantling.

WARNING:

Electrical hazard. A permanent magnet motor produces voltage when the shaft is rotating. The conductors must be insulated.

CAUTION:

- Magnetic stray fields may damage cardiac pacemaker and other medical implants. Stay clear of any magnetic stray fields that can occur near an open or disassembled permanent-magnet synchronous motor, or near a separate rotor of such a motor. Keep magnetic media away, including credit cards and watches.
- Crush hazard during disassembly or assembly of a permanent-magnet synchronous motor. Fingers or other body parts can be trapped and injured. Magnetic items such as tools attracted to the rotor can also cause personal injury.
- Assembly and disassembly of permanent-magnet synchronous motors must be performed by qualified personnel and according to relevant instructions.

Make sure that you follow these requirements:

- Check the explosion risk before you weld or use electrical hand tools.
- Allow all system and pump components to cool before you handle them.
- Make sure that the product and its components have been thoroughly cleaned.
- 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.
- If the unit has a permanent magnet motor, ensure that you have read and understood all safety instructions regarding permanent magnet motors.

Maintenance guidelines

During maintenance and before reassembly, always remember to perform these tasks:

- Clean all parts thoroughly, particularly O-ring grooves.
- Change all O-rings, gaskets, and seal washers.
- Lubricate all springs, screws, and O-rings with grease.

During reassembly, always make sure that existing index markings are in line.

The reassembled drive unit must always be insulation-tested and the reassembled pump must always be test-run before normal operation.

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 suitable lubricants to prevent seizing.

If there is a question regarding the tightening torques, please contact a sales representative.

Screws and nuts

Table 1: Stainless steel, A2 and A4, torque Nm (ft-lbs)

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)
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 2: Steel, torque Nm (ft-lbs)

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)

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 above.

Change the coolant

This image shows the plugs that are used to change the coolant.

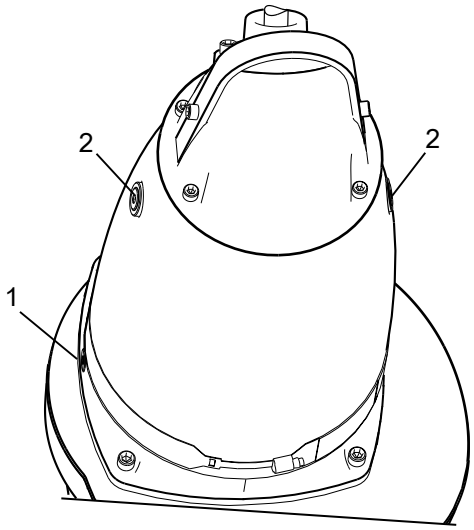


Figure 20: With a cooling jacket

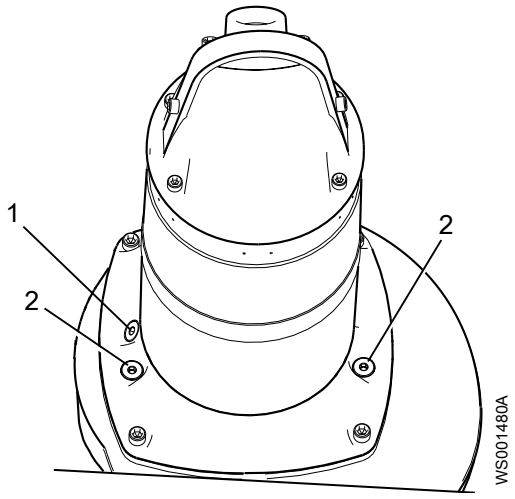


Figure 21: Without a cooling jacket

1. Inspection plug
2. Coolant plugs

Empty the coolant

WARNING:
The seal housing may be pressurized. Hold a rag over the inspection/ filling plugs to prevent splatter.

1. Empty the coolant in the inspection chamber:
   a) Remove the inspection plug.

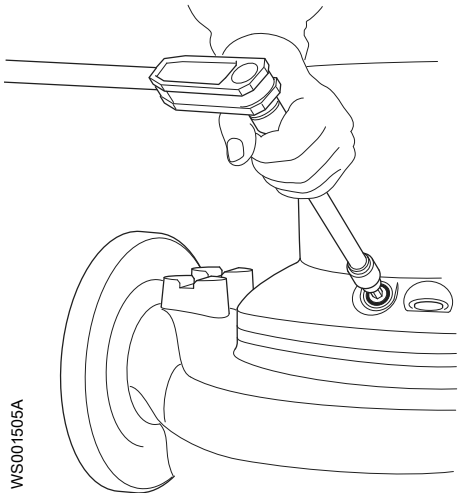


Figure 22: Without a cooling jacket

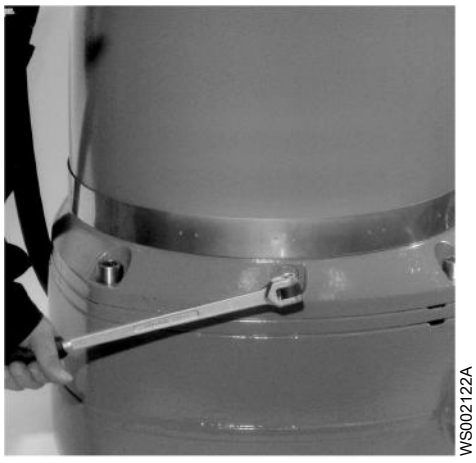
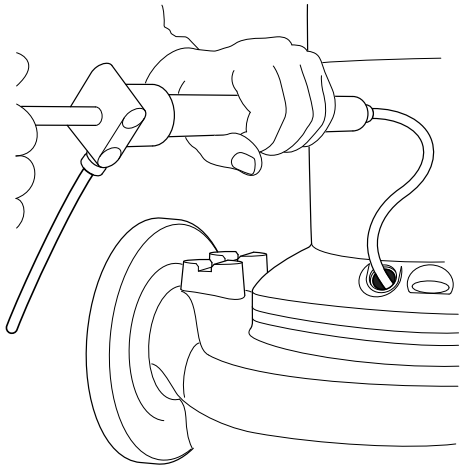


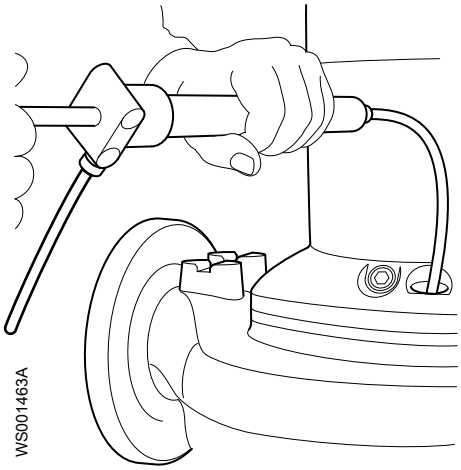
Figure 23: With a cooling jacket

   b) Pump out any coolant from the inspection chamber, as shown here.



c) Replace the inspection plug and O-ring and tighten.
   Tightening torque: 44 Nm (33 ft-lbs)

2. Empty the coolant:
   a) Place the pump in a horizontal position, or leave it upright to use a pump to empty the coolant.



   b) If the pump is laid in a horizontal position, place a container under the pump.
   c) Remove the coolant plugs and empty the coolant.

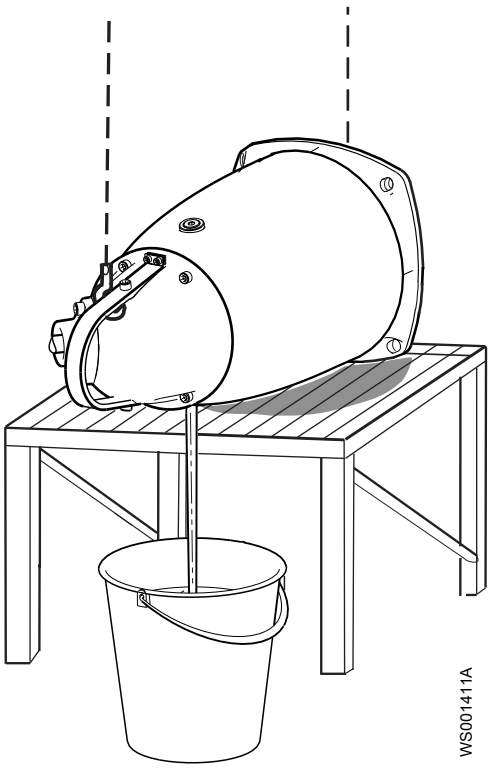


Figure 24: With a cooling jacket

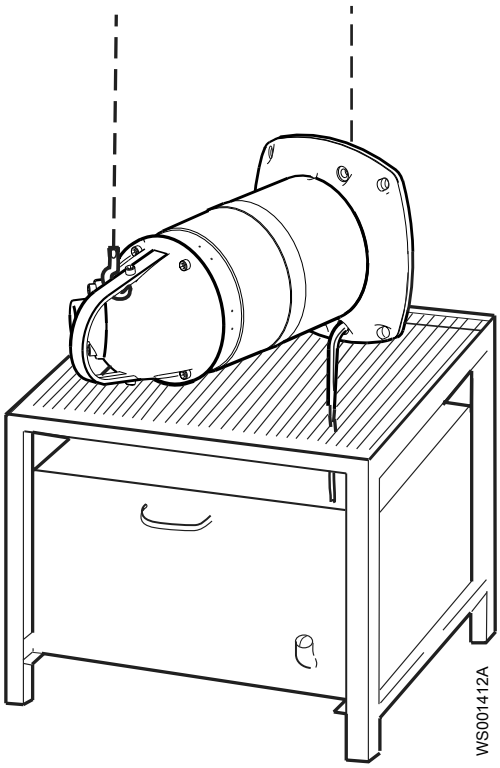


Figure 25: Without a cooling jacket

Fill with coolant

Use a coolant that is a mixture of 70% water and 30% monopropylene glycol. The coolant should prevent corrosion and be nonpoisonous (generally recognized as safe by the FDA as food additives under part 184 and 182).

NOTICE:

Clean water with an anti-corrosive is an acceptable coolant when there is no risk of freezing.

1. Fill with coolant until it overflows through the opposite hole, as shown here.
   Quantity: approximately
   - 2.2 L (2.3 qt.) without cooling jacket
   - 10.5 L (11.2 qt.) with cooling jacket

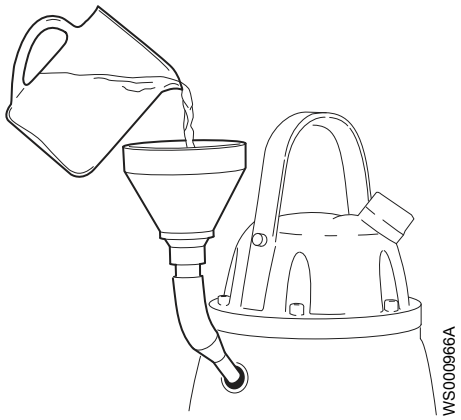


Figure 26: With cooling jacket

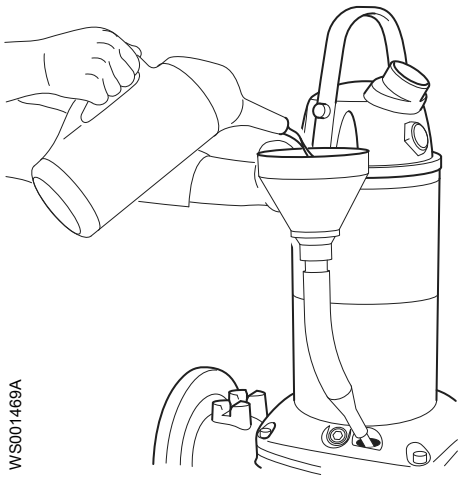


Figure 27: Without cooling jacket

2. Replace the O-rings.
3. Tighten the coolant plugs.
   Tightening torque: 44 Nm (33 ft-lbs)

Service the pump

Type of service	Purpose	Inspection 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.	Within the first year of operation.
Periodical inspection	To prevent operational interruptions and machine breakdown. Measures to secure performance and pump 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.	Up to 12,000 hours or 3 years, whichever comes first. Applies to normal applications and operating conditions at media (liquid) temperatures <40°C.
Major overhaul	To secure a long operating lifetime for the product. It includes replacement of key components and the measures taken during an inspection.	Up to 24,000 hours or 6 years, whichever comes first. Applies to normal applications and operating conditions at media (liquid) temperatures <40°C.

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).

Inspection

Service item	Action
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.
Connection to power	Check that the connections are properly tightened.
Electrical cabinets	Check that they are clean and dry.
Impeller	1. Check the impeller clearance. 2. Adjust the impeller, if necessary.
Inspection chamber	1. Drain all liquid, if any. 2. Check the resistance of the leakage sensor. Normal value approx.1200 ohms, alarm approx. 430 ohms.
Insulation	Use a megger maximum 1000 V. 1. Check that the resistance between the earth (ground) and phase lead is more than 5 megohms. 2. Conduct a phase-to-phase resistance check.
Junction box	Check that it is clean and dry.
Level regulators	Check the condition and functionality.
Lifting device	Check that local safety regulations are followed.
Lifting handle	1. Check the screws. 2. Check the condition of the lifting handle. 3. Replace if necessary.
O-rings	1. Replace the oil plug O-rings. 2. Replace the O-rings at the entrance or junction cover. 3. Grease the new O-rings.
Overload protection and other protections	Check the correct settings.
Personnel safety devices	Check the guard rails, covers, and other protections.
Rotation direction	Check the impeller rotation.
Seal housing	1. Fill with new coolant, if necessary. 2. Check that the freezing point is lower than -13°C (9°F).
Terminal board	Check that the connections are properly tightened.
Thermal contacts	Normally closed circuit; interval 0–1 ohm.
Thermistor	Check the resistance is between 20–250 ohms and the measured voltage is maximum 2 V DC.
Voltage and amperage	Check the running values.

Major overhaul

For a major overhaul, take this action in addition to the tasks listed under Inspection.

Service item	Action
Support and main bearing	Replace the bearings with new bearings.
Mechanical seal	Replace with new seal units.

Service in case of alarm

For information about indication values for sensors, see *Sensor-connection* (page 31).

Alarm source	Action
FLS10	1. Drain the fluid in the inspection chamber. Fill with new coolant if necessary. 2. Check the freezing point (lower than -13°C or 9°F). Check the inspection chamber again after one week of operation. If leakage has occurred: 1. Drain the fluid. 2. Change the mechanical seal unit. 3. Replace with new coolant.
The thermistor/Thermal contact	1. Check the coolant level (pump with cooling jacket). 2. Check the start and stop levels.
The overload protection	Check that the impeller can rotate freely.

Replace the impeller

Required tools:

- 12 mm hexagon bit adapter with an extension of at least a 100 mm (4 in.)
- Rod (wood or plastic) for locking the impeller in place.

WARNING:

- If you fail with the impeller installation, you must redo the installation procedure from the beginning.
- A worn impeller and/or pump housing can have very sharp edges. Wear protective gloves.
- When laying the pump on its side, do not allow the weight of the pump to rest on any portion of the impeller. The impeller must not be allowed to make contact with the concrete floor or other hard and rough surfaces.

Replace the impeller for wet installation

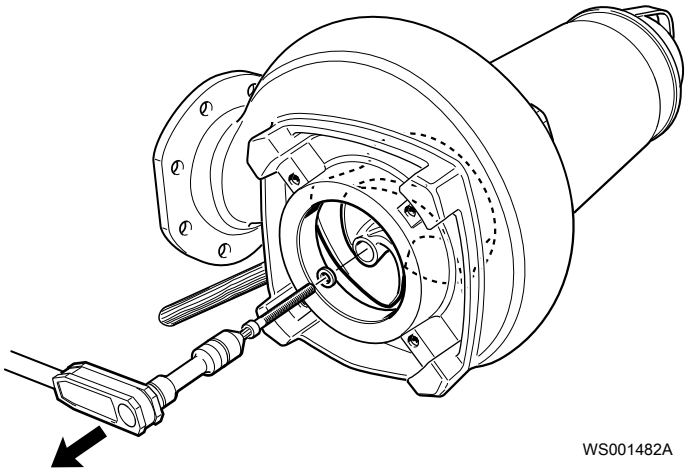
Remove the impeller: wet installation

CAUTION:

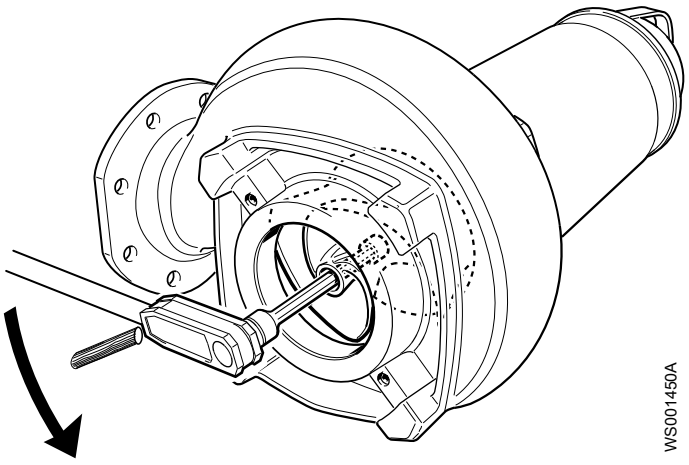
Wear heavy work gloves when you handle impellers. The sharp edges can cause physical injury.

1. Place the pump in a horizontal position.
2. Remove the impeller:

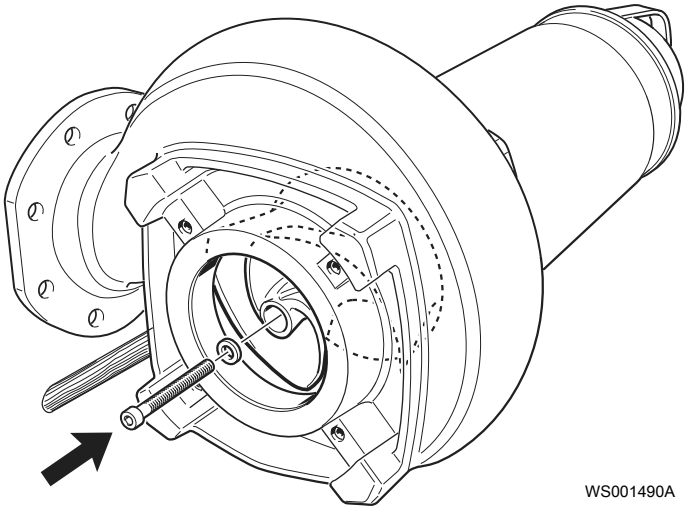
a) Remove the flush valve cover and its O-ring.
b) Lock the impeller in place by inserting a rod through the hole.
c) Remove the impeller screw.



d) Turn the adjustment screw counterclockwise until the impeller breaks free from the shaft.



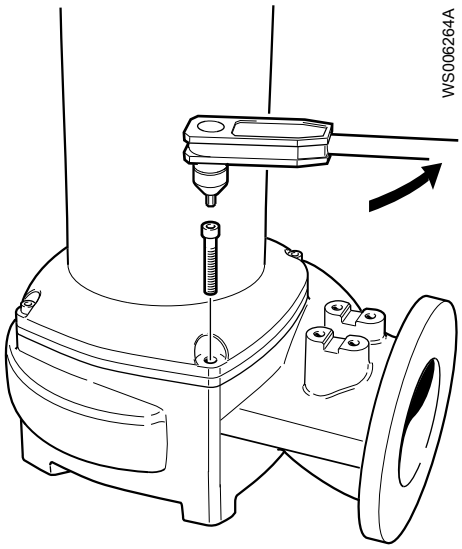
e) Hand-tighten the impeller screw to prevent it from falling off.



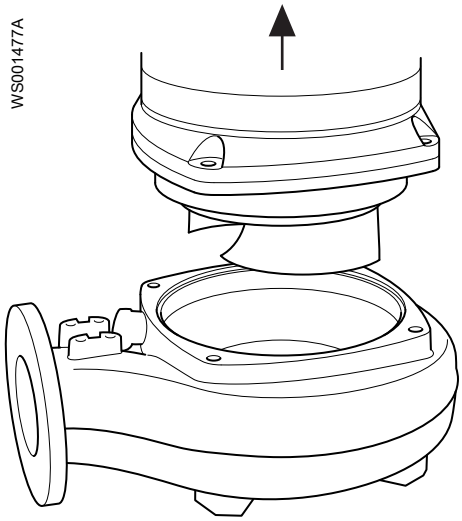
f) Remove the rod.

3. Raise the pump.
4. Remove the drive unit from the pump housing:

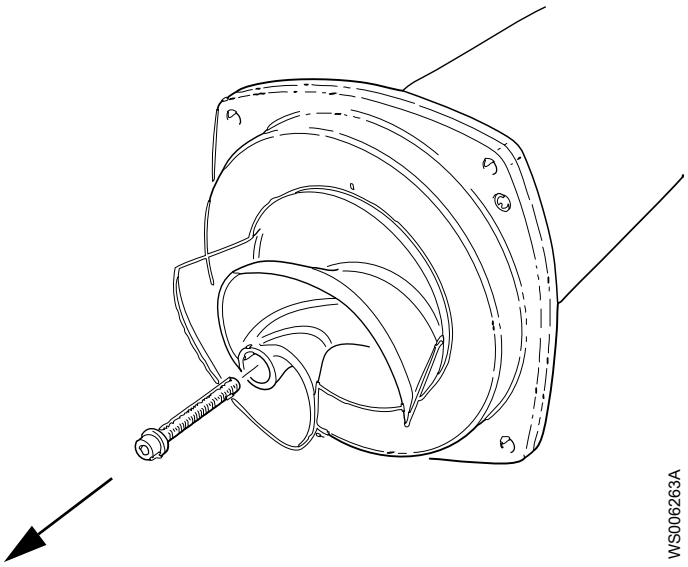
a) Remove the pump housing screws.



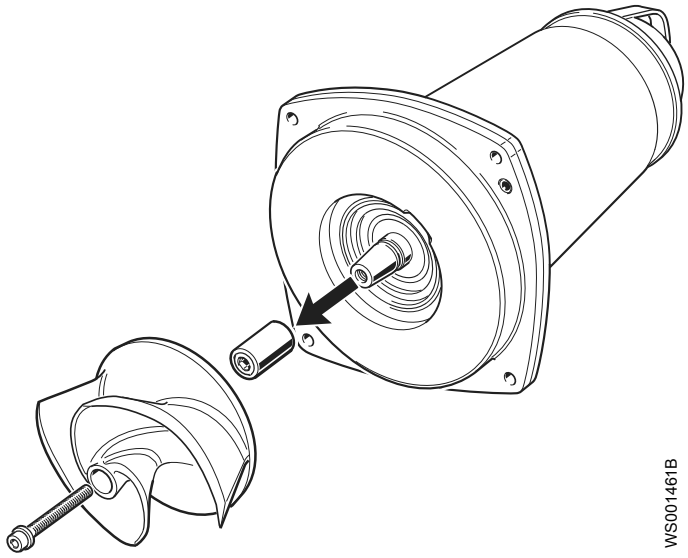
b) Remove the drive unit from the pump housing.



5. Remove the impeller:
   a) Place the drive unit horizontally.
   b) Remove the impeller screw.



c) Remove the impeller and the conical sleeve.



Install the impeller: wet installation

1. Mount the impeller:
   a) Make sure that the end of the shaft is free from burrs.
      Polish off any flaws with a fine emery cloth.
   b) Grease the shaft end.

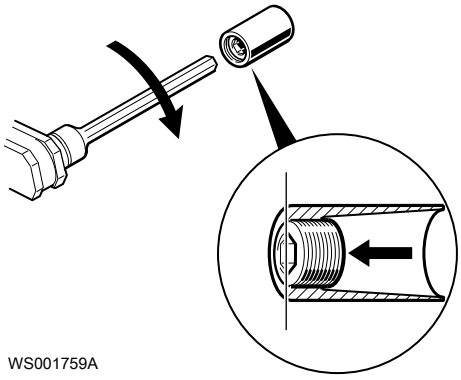
NOTICE:

Surplus grease can cause the impeller to become loose. Remove surplus grease from conical and/or cylindrical surfaces of shafts and/or sleeves.

c) Grease the conical sleeve, the threads of the adjustment screw, the washer, and the impeller screw.

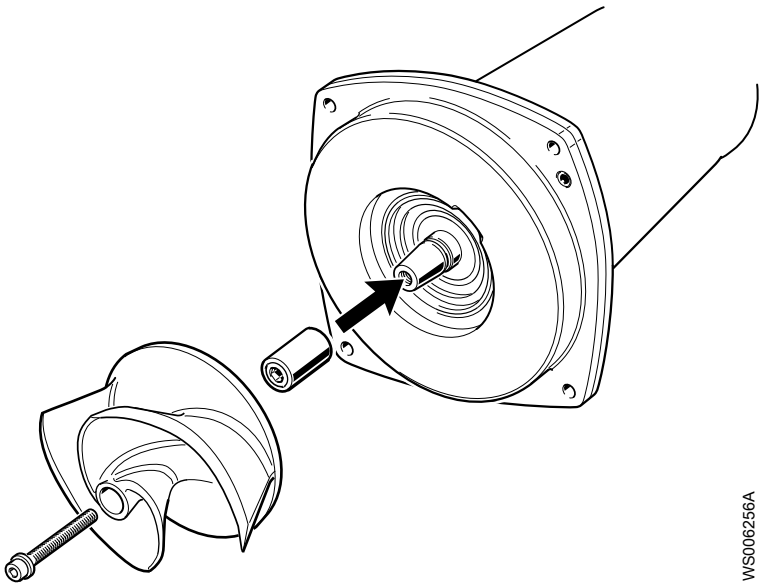
Always use a new impeller screw.

d) Adjust the adjustment screw so that it is flush with the sleeve.

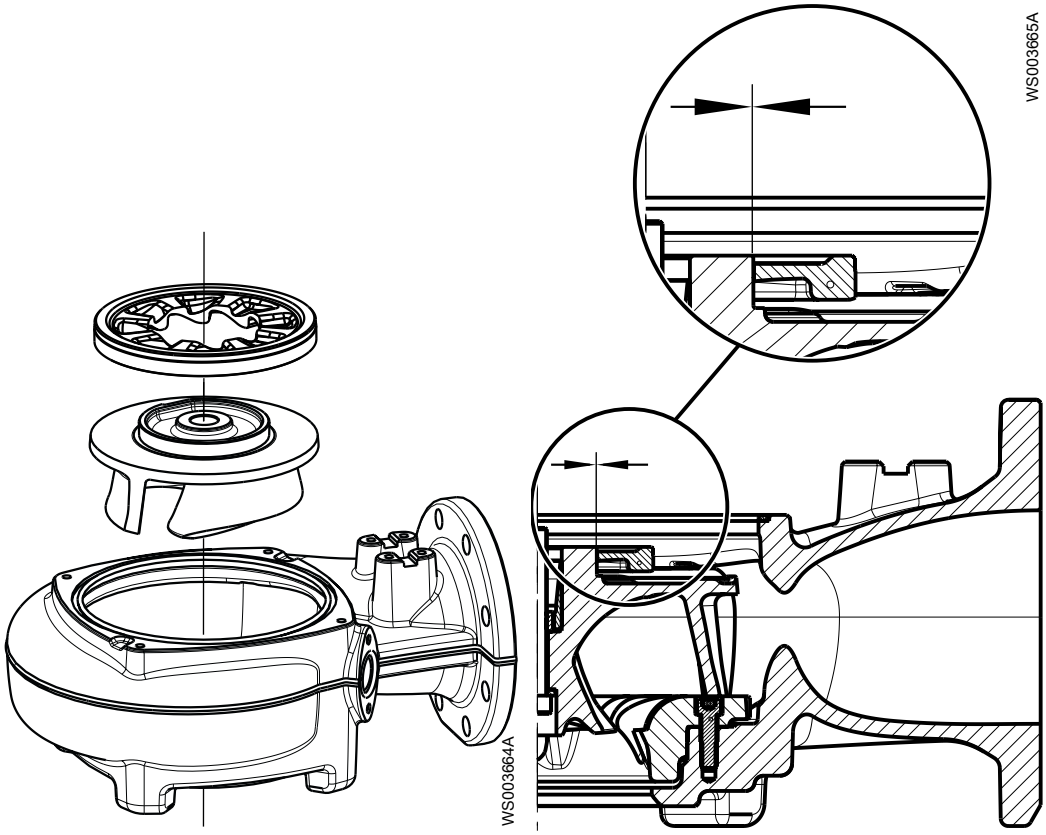


e) Fit the sleeve and impeller to the shaft.

f) Hand-tighten the impeller screw to prevent it from falling off.

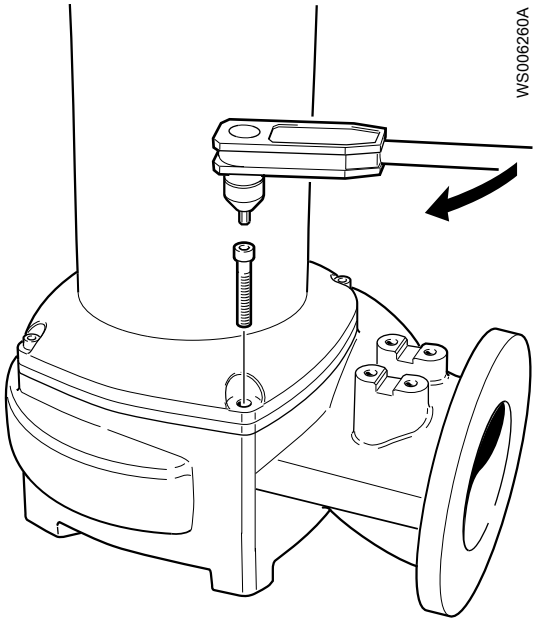


2. If applicable, check that the clearance between the impeller and the insert ring is maximum 1 mm (0.04 in.) radial. If not, send the pump for service.
   The insert ring is pressed into the seal housing cover.

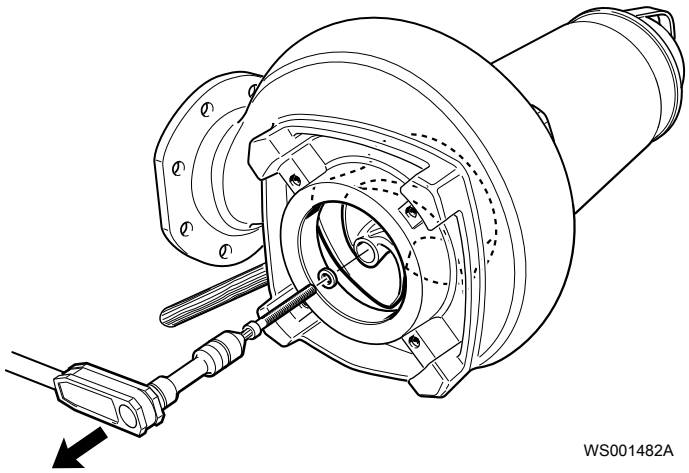


3. Fit the pump housing:
   a) Fit a new and greased O-ring on the seal housing cover.
   b) Grease the pump housing screws.
   c) Raise the drive unit.
   d) Place the drive unit into the pump housing.

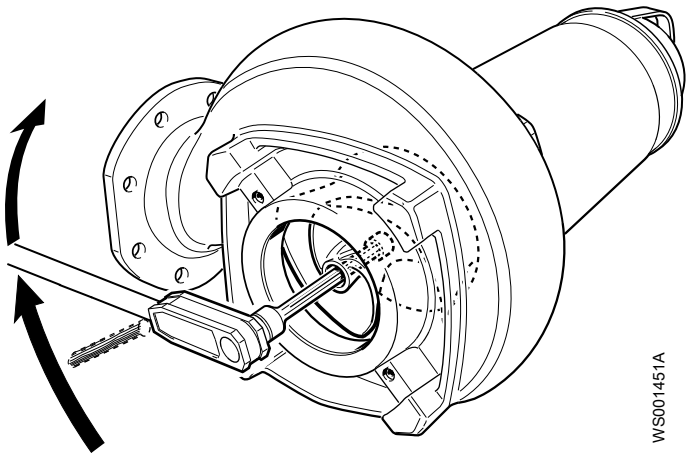
e) Adjust its position so that the inspection hole is on the same side as the flush valve.
f) Tighten the screws in diagonal sequence.
For tightening torque, see *Torque values* (page 38).



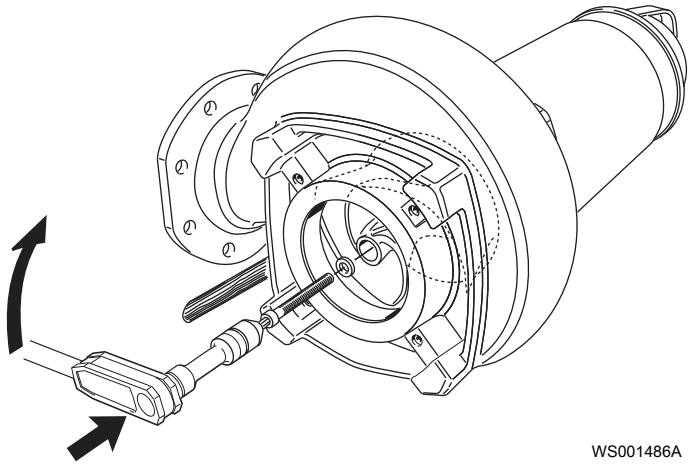
4. Remove the impeller screw:
   a) Place the pump horizontally.
   b) Lock the impeller in place by inserting a rod through the hole.
   c) Remove the impeller screw and the washer.



5. Adjust the impeller:
   a) Using a hexagon-bit adapter, turn the adjustment screw clockwise until the impeller makes contact with the pump housing.
   For tightening torque, see *Torque values* (page 38).
   b) Tighten it a further 1/8 turn (45°).



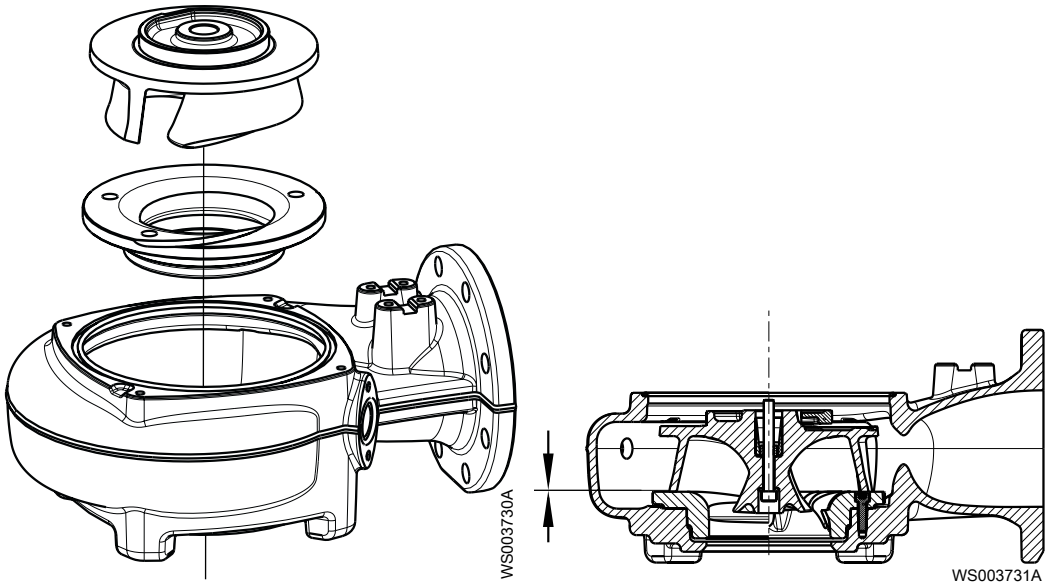
6. Fasten the impeller:
   a) Fit the greased washer and impeller screw.
   b) Tighten the impeller screw.
      For tightening torque, see *Torque values* (page 38).
   c) Tighten it a further 1/8 turn (45°).



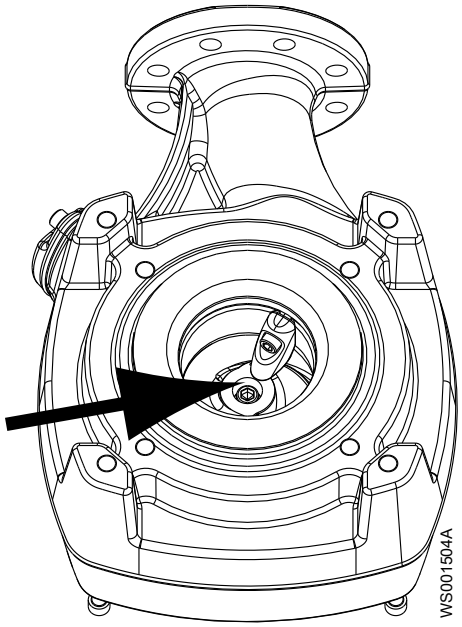
   d) Remove the rod used to lock the impeller.
   e) Fit the O-ring and flush valve cover and fasten it with screws.
      For tightening torque, see *Torque values* (page 38).
   f) Check that the impeller can rotate freely.

CAUTION:
Beware of the pinch point hazard between the rotating impeller and the guide pin.

7. Check that the clearance between the impeller and the insert ring is 0.1–0.5 mm (0.004–0.02 in.).



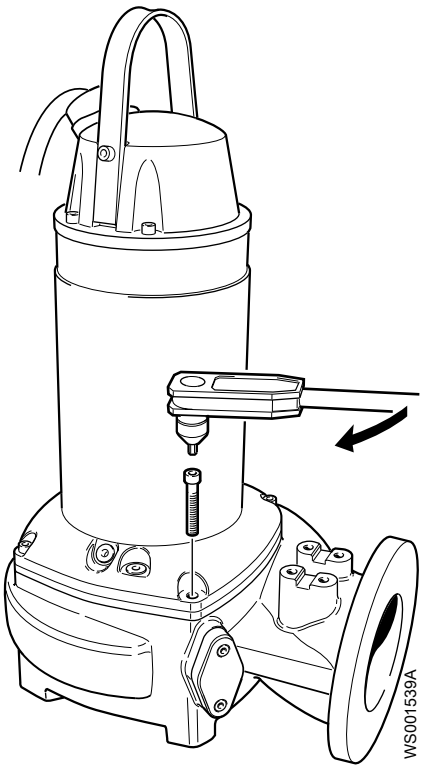
8. If applicable, adjust clearance to 0.1–0.5 mm (0.004–0.02 in.) between the guide pin and the impeller.



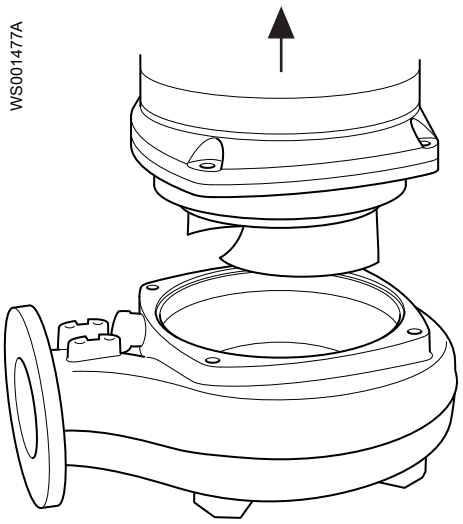
Replace the impeller for dry installation

Remove the impeller: dry installation

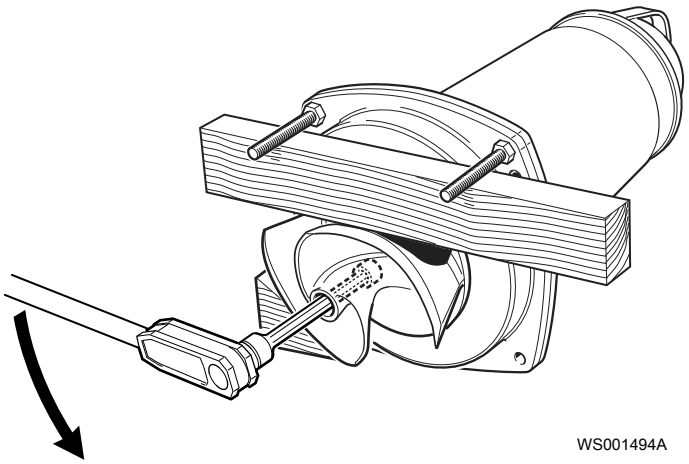
1. Remove the drive unit from the pump housing:
   a) Remove the pump housing screws.



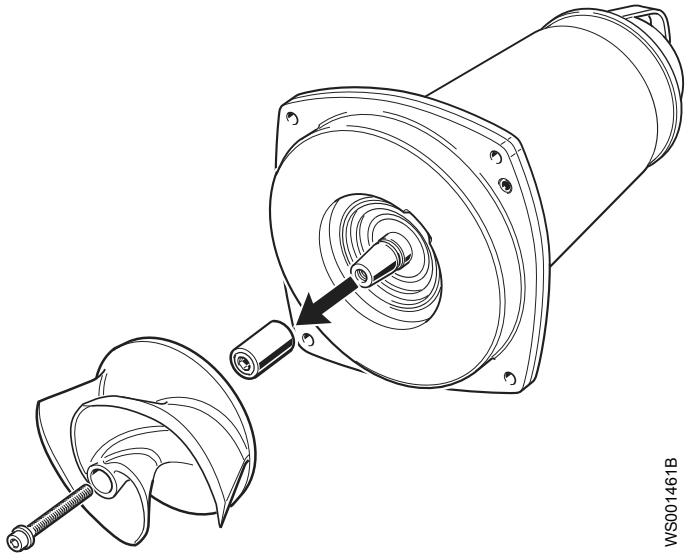
b) Remove the drive unit from the pump housing.



2. Remove the impeller:
   a) Place the drive unit horizontally.
   b) Lock the impeller as shown in the figure.
   c) Remove the impeller screw.



d) Turn the adjustment screw counterclockwise until the impeller breaks free from the shaft.
e) Remove the impeller and the conical sleeve.



Install the impeller: dry installation

1. Prepare the sleeve:
   a) Make sure that the end of the shaft is free from burrs.
      Polish off any flaws with a fine emery cloth.
   b) Grease the shaft end.

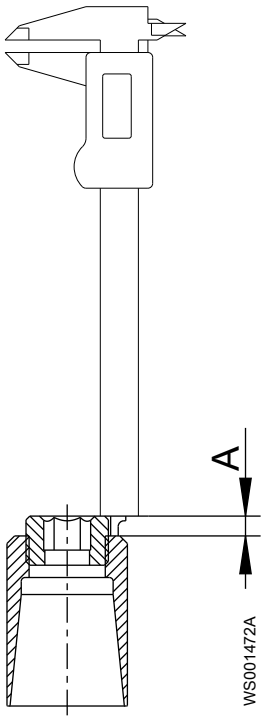
NOTICE:
Surplus grease can cause the impeller to become loose. Remove surplus grease from conical and/or cylindrical surfaces of shafts and/or sleeves.

c) Grease the conical sleeve, the threads of the adjustment screw, the washer, and the impeller screw.

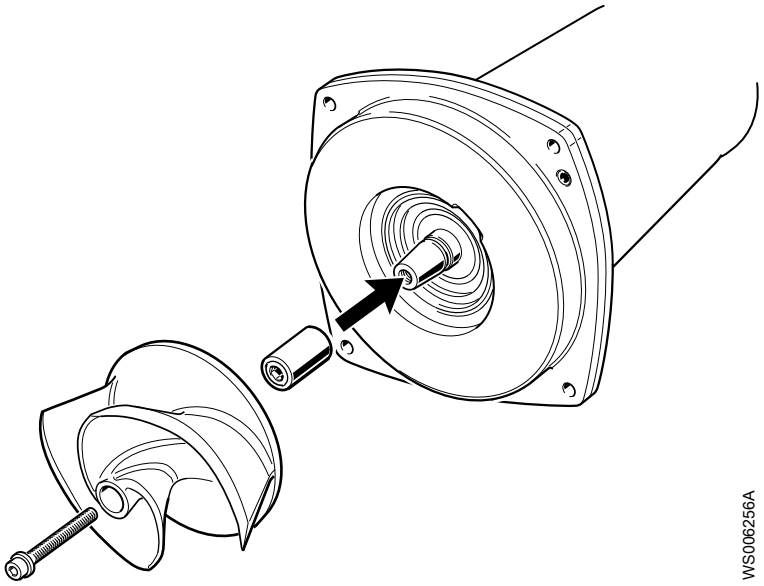
Always use a new impeller screw.

d) Unscrew the adjustment screw approximately 5 mm (0.2 in.).

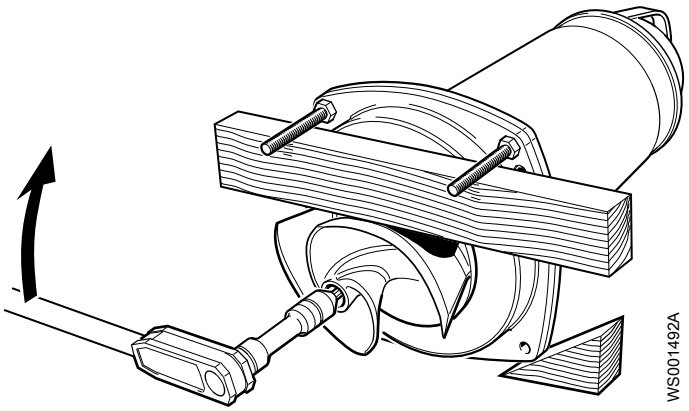
e) Measure and note the distance A.



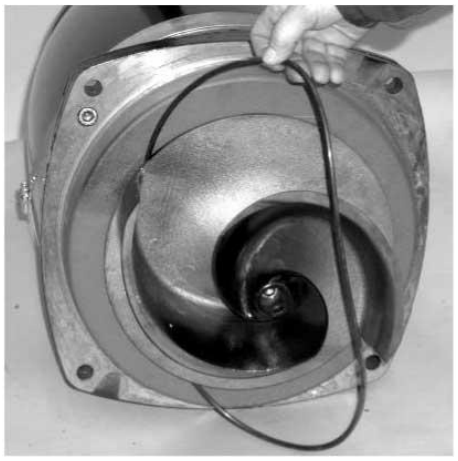
2. Mount the impeller:
   a) Fit the sleeve and the impeller to the shaft.



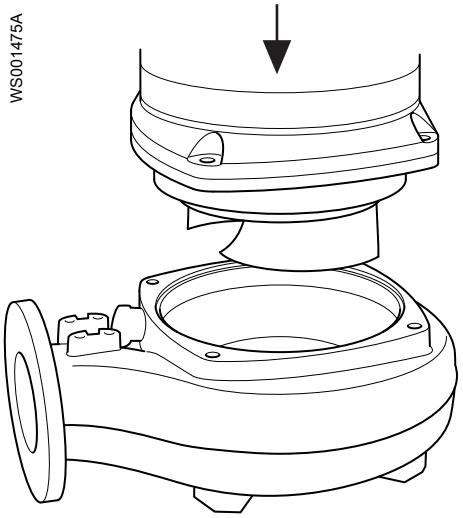
   b) Fit the impeller screw and washer and tighten.



3. Make sure that the O-ring is removed from the seal housing cover.

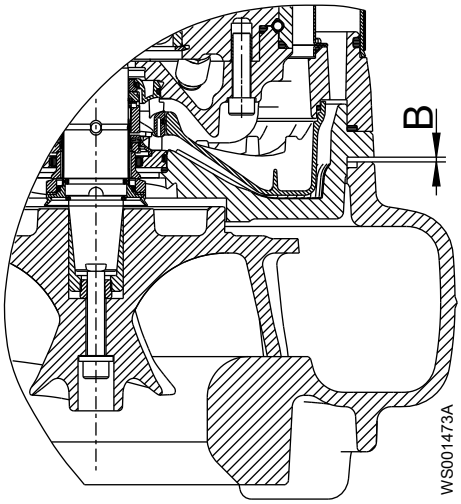


4. Measure the trim distance:
   a) Place the drive unit in the pump housing.
      Make sure that the drive unit is parallel with the pump housing by hand-tightening the pump housing screws.

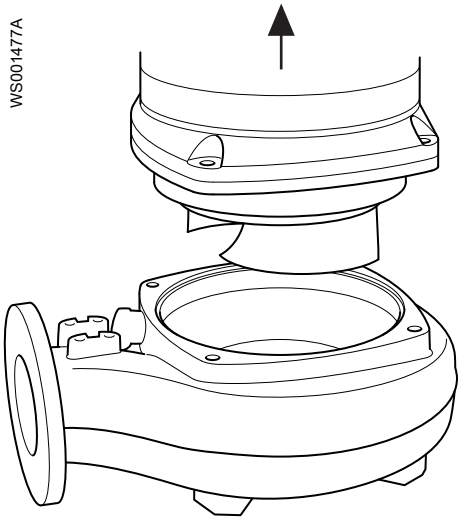


   b) Check the distance between the seal housing cover and the pump housing with a feeler gauge.
      Check diagonally at four points.

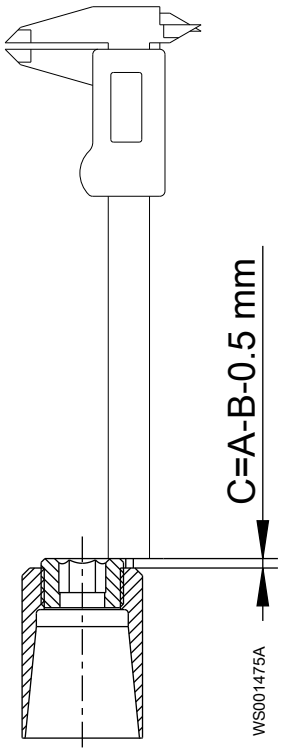
c) Note the largest distance B.



d) Lift the drive unit out of the pump housing and remove the impeller and conical sleeve.

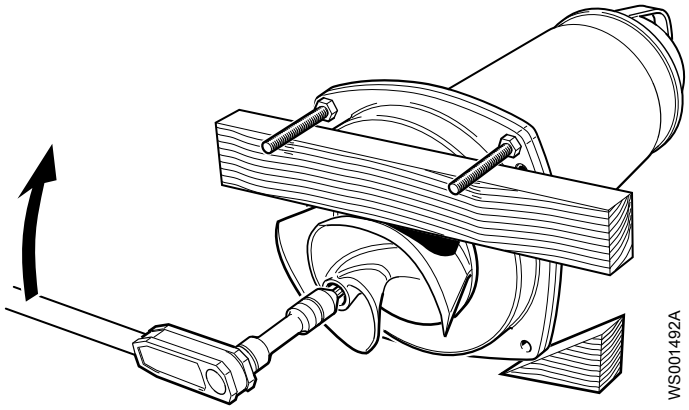


5. Trim to the correct distance:
   a) Calculate the measure C according to the formula shown in the image.

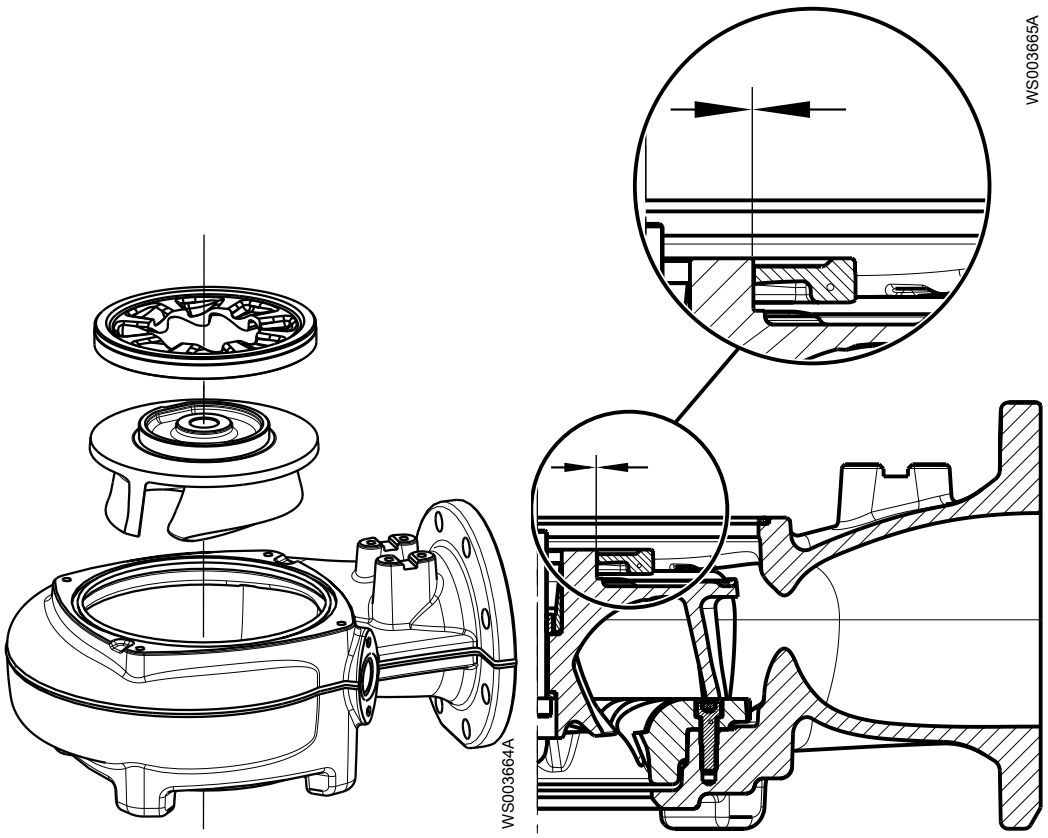


b) Turn the adjustment screw until C is reached.

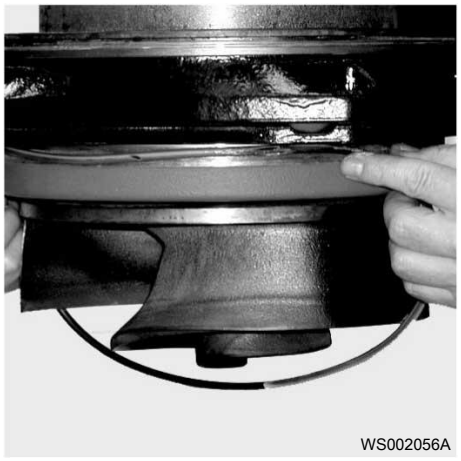
6. Fasten the impeller:
   a) Fit the sleeve, impeller, greased washer with a greased impeller screw.
   b) Tighten the impeller screw.
      For tightening torque, see *Torque values* (page 38).
   c) Tighten it further 1/8 turn (45°).



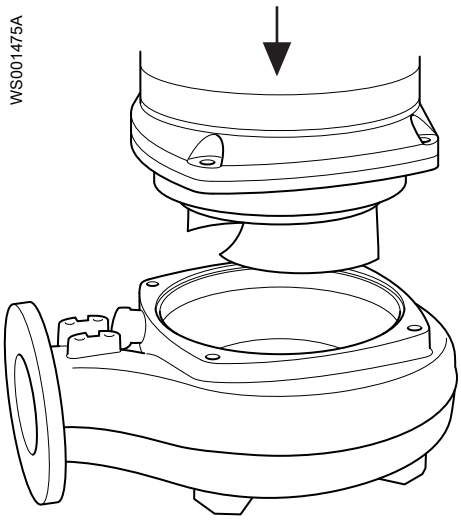
7. If applicable, check that the clearance between the impeller and the insert ring is maximum 1 mm (0.04 in.) radial. If not, send the pump for service.
   The insert ring is pressed into the seal housing cover.



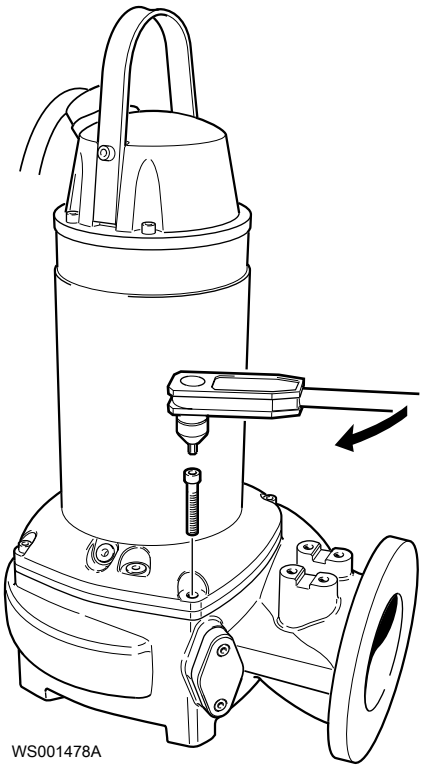
8. Install the drive unit in the pump housing:
   a) Fit a new and greased O-ring to the seal housing cover.



   b) Place the drive unit in the pump housing.



c) Adjust the position of the drive unit so that the inspection hole is on the same side as the flush valve.
d) Tighten the greased screws diagonally.
   For tightening torque, see *Torque values* (page 38).



If you need to adjust the impeller, redo the replace the impeller procedure from the beginning.

Troubleshooting

Introduction

Follow these guidelines when troubleshooting the pump:

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

The pump does not start

WARNING:

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

WARNING:

Electrical hazard. A permanent magnet motor produces voltage when the shaft is rotating. The conductors must be insulated.

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 the local Xylem service shop.
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.
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.

Cause	Remedy
	• 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.

If the problem persists, refer to the Flygt Service Guide on the web or contact the local Xylem service shop. Always state the serial number of your pump when you contact Xylem, see *Product Description* (page 12).

The pump does not stop when a level sensor is used

WARNING:

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

WARNING:

Electrical hazard. A permanent magnet motor produces voltage when the shaft is rotating. The conductors must be insulated.

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 the local Xylem service shop.
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.

If the problem persists, refer to the Flygt Service Guide on the web or contact the local Xylem service shop. Always state the serial number of your pump when you contact Xylem, see *Product Description* (page 12).

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:

Cause	Remedy
	• 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.
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.

If the problem persists, refer to the Flygt Service Guide on the web or contact the local Xylem service shop. Always state the serial number of your pump when you contact Xylem, see *Product Description* (page 12).

The pump runs but the motor protection trips

WARNING:

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

WARNING:

Electrical hazard. A permanent magnet motor produces voltage when the shaft is rotating. The conductors must be insulated.

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, notify a certified electrician.
The phase currents vary, or they are too high.	Contact the local Xylem service shop.

Cause	Remedy
The insulation between the phases and ground in the stator is defective.	1. Use an insulation tester. With a 1000 V DC megger, check that the insulation between the phases and between any phase and ground is > 5 megohms. 2. If the insulation is less: Contact the local Xylem service shop.
The density of the pumped fluid is too high.	Make sure that the maximum density is 1100 kg/m^3 (9.2 lb/US gal) • Change the impeller, or • Change to a more suitable pump. • Contact the local Xylem service shop.
There is a malfunction in the overload protection.	Replace the overload protection.

If the problem persists, refer to the Flygt Service Guide on the web or contact the local Xylem service shop. Always state the serial number of your pump when you contact Xylem, see *Product Description* (page 12).

The pump delivers too little or no water

WARNING:

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

WARNING:

Electrical hazard. A permanent magnet motor produces voltage when the shaft is rotating. The conductors must be insulated.

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, transpose two phase leads. • If it is a 1-phase pump: Contact the local Xylem service shop.
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.

Cause	Remedy
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.

If the problem persists, refer to the Flygt Service Guide on the web or contact the local Xylem service shop. Always state the serial number of your pump when you contact Xylem, see *Product Description* (page 12).

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Flygt Product Direct Sales Offices

To find a Flygt product sales office near you, visit:

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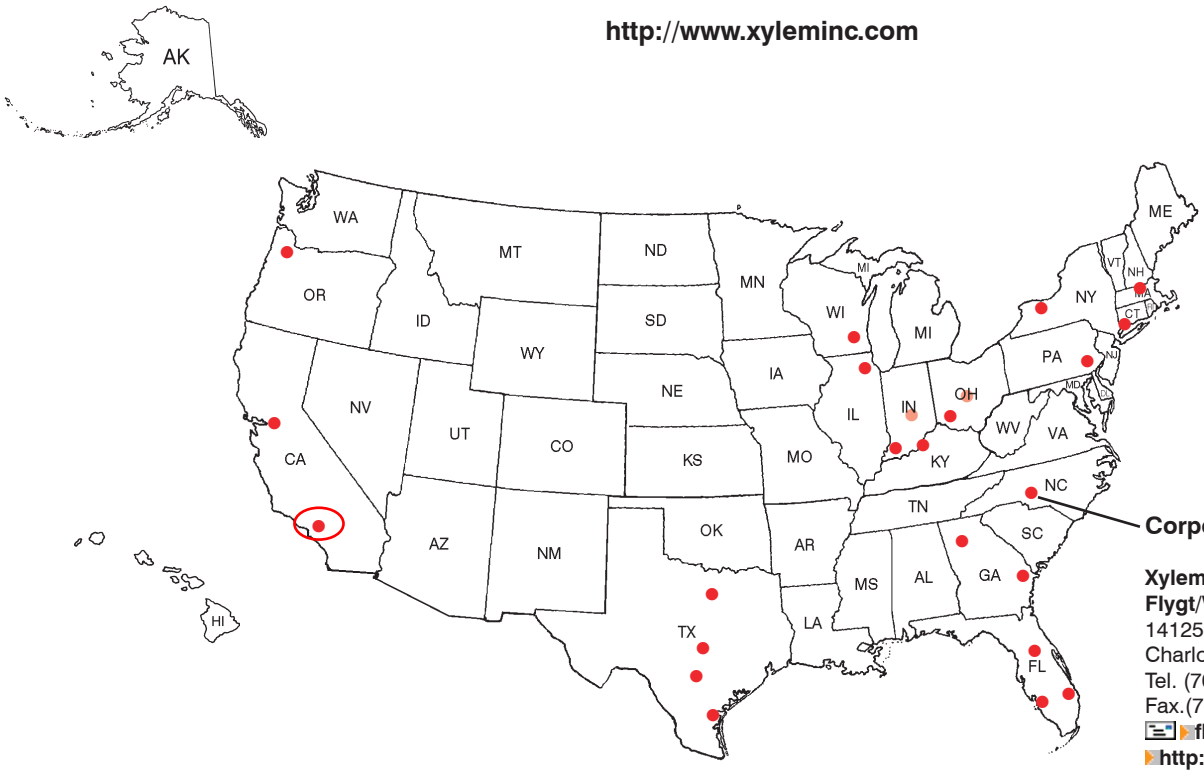

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The faultless functioning of a Flygt Pumping Station will depend upon the correct selection of the pump to suit system requirements and proper installation. A great majority of Flygt Electric Submersible Wastewater Pumps are installed in underground wet pits with Automatic Discharge Connections, Guide Bars and Access Covers as shown in the station drawings. Wet Pits constructed of precast concrete rings offer significant savings in labor costs over poured-in-place concrete, masonry or brick and are universally accepted for use in sanitary or storm sewer systems. Precast concrete sections are available up to 120 inch inside diameter (sometimes up to 144 inch inside diameter) throughout the U.S. and are generally manufactured in accordance with the provisions of ASTM Specification C478.

Because of this, Flygt official engineering documentation is based on stations designed in precast concrete circular man-holes. Each individual station drawing shows a suggested Simplex and a suggested Duplex Pumping Station built of precast concrete sections installed between a Bottom Slab and a Top Slab (the Top Slab, usually at ground level, contains the cast-in Access Cover). The configurations and dimensions shown on these Proposed Layouts are suggested minimum requirements only, all details, including sizing of pit, type, size, location and arrangement of valves and piping, etc. are to be specified by the Consulting Engineer and are subject to his approval.

The following is a partial list of useful suggestions for construction and installation. ***Please always observe local regulations applicable.***

A. Excavation:
Excavate a large enough hole to provide sufficient working room around the station. The outside diameter of the Bottom Slab should be at least one foot larger than that of the concrete sections used.

B. Connecting Pipes:
Provide connecting holes for the Influent Pipe, Effluent Pipe(s) and Cable Thrulets in accordance with the Engineer's specification. Flexible joints outside of concrete wall will reduce the danger of dislocation due to settlement.

C. Backfill:
Backfill gradually and evenly around station after concrete and joints have hardened. Compact backfill to minimize post-installation settlement.

D. Top Slab with Access Cover:
Diameter of Top Slab shall be at least two feet larger than O.D. of ring sections. The Access Cover must be installed and properly oriented in the Top Slab.

1. See Station Drawings for Pump Model and Access Cover location in relation to the centerline of the station.

2. Positioning of the Hinge Side of the Cover (See Accessories Section).

3. The Top Slab and Access Cover must be level.

E. Automatic Discharge Connection:
The Automatic Discharge Connection must be attached to the Bottom Slab at the exact location required relative to the Access Cover.

SUGGESTED PROCEDURES:

1. Attach the Upper Guide Bar Bracket(s) to the Access Frame (See Accessories Section). Also, the centerline of the Bracket(s) will determine the centerline of the installed pump(s).

2. Place the pump Discharge Connection(s) on the Bottom Slab and line up as shown in the Accessories Section.

3. Cut to length and install the Guide Bars between the Upper Guide Bar Bracket(s) and Discharge Connection(s).

4. Before securing anchor bolt nuts, check across the Discharge Connection(s) Outlet Flange(s) face with level and shim if necessary. Guide Bars should be Parallel and Vertical.

F. Internal Piping and Manifold:
Use proper gaskets, tighten bolts gradually and evenly. In deep stations, install Discharge pipe Brackets to relieve Discharge Connections from overload and intermediate Guide Bar Brackets to prevent Guide Bars from bending.

G. Installation of Pump Units:
Lower Pump Units into place along guide bars. Check visually metal-to-metal contact between Volute Flange and Discharge Connection.If necessary, re-check and re-align Discharge Connection(s) and Guide Bars with pumps in place.

WARRANTY
Xylem Water Solutions USA, Inc.

For the period defined, Xylem Water Solutions USA, Inc. offers a commercial warranty to the original End Purchaser against defects in workmanship and material on Flygt Products. Warranty covers Flygt parts and labor as outlined in **ADDENDUM – A**.

COVERAGE:
Xylem Water Solutions USA, Inc. will pay the cost of parts and labor during the warranty period, provided that the Flygt product, with cable attached, is returned prepaid to a Xylem Water Solutions USA, Inc. Authorized Service Facility for Flygt Product repairs. Coverage for Flygt parts and labor will be provided for the period shown in **ADDENDUM - A.** The warranty period will begin from date of shipment or date of a valid Start-up (For permanently installed pumps only). In cases where the Start-up date is used as the beginning of the warranty on a permanently installed Flygt pump, a Start-up Report completed by an approved service technician from a Xylem Water Solutions USA, Inc. Authorized Service Facility for Flygt products must be received by the Xylem Water Solutions USA, Inc. Area Service Manager for Flygt Products within thirty (30) days of the initial onset of the unit placed into service. If not received, the beginning of the warranty coverage will default to the Flygt product ship date. A Start-up for a permanently installed Flygt pump must occur within one (1) year from the date of shipment from a Xylem Water Solutions USA, Inc. authorized facility for Flygt Products or warranty will automatically default to ship date as start of warranty. (See **STORAGE** section) When using the start-up date as the beginning of the warranty, a copy of the Start-up Report will be required to support any Warranty Claims. Warranty on Flygt Dewatering pumps will begin with ship date only. No other date on Flygt Dewatering pumps will be considered.

Xylem Water Solutions USA, Inc.'s sole obligation under this Warranty for Flygt Products shall be to replace, repair or grant credit for Flygt Products upon Xylem Water Solutions USA, Inc.'s exclusive determination that the Flygt Product does not conform to the above warranty. In the event that the Flygt product is replaced, warranty on the replacement product will be equal to the balance remaining on the original product or ninety (90) days, which ever is greater.

MISUSE:
This Warranty shall not apply to any Flygt product or part of Flygt product which (i) has been subjected to misuse, misapplication, accident, alteration, neglect, or physical damage (ii) has been installed, operated, used and/or maintained in a manner which is in an application that is contrary to Xylem Water Solutions USA, Inc.'s printed instructions as it pertains to installation, operation and maintenance of Flygt Products, including but without limitation to (iii) operation of equipment without being connected to monitoring devices supplied with specific products for protection; or (iv) damaged due to a defective power supply, improper electrical protection, faulty installation or repair, ordinary wear and tear, corrosion or chemical attack, an act of God, an act of war or by an act of terrorism; or (v) has been damaged resulting from the use of accessory equipment not sold by Xylem Water Solutions USA, Inc. or not approved by Xylem Water Solutions USA, Inc. in connection with Flygt products.

WEAR PARTS:
This warranty does not cover costs for standard and/or scheduled maintenance performed, nor does it cover Flygt parts that, by virtue of their operation, require replacement through normal wear (aka: Wear Parts), unless a defect in material or workmanship can be determined by Xylem Water Solutions USA, Inc.. Wear Parts are defined as Cutters, Cutting Plates, Impellers, Agitators, Diffusers, Wear Rings (Stationary or Rotating), Volutes (when used in an abrasive environment), oil, grease, cooling fluids and/or any items deemed necessary to perform and meet the requirements of normal maintenance on all Flygt equipment.

WARRANTY
Xylem Water Solutions USA, Inc.

DISCLAIMERS:
(i) Xylem Water Solutions USA, Inc.'s warranties are null and void when Flygt Products are exported outside of the United States of America without the knowledge and written consent of Xylem Water Solutions USA, Inc.; (ii) Xylem Water Solutions USA, Inc. makes no independent warranty or representation with respect to parts or products manufactured by others and provided by Xylem Water Solutions USA, Inc. (however, Xylem Water Solutions USA, Inc. will extend to the Purchaser any warranty received from Xylem Water Solutions USA, Inc.'s supplier for such parts or products).

LIMITATIONS:
XYLEM WATER SOLUTIONS USA, INC. NEITHER ASSUMES, NOR AUTHORIZES ANY PERSON OR COMPANY TO ASSUME FOR XYLEM WATER SOLUTIONS USA, INC., ANY OTHER OBLIGATION IN CONNECTION WITH THE SALE OF ITS FLYGT EQUIPMENT. ANY ENLARGEMENT OR MODIFICATION OF THIS WARRANTY BY A FLYGT PRODUCT DISTRIBUTOR, OR OTHER SELLING AGENT SHALL BECOME THE EXCLUSIVE RESPONSIBILITY OF SUCH ENTITY.

THE FOREGOING WARRANTY IS EXCLUSIVE AND IN LIEU OF ANY AND ALL OTHER EXPRESS OR IMPLIED WARRANTIES, GUARANTEES, CONDITIONS OR TERMS OF WHATEVER NATURE RELATING TO FLYGT PRODUCT(S), INCLUDING AND WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE WHICH ARE HEREBY EXPRESSLY DISCLAIMED AND EXCLUDED. PURCHASER'S EXCLUSIVE REMEDY AND XYLEM WATER SOLUTIONS USA, INC.'S AGGREGATE LIABILITY FOR BREACH OF ANY OF THE FOREGOING WARRANTIES IS LIMITED TO REPAIRING OR REPLACING FLYGT PRODUCTS AND SHALL IN ALL CASES BE LIMITED TO THE AMOUNT PAID BY THE PURCHASER HEREUNDER. IN NO EVENT IS XYLEM WATER SOLUTIONS USA, INC. LIABLE FOR ANY OTHER FORM OF DAMAGES, WHETHER DIRECT, INDIRECT, LIQUIDATED, INCIDENTAL, CONSEQUENTIAL, PUNITIVE, EXEMPLARY OR SPECIAL DAMAGES, INCLUDING BUT NOT LIMITED TO LOSS OF USE, LOSS OF PROFIT, LOSS OF ANTICIPATED SAVINGS OR REVENUE, LOSS OF INCOME, LOSS OF BUSINESS, LOSS OF PRODUCTION, LOSS OF OPPORTUNITY OR LOSS OF REPUTATION.

XYLEM WATER SOLUTIONS USA, INC. WILL NOT BE HELD RESPONSIBLE FOR TRAVEL EXPENSES, RENTED EQUIPMENT, OUTSIDE CONTRACTOR'S FEES, OR ANY EXPENSES ASSOCIATED WITH A FLYGT PRODUCT REPAIR SHOP NOT AUTHORIZED BY XYLEM WATER SOLUTIONS USA, INC. U.S.A., INC. REIMBURSEMENT COSTS FOR CRANES AND/OR ANY SPECIAL EQUIPMENT USED IN CONJUNCTION FOR THE REMOVAL AND/OR REINSTALLATION OF ANY FLYGT EQUIPMENT IS NOT COVERED UNDER THIS WARRANTY.

ANY UNAUTHORIZED ALTERATIONS TO SUPPLIED FLYGT EQUIPMENT USED WITHOUT XYLEM WATER SOLUTIONS USA, INC. SUPPLIED FLYGT BRAND CABLE OR CONTROLS WILL NOT BE COVERED UNDER THIS WARRANTY, UNLESS IT CAN BE PROVEN SUCH ANCILLARY EQUIPMENT IS SUITABLE FOR THE PURPOSE AND EQUAL TO XYLEM WATER SOLUTIONS USA, INC. SUPPLIED FLYGT BRAND CABLES OR CONTROLS THAT WOULD ORIGINALLY HAVE BEEN SUPPLIED WITH THE TYPE OF EQUIPMENT IN USE.

REQUIREMENTS:
A copy of Electrical System Schematics of the Control used (including a Control's Bill of Material) could be required to support a Warranty Claim when a non Flygt Brand Control is used. In addition, a written record, hereby known as "the log", will be associated with each unit serial number and must be maintained by the organization having product maintenance responsibility. The log must record each preventative maintenance activity and any repair activity during the life of the warranty or verification that a Xylem Water Solutions USA, Inc. authorized Service Contract for Flygt Products is in force and must be available for review and/or auditing. Failure to meet these conditions could render this warrant null and void. Such logs could be required to determine warranty coverage.

WARRANTY
Xylem Water Solutions USA, Inc.

STORAGE:
Should a delay occur between ship date and the date of start-up, maintenance as outlined in Xylem Water Solutions USA, Inc.'s Care & Maintenance Manual for Flygt Products must be performed by the "CONTRACTOR" and/or "OWNER" during any such period of storage. Documentation providing proof and outlining what maintenance was performed must be provided to Xylem Water Solutions USA, Inc. or its Flygt Products representative within thirty (30) days of said maintenance, or the Xylem Water Solutions USA, Inc. warranty for Flygt Products could be considered void.

CONTROLS:
Warranty coverage for permanently installed controls will start for the end purchaser on the date of shipment. This warranty does not apply to controls that have been damaged due to a defective and/or improper input power supply, improper electrical protection, accidental damage, improper or unauthorized installation and/or repair, unauthorized alteration, negligence, environmental corrosion or chemical attack, improper maintenance or storage of control, any act of God, an act of war, an act of terrorism or damage resulting from the use of accessory equipment not approved by Xylem Water Solutions USA, Inc.. Further, this warranty does not apply in the event an adjustment is found to correct the alleged defect.

Solid state devices will be covered for a period of one (1) year except in the Flygt Standard Control Panel (FSCP) where the solid state devices will be covered for the full warranty period of the control panel. Electrical control panels containing controllers, PLC's, drives, soft starts, and other computerized equipment will require Transient Voltage Surge Suppression (TVSS) protection in order to satisfy the requirements of this warranty. The protection equipment associated with the control must be kept in working condition during the life of the warranty. Auxiliary equipment supplied with the control (air-conditioners etc.) is limited by the respective original equipment manufacturer's warranty offered. Consumable items such as: light bulbs, fuses, and relays are covered under normal operating conditions. Electrical surges experienced during startups and/or during normal operating use of the control panel will cause the consumable items not to be covered under this warranty policy. Components not supplied by Xylem Water Solutions USA, Inc. will not covered by this warranty.

TOP (The Optimum Pump Station)
Xylem Water Solutions USA, Inc. will warrant the Flygt TOP pre-engineered fiberglass pump station components against defects in material and workmanship for a period of one (1) year from date of start-up or eighteen (18) months from date of shipment and is valid only to the original owner of the station. Warranty shall cover the cost of labor and materials required to correct any warrantable defect, excluding any removal and reinstallation costs, FOB Xylem Water Solutions USA, Inc.'s authorized warranty service location for Flygt's TOP.

Flygt Products contained within a TOP pre-engineered fiberglass pump station will carry the standard Xylem Water Solutions USA, Inc. warranty for Flygt products and/or accessories installed in the TOP pre-engineered fiberglass pump station.

All Flygt Product restrictions and/or limitations as outlined and described within the context of this warranty are germane to all sections of this Xylem Water Solutions USA, Inc. Warranty document.

Xylem Water Solutions USA, Inc.
National Quality Assurance - US Corporate

WARRANTY
Xylem Water Solutions USA, Inc.

ADDENDUM – WARRANTY COVERAGE BY PRODUCT

PRODUCT	PRODUCT SERIES AND CONFIGURATION	Months 1 - 12	Months 13 - 18	Months 19 - 36	Months 37 - 39	Months 40 - 60
Axial Flow/ Mixed Flow/ Centrifugal Pumps & Mixers	3000 Series (CP, NP, DP, CT, NT, CZ, NZ, LL) 4000 Series (SR, PP) 7000 Series (PL)	100%		50%		25%
Flygt Standard Control Panels (FSCP)	Standard Control Panels (FSCP – permanently installed)	100% (From Ship Date)				
ETO Electrical Control Panels	Engineered to Order, Xylem Manufactured Control Panels (permanently installed) - 3 Years	100% - 1 YR	LIMITED - 2 - YR			
Abrasion/Corrosion Resistant & Chopper/ Grinder Pumps	3000 Series (MP, MF, MH, FP, FS, FT, HP, HS) 5000 Series (HP, HS) 8000.280 Series (DP, DZ, DT, DS, DF)	100%				
Dewatering Pumps	2000 Series (BS, KS) 3000 Series (CS, NS, DS) 8000.280 Series (DS, DF)	100% (From Ship Date)				
TOPS	Fiberglass Pump Station	100% (From Ship Date)				
Accessories	Permanent / Portable	100% (From Ship Date)				
Hydro ejectors/ Aerators	HE, JA	100%				
Portable Pump Controls TOPS Control Panels	Control Boxes (Nolta, MSHA etc.) TOPS control panels (permanently installed)	100% (From Ship Date)				
Small Pumps	3045, 3057, SX	100% (From Ship Date)				
Parts - *	All new Flygt parts (mechanical & electrical)	100% (From Ship Date)				

* - Parts that fail where used in a repair are warranted for one (1) year from the date of the repair for the failed part only – no labor; This Includes Flygt pump controllers, Flygt supervision equipment, Flygt submersible level transducers, etc.

H. Grouting:
After proper alignment of all components, including metal-to-metal connection of pump flange is established, grout Access Cover, Discharge Connection(s) and Pipe Thrulets. Build up and shape slopes at bottom of the station as shown in Station Drawings. This will help in preventing build-up of solids at the bottom where side walls meet the floor.

I. Surface Protection:
An epoxy-coal tar system is suggested for all internal surfaces, concrete or metallic, if possible, follow the recommendations in WPCF Manual of Practice No. 17 "Paints and Protective Coatings for Wastewater Treatment Facilities" or the instructions of a reputable manufacturer of protective coating systems, such as Carboline, Koppers, Inertol, Perry-Austen, etc. Proper surface preparation and careful application will pay off in reduced maintenance costs and longer life.

J. Storage of Pump Units Prior to Start-Up:
It is ***not*** good practice to store the Pump Units in the wet pit, especially when long periods between installation and start-up are anticipated. If this practice cannot be avoided, rather than leaving them on their Discharge Connections, secure them and their power cable at some point above any anticipated liquid level. Pay special attention to unprotected open cable ends; seal them off and make sure that they are not submerged or exposed to moisture. Penetration of moisture thru the cable may cause breakdown of the insulation, arcing at the pump terminal board, destruction of the Junction Chamber and serious damage to the pump. If in doubt, before start-up, re-check the cable, Cable Entry and Junction Chamber following instructions in the Maintenance Manual under "Electrical Checks". If possible, connect Pumps power cables to Control Panel and during longer periods until the official start-up, start and run the units manually for 30 seconds at least once every two weeks. (see "Storage" in this section of the catalog.)

Your Flygt Pump is designed to provide long and dependable service under adverse conditions. Observation of the following rules and guidelines will further improve performance, reduce maintenance costs and extend useful service life. This is a brief description of the most important factors to be taken into consideration. For more detailed information or if in doubt, consult your local Flygt distributor.

These guidelines generally apply to standard cast iron wastewater pumps (CP/NP, CT/NT, CS/NS) only. Stainless Steel, Warm Liquid, etc. versions require special consideration.

Environmental Temperature Limits
The upper limit for both the pumped liquid and the general surroundings of the pump is 115°F except for Warm Liquid Pumps. For more information contact Flygt Application Engineering.

Volatile Liquids
Volatile liquids vaporize rapidly even at normal (ambient) temperatures and pressures, causing the impeller to become “vapor bound”. To prevent vaporizing (flashing), either the inlet pressure (submergence) has to be increased or the temperature reduced. Pumping of volatile liquids which are corrosive or hazardous is neither recommended nor covered by warranty.

Corrosion and Chemical Attack
A Flygt Sewage Pump, while not specifically a chemical pump, can provide reasonable service in mildly corrosive liquids within an approximate pH range of 6.0 to 9.0 (cast iron parts, stainless steel fasteners and synthetic rubber O-rings). It must be noted that although the pH value is a useful guide, it is non-conclusive. If the standard cast iron version does not meet your requirements, refer to the Special Applications Section of the catalog.

Excessive operation or large underwater steel structures nearby (galvanic action) may also accelerate corrosion. Special consideration must be given to industrial contaminants, for example, moderate or localized concentrations of some hydrocarbons, oxidizers, chlorinated compounds, and solvents (aromatics, aliphatics, etc.) will damage cable (oil resistant chloroprene), grommets (neoprene), and O-rings (nitrile rubber). For more information, contact Flygt's Application Engineering department.

Abrasion
When pumping liquids containing abrasive particles, inspect the pump (liquid end and seal) more often. Low pumping rates may result in sedimentation and accumulation of particles in the volute, causing abnormal wear or even clogging. The higher the pumping rate, the higher the friction wear.

Viscosity
Viscosity, or internal resistance of the liquid to flow, is an inherent characteristic of a liquid which may change as a result of foreign material in suspension. Either way, viscosities higher than that of water adversely affect performance (head and flow) and may increase power requirement (kW input) beyond the capacity of the motor.

Submergence
In general, a Flygt Wastewater Pump will operate with a minimum of submergence (flooded impeller). Deeper submergence will improve motor cooling for non-jacketed motors and reduce aeration. Depth limitation (submergence) is 65 ft. Deeper submergence is possible, depending on the pump model involved but must have approval of Flygt Application Engineering in order to protect warranty. Avoid submerging pumps in heavy concentrations of sludges.

Voltage
Voltage at the pump terminal board must be within the following ranges:

200 volt motor = 180 to 220 volts
230 volt motor = 207 to 253 volts
460 volt motor = 414 to 506 volts
575 volt motor = 518 to 633 volts

Watch for undersized wiring systems or overlong cables which may cause excessive voltage drops. Measurement at the control box under full load is satisfactory if voltage drop in the pump cable is taken into consideration.

Voltage Balance
Proper balance among the three supply-voltage phases applied to the pump motor is vital. A voltage imbalance of only 1% between phases may result in a 6-10% amperage imbalance.This can be in the form of circulating currents internally in the stator which may not appear as line-current differences but will cause excessive stator temperature rise thus substantially shortening motor life or causing a dry burnout. These high temperatures can also affect rotor, bearing and shaft seals.

Motor
The combined effect of voltage, frequency and specific

gravity variation may equal (but not exceed) 1.10. To obtain maximum efficiency and avoid undue heat-rise in the motor and consequent reduction of stator, seals and bearing life, the pump should not be subjected to more than 12 to 15 starts per hour, evenly spaced, on a continuous basis. The limitation is based on a nominal in-rush current at peak power input, nominal ambient temperature, depth of submergence, impeller loading, viscosity and specific gravity. The Flygt Engineering Department must be consulted if a greater number of starts per hour is required.

Solids Content

A liquid (usually water) when containing suspended solids in various quantities becomes a “slurry”. There are no definite rules governing the pumping of slurries, some combinations are to stiff or viscous to be pumped at relatively low concentrations (clay, bentonite, paper stock) while others can be pumped with considerable ease at much higher concentrations (coal, silt, sand, dust). In general, maintain a minimum flow velocity necessary to keep the solids in suspension.

Specific Gravity

The power requirement (kW input) of a centrifugal pump increases proportionally with the specific gravity (S.G.) of the liquid. The S.G. may be increased also by the solids content.

Storage

General Information | Issued: 2/96 | Supersedes: 6/90

Each Flygt pump leaves the factory properly assembled and prepaired to perform even after a reasonable idle time in storage. However, as prolonged idle time can be detrimental to any rotating machinery, the procedures outlined below should be followed in order to insure that the equipment is in top condition to operate when finally installed. Whenever possible, store pumping units in a dry environment free of extreme temperatures and strong direct sunlight.

NEW pumps:

Storage 6 to 12 months:
In general, rotating machinery left idle for extended periods of time, tends to establish a "set" position due to inaction of the moving parts. Some of these areas may be damaged (especially seals) from the sudden fast breakaway of start-up after a prolonged idle time. To insure that all rotating parts are free for final installation and start-up, it is good practice to rotate the impeller by hand once a month. It is also good practice to relieve the tension on the cable entry sealing grommet by backing off the cable entry compression screws slightly. If this is done, it is most important that a clear note be attached as a reminder to:
Re-Tighten Cable Entry Compression Screws Before Installation.

Storage 12 to 24 months:
In addition to the above, apply a protective spray coating of silicone or rust inhibiting oil to the impeller and inside of the volute by spraying in through the volute outlet and up through the volute inlet. Also coat the volute outlet flange face.

USED pumps:

Before storing a used pump for an extended period of time, the unit should be dismantled, checked for any defects, repaired where necessary and reassembled. At reassembly, follow instructions in the ***Service Manual***, especially regarding seal assemblies. Protect the impeller and volute as mentioned in the paragraph above.

In all cases, it is good practice to check all external bolts, nuts and screws for tightness before final installation after extended storage.

CONTROLS:

It is most important to make sure that Electrical Controls, when subjected to extended storage, be stored in a protected dry environment free from any corrosive atmosphere. Moisture in any form, including condensation, can cause serious corrosion problems to the contact point surfaces as well as terminal connections.

Even though all terminal connections have been made tight on initial assembly at the factory, they may not remain 100% tight over an extended storage period due to the compressibility of the copper wire and possible movement due to variations in ambient temperature. The problem will vary in degree depending on wire size and whether the terminal connection is of solid or stranded wire. To insure proper operation, recheck all terminal connection screws for tightness prior to placing the control on line.

Start-Up Checklist

11161 Harrel Street
Mira Loma, CA 91752
951 332 3669

Project: _____
Customer Name: _____
Customer Number: _____
Contact Name & Phone: _____

Ladies & Gentlemen:

The following pre-start-up checklist must be completed and returned to Manny Padilla at Xylem Water Solutions prior to the actual start-up date. Under no circumstances will this requirement be waived.

1.	Pump installed and cable wired into control panel	☐ Yes	☐ No
2.	Floats installed and wired into the control panel	☐ Yes	☐ No
3.	Power supply available and wired into the control panel	☐ Yes	☐ No
4.	Lifting equipment available if pumps are not accessible with our truck	☐ Yes	☐ No
5.	Water supply available to run each pump for ½ hour	☐ Yes	☐ No
6.	If control panel is not supplied by Flygt, will a representative from panel manufacturer be present for start-up?	☐ Yes	☐ No
7.	Will a representative of the owner be present at start-up for training of the operation of the pump/mixer?	☐ Yes	☐ No

Date:_____ Name: _____ Signature: _____

If you have any questions, please feel free to contact the Flygt Branch Office at 951-332-3669 / Fax 951/332-3679

Notes:

Please include directions to the jobsite and pump location. Also, it is Imperative that you provide 5 working days' notice prior to the requested start-up date. Our field service calls require advance notice for every start-up. There are no exceptions to this requirement.

NOTE: XYLEM FLYGT DOES NOT PERFORM CONFINED SPACE ENTRY.

Signature:_____

Date:_____

Pump Start-Up Report Form

(Use 1 form for all similar pumps)

1. Station Owner's Name:_____

   Station Name: _____

   Address: _____

   Phone Number: _____

   Person in Charge: _____

   Purchased From: Xylem Water Solutions USA, Inc. / Flygt Products

2. P1-Model Number: _____

   P2-Model Number: _____

   P3-Model Number: _____

   P4-Model Number: _____

   Impeller:_____ Voltage:_____ FLA:_____ Phase:_____ Horsepower:_____

   Pit Depth:_____Weight:_____Config:_____Permit:_____SOW Access:_____

   Rotation: Direction of impeller rotation (use CW for Clockwise, CCW for Counterclockwise direction)

   _____Note: Observe starting rotation before submergence.

   Does impeller turn freely by hand? Yes_____ No_____

3. Condition of Equipment: Good_____Fair_____Poor_____

   Condition of Cable Jacket: Good_____Fair_____Poor_____

   Resistance of cable and pump motor (measured at pump control)

   Red/Black:_____ohms Red/White:_____ohms White/Black:_____ohms

   Resistance of ground circuit between control panel and outside of pump: _____ohms

   Meg Ohm check of cable and motor insulation:

   Pump 1_____ Pump 2_____ Pump 3_____ Pump 4_____

4. Liquid being pumped:_____

   Debris in bottom of tank/station? YES_____ NO_____

   Was debris removed in your presence? YES_____ NO_____

5. Control Panel Manufacturer:_____

   Model/Serial Number: _____

   Short circuit protection: _____Type:_____

   Number and size of short circuit device(s): Amp Rating:_____

   Overload Type: _____Amp Rating:_____

   Do protection devices comply with pump motor amp rating? Yes_____ No_____

   Are all connections tight? Yes_____ No_____

   Is the interior of the panel dry? Yes_____ No_____

   (If No, correct problem)

Comments:_____

_____

_____

Electrical Readings:

Single Phase:

Voltage supply at panel line connection (pump off) L1-L2:_____ Volts

Voltage supply at panel line connection (pump on) L1-L2:_____ Volts

Amperage: Load connection (pump on) L1:_____ Amps

Three Phase:

Voltage supply at panel line connection (pump off):

L1-L2:_____ L1-L3:_____ L2-L3:_____

Voltage supply at panel line connection (pump on):

L1-L2:_____ L1-L3:_____ L2-L3:_____

Running Current P1: L1:_____ L2:_____ L3:_____ L4:_____

Running Current P2: L1:_____ L2:_____ L3:_____ L4:_____

Running Current P3: L1:_____ L2:_____ L3:_____ L4:_____

Running Current P4: L1:_____ L2:_____ L3:_____ L4:_____

6. Pump sensor(s) Readings: (Reading should be taken disconnected from control panel)

   Motor thermal sensor & FLS resistance: P1____ P2____ P3____ P4____ohms (max 1500 ohms)

   Motor thermal sensor only resistance P1____ P2____ P3____ P4____ohms (1 ohms)

   PT100 sensor resistance (if present) P1____ P2____ P3____ P4____ohms (80-100 ohms max)

   (FLS is 1500 ohms in safe mode/330 ohms in fail mode) (FLS10 is 1200 ohms in safe mode/330 ohms in fail mode)

7. Liquid level controls:_____

   Are controls installed away from turbulence? Yes _____ No_____

9. Is pump seated on discharge connection properly? Yes _____ No_____

   Was pump discharge checked for leaks while pumping? Yes _____ No_____

   Do check valves operate properly? Yes _____ No_____

   Are pump(s) noisy while operating under load? Yes _____ No_____

10. Comments: _____

    _____

    _____

    Station Access Description (Pavement, Stones, Obstacles, Concerns, etc.):_____

    _____

    Has operator received instruction and C&M manuals? Yes_____ No_____

Location of Flygt Products Service Center:

11161 Harrel Street
Mira Loma, CA 91752
Phone: (951) 332-3669
Fax: (951) 332-3679

I have received the above information

Name of Operator: _____

Name of Company: _____

I certify this report to be accurate:

Signed by: _____

Employed By: Xylem Water Solutions USA, Inc. / Flygt Products

Date: _____

Xylem Water Solutions USA, Inc. - Flygt Products

11161 Harrel Street
Mira Loma, CA 91752
Tel 951 332-3669
Fax 951 332-3679

Flygt Submersible Pump Maintenance Requirements

A. Monthly [(30 days) Maintenance Requirements / 200 Hours]

1. Data: Pump Model_____ Serial No. _____

HP _____ Voltage _____

Phase_____ Cycle _____

FLA _____ LRA _____

Motor Ohms _____

Pump Location _____

Data _____ Inspected by _____

2. Visually inspect the wet well.

a) Foreign objects and scum accumulation: Y N

b) Verify that pumps are seated on discharge elbow: Y N

3. Record electrical data.

a) Voltage (balanced, +/- 1%) (+/- 10% rated motor voltage) Y N

1. Running: R-W: W-B: B-R:

2. Not Running: R-W: W-B: B-R:

b) Amperage: (less than FLA, Balanced)

R: W: B:

c) Run time meter: Hours:

4. Pump down the wet well water level until pumps break suction to clean scum and grit out of the wet well. The station will be cleaner and will have fewer odors. Accomplish this as needed.

Result: _____

5. General: Items Requiring Action

B. Six Months Maintenance Requirements / 2000 Hours

1. Data: Pump Model _____ Serial No. _____

   HP _____ Voltage _____

   Phase _____ Cycle _____

   FLA _____ LRA _____

   Motor Ohms _____

   Pump Location _____

2. Accomplish Monthly / 200 hours tasks

3. Lift the submersible pumps out o the wet well

   a) Check oil for contamination. (If brown milk shake colored, which indicates water intrusion, change oil once before changing seal. Re-inspect oil after one month to verify leakage in oil housing.) The Flygt pump can tolerate 30% water in the oil chamber.
   If water intrusion continues, change seal. Result _____

   b) Check motor housing for fluid Result _____

   c) Check wear ring for proper clearance, approximately 30/1000 inch.

   Result _____

   d) Inspect pump for coating and mechanical integrity.

   Result _____

   e) Check pump volute for foreign debris, cavitation and wear.

   Result _____

   f) Condition of bearings. Test run dry, listen to bearing.

   Result _____

   g) Shaft rotation view from top: Clockwise Result _____

   h) Vertical guide bars tight. Result _____

   i) Reinstall pump and verify that pump is on the discharge elbow without leaking during operation.

   Result _____

4. Check pump/motor characteristics.

a) Megger motor (use 500 to 1000 VDC) Result _____

(Must be 2 mega ohms or greater)

R-G: W-G: B-G: Ohms:

b) Check stator resistance through cable (less than 25 ohm)

R-W: W-B: B-W: Ohms:

c) Check motor thermal sensors electrical using milli-ohm meter (max 2.5 volts):

Thermal sensors: Blue-Orange _____ (less than one ohm)

Result _____

d) Units with both Thermal sensor and moisture (FLS) sensor (max 2.5 volts)

Result _____

FLS Sensor and Thermal Sensor: Blue –Orange _____ (1500 ohms)

e) Units with thermistor, use no more than 2.5 volts to check.

Result _____

Thermistor sensor: Yellow-Green _____ (150 to 300 ohms)

f) Check ground safety check (less than 1 ohm) Result _____

g) Check the flexible motor cable for cuts and abrasions.

Result _____

5. Check Electrical control panel connects for pump.

a) Connections must be tight. Result _____

b) Motor or thermal leads must be connected in series with motor contactor or using control relay.

Result _____

c) Check proper operation of MiniCas if provided. Result _____

d) Check proper operation of CAS if provided. Result _____

e) Operate pump in hand mode to simulate normal operation.

Result _____

f) Check electrical protection of circuit breaker. Result _____

g) Disconnect thermal sensors wires (O/Blue) to simulate fault.

Result _____

6. General: Items Requiring Action

_____
_____
_____
_____
_____
_____
_____
_____

C. Yearly Inspection / 4000 Hours

1. Accomplish 6 month requirement. Result _____

2. Change oil if water present in Motor. Result _____

D. Inactive Pump / 30 Days

1. See Pump Storage and Installation Requirements. Result _____

2. Rotate pump impeller by hand 10 times or electrically for 15 to 30 seconds. This will lubricate the mechanical seal and exercise the pump.

Result _____

3. Store pump/motor and cable in a protected location away from the sun and elements.

E. Data

Pump Model _____ Serial No. _____

HP _____ Voltage _____

Phase _____ Cycle _____

FLA _____ LRA _____

Motor Ohms _____

Pump Location _____

Data _____ Inspected by _____

F. General: Items Requiring Action

_____

_____

_____

_____

_____

_____

_____

_____

G. General Information

See Flygt Operations and Maintenance manuals and factory maintenance checklist for specific model pumps in operation. If you have further questions, contact Flygt or factory authorized repair facility.

Flygt 3153, 60Hz

FLYGT
a xylem brand

Table of Contents

N-pump, Standard Motor

Product description

Usage

A submersible pump for efficient pumping of clean water, surface water, and wastewater containing solids or long-fibered material. The pump is designed for sustained high efficiency. For abrasive media, Hard-Iron™ is required. Stainless steel N-impeller is available as an option.

Denomination

Type	Non-explosion proof version	Explosion proof version	Pressure class	Installation types
Cast iron	3153.181	3153.091	LT – Low head MT – Medium head HT – High head SH – Super head	P, S, T, Z
Hard-Iron™	3153.185	3153.095	LT – Low head MT – Medium head HT – High head SH – Super head	P, S, T, Z
Stainless steel	3153.660	3153.670	MT – Medium head HT – High head	P, S

The pump can be used in the following installations:

P Semi permanent, wet well arrangement with pump installed on two guide bars with automatic connection to discharge.

S Portable semi permanent, wet well arrangement with hose coupling or flange for connection to discharge pipeline.

T Vertical permanent, dry well arrangement with flange connection to suction and discharge piping.

Z Horizontal permanent, dry well arrangement with flange connection to suction and discharge piping.

Application limits

Feature	Description
Liquid temperature	Maximum 40°C (104°F)
Liquid temperature, warm water version	Maximum 70°C (158°F)
Depth of immersion	Maximum 20 m (65 ft)
pH of the pumped liquid	5.5 – 14
Liquid density	Maximum 1100 kg/m^3

Motor data

Feature	Description
Motor type	Squirrel-cage induction motor
Frequency	60 Hz
Power supply	3-phase
Starting method	• Direct on-line • Star-delta • Variable Frequency Drive (VFD)
Number of starts per hour	Maximum 30
Code compliance	IEC 60034-1
Voltage variation	• Continuously running: Maximum ±5% • Intermittent running: Maximum ±10%
Voltage imbalance between phases	Maximum 2%
Stator insulation class	H (180°C, 356°F)

Cables

Application	Type
Direct-on-line start or Y/D start with two cables	Flygt SUBCAB® - a heavy duty 4 cores motor power cable with two twisted pair screened control cores. Conductor insulation rating of 90°C, which allows for increased current. Superior mechanical strength and high abrasion and tear resistant. Chemical resistant within pH 3-10 and ozone, oil, and flame resistant. Used up to 70°C water temperature. Cables < 10 mm^2 with unscreened control cores.
Y/D start	Flygt SUBCAB® - a heavy duty 7 cores motor power cable with two twisted pair screened control cores. Conductor insulation rating of 90°C, which allows for increased current. Superior mechanical strength and high abrasion and tear resistant. Chemical resistant within pH 3-10 and ozone, oil, and flame resistant. Used up to 70°C water temperature. Cables < 7G6 mm^2 with unscreened control cores.

Monitoring equipment

- Thermal contacts opening temperature 140° C (284° F)
- Leakage sensor in the inspection chamber (FLS 10)

Materials

Table 11: Major parts except mechanical seals

Denomination	Material	ASTM	EN
Major castings	Cast iron, gray	35B	GJL-250

Denomination	Material	ASTM	EN
Pump housing	Cast iron, gray	35B	GJL-250
Impeller, alternative 1	Cast iron, gray	35B	GJL-250
Impeller, alternative 2	Cast iron, Hard-Iron™	A 532 IIIA	GJN-HB555(XCR23)
Impeller, alternative 3	Stainless steel, Duplex	CD-4MCuN	10283:2010 -1.4474
Insert ring, alternative 1	Cast iron, gray	35B	GJL-250
Insert ring, alternative 2	Cast iron, Hard-Iron™	A 532 IIIA	GJN-HB555(XCR23)
Cooling jacket, inner	Aluminum	AA 1050A	AW-1050A
Cooling jacket, outer, alternative 1	Steel	GR65	S235JRG2
Cooling jacket, outer, alternative 2	Stainless steel	AISI 316L	1.4404,1.4432, …
Lifting handle	Stainless steel	AISI 316L	1.4404,1.4432, …
Shaft	Stainless steel	AISI 431	1.4057+QT800
Screws and nuts	Stainless steel, A4	AISI 316L, 316, 316Ti	1.4401,1.4404, …
O-rings, alternative 1	Nitrile rubber (NBR) 70° IRH	-	-
O-rings, alternative 2	Fluorinated rubber (FPM) 70° IRH	-	-
Glycol	Heat transfer fluid based on monopropylene glycol.	-	-

Table 12: Mechanical seals

Alternative	Inner seal	Outer seal
1	Corrosion resistant cemented carbide/ Corrosion resistant cemented carbide	Corrosion resistant cemented carbide/ Corrosion resistant cemented carbide
2	Corrosion resistant cemented carbide/ Corrosion resistant cemented carbide	Silicon carbide/ Silicon carbide

Surface treatment

Priming	Finish
Painted with a primer, see internal standard M0700.00.0002	Navy gray color NCS 5804-B07G. Two-component high-solid top coating, see internal standard M0700.00.0004 for standard painting and M0700.00.0008 for special painting.

Options

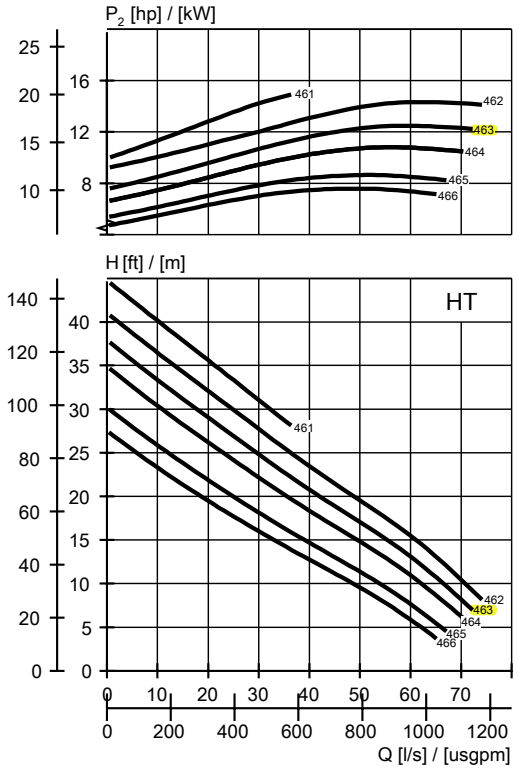
- Warm liquid version (non-explosion proof versions)
- Sensors: Thermistor, FLS, PT 100, VIS 10
- Surface treatment (Epoxy)
- Zinc anodes
- Other cables

Accessories

Discharge connections, adapters, hose connections, and other mechanical accessories.

Electrical accessories such as pump controller, control panels, starters, monitoring relays, cables.

HT



WS004078A

Table 15: 460 V, 60 Hz, 3-phase

Rated power, kW	Rated power, hp	Curve/ Impeller No	Revolutions per minute, rpm	Rated current, A	Starting current, A	Power factor, cos φ	Installation
8.9	12	464	1765	16	112	0.8	P,S,T,Z
8.9	12	465	1765	16	112	0.8	P,S,T,Z
8.9	12	466	1765	16	112	0.8	P,S,T,Z
11.2	15	463	1755	19	112	0.84	P,S,T,Z
11.2	15	464	1755	19	112	0.84	P,S,T,Z
11.2	15	465	1755	19	112	0.84	P,S,T,Z
11.2	15	466	1755	19	112	0.84	P,S,T,Z
14.9	20	461	1760	26	157	0.83	P,S,T,Z
14.9	20	462	1760	26	157	0.83	P,S,T,Z
14.9	20	463	1760	26	157	0.83	P,S,T,Z
14.9	20	464	1760	26	157	0.83	P,S,T,Z
14.9	20	465	1760	26	157	0.83	P,S,T,Z
14.9	20	466	1760	26	157	0.83	P,S,T,Z

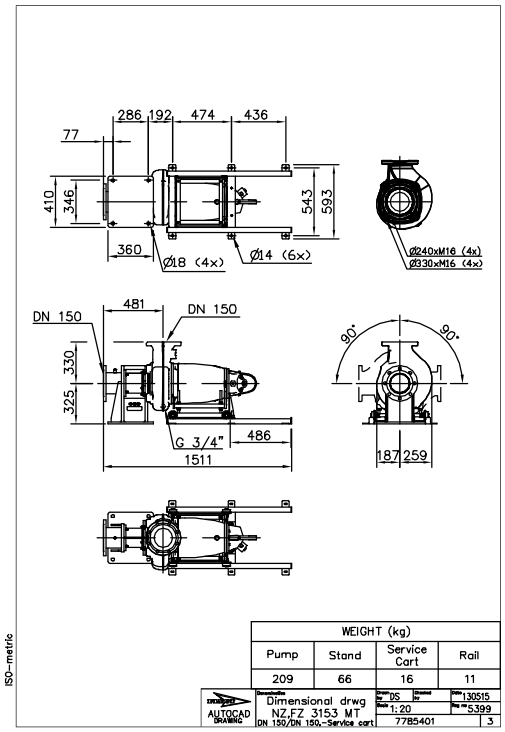


Figure 27: MT, Z-installation

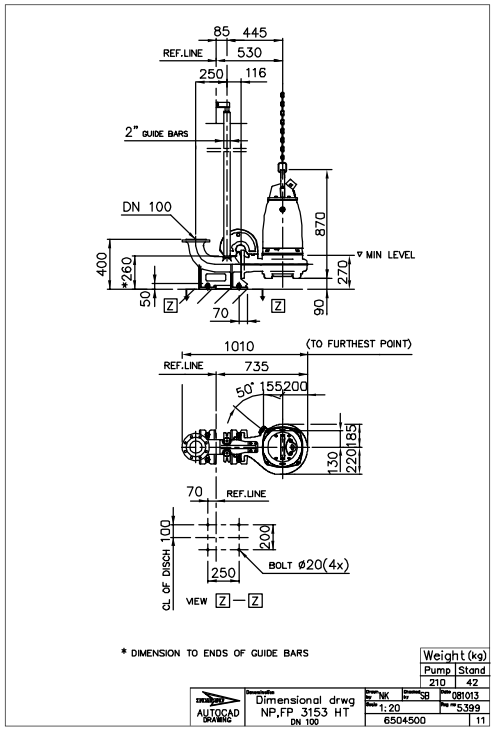


Figure 28: HT, P-installation

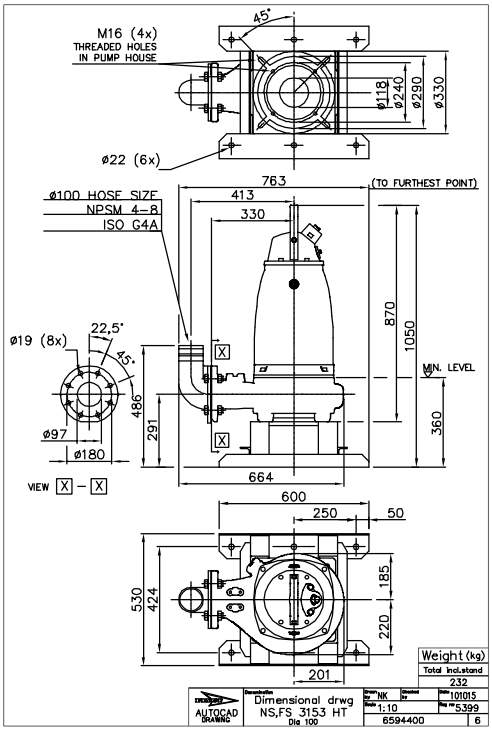


Figure 29: HT, S-installation

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2) A leading global water technology company

We're 12,500 people unified in a common purpose: creating innovative solutions to meet our world's water needs. Developing new technologies that will improve the way water is used, conserved, and re-used in the future is central to our work. We move, treat, analyze, and return water to the environment, and we help people use water efficiently, in their homes, buildings, factories and farms. In more than 150 countries, we have strong, long-standing relationships with customers who know us for our powerful combination of leading product brands and applications expertise, backed by a legacy of innovation.

For more information on how Xylem can help you, go to xyleminc.com

Refer to www.xylemwatersolutions.com/contacts/ for contact details of your local sales and service representative.

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Let's Solve Water

Xylem Water Solutions Global Services AB
361 80 Emmaboda
Sweden
Tel: +46-471-24 70 00
Fax: +46-471-24 47 01
http://tpi.xyleminc.com

Visit our Web site for the latest version of this document and more information

The original instruction is in English. All non-English instructions are translations of the original instruction.

Individual Parts List

NP 3153 HT

Serial No 3153.095 1480007

FM APPROVED

6102 -

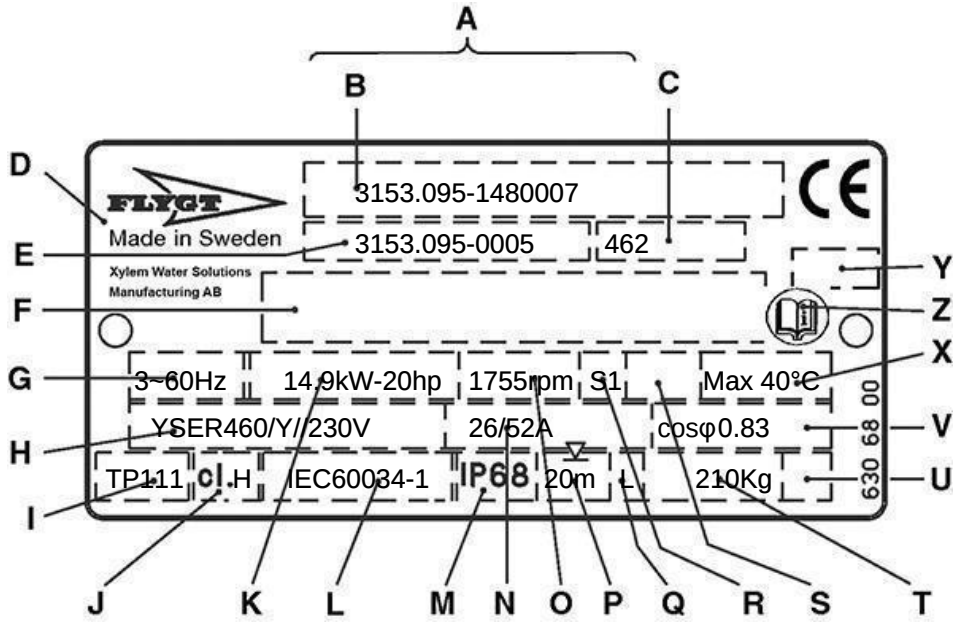
FLYGT
a xylem brand

Dataplate

Flygt NP 3153 HT

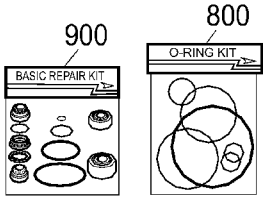
Date: 2015-04-22

Serial No: 3153.095 1480007



Dataplate interpretation:

A	Serial number	**M**	Degree of protection
B	Product code + Number	**N**	Rated current
C	Curv code / Propeller code	**O**	Rated speed
D	Country of origin	**P**	Max. submergence
E	Product number	**Q**	Direction of rotation R=right, L=left
F	Additional information	**R**	Duty class
G	Phase; Type of current; Frequency	**S**	Duty factor
H	Rated voltage	**T**	Product weight
I	Thermal protection	**U**	Locked rotor code letter
J	Thermal class	**V**	Power factor
K	Rated shaft power	**X**	Max. ambient temperature
L	International standard	**Y**	Notified body Only for EN-approved Ex-products
		Z	Read Installation Manual



(1 kg = 2.2 pound, 1 Lit=0.26 US gallon, 1 l = 0,22 UK gallon)

Recommended spare parts:

See REC. column: **A** = Parts for inspection and maintenance
B = Parts for major overhaul

For service;
To ensure long operating life use Flygt Bearing Grease 90 20 61 (Cartridge).
Lubrication kit 84 15 40 contains two 90 20 61 and one 84 15 30 (Grease gun).

The O-ring kit contains a full set of O-rings. Position no 800.

The Basic Repair kits contain both inner and outer Mechanical seals, bearings and a O-ring kit. Position no 900.

A complete set of tools can be ordered for repair and maintenance work, i.e. standard hand tools and special tools for seal change and hydraulic-end use.
Order:
This partlist can be used as an order form by marking out the number of parts in the Qty/Order column.
Please send or fax the form to your Flygt representative.

Parts List

Flygt NP 3153 HT
Serial No 3153.095 1480007

Item no	Part no	Type	Rec	Denomination	Qty/ord.
1	642 15 00			Lifting handle	1
2	83 04 56			Hex.socket hd screw M10X35-A4-80	2
7	83 45 52			Cable tie 292X3.5 MM	1
7	83 45 59			Cable tie 200X2.4 PA 6/6 -55+105	1
8	630 68 00			Data plate USE 6306801 AS SPARE PART	2
8	630 70 00			Certificate plate FM	2
9	81 65 46			Marking plate	1
9	83 93 50			Marking strip 5-GW(T1,T2,T15,T16)	1
9	83 93 51			Marking strip W5,V5,U5,V2,W1,U2,V1,W2,U	1
9	773 29 00			Connection plate	1
10	82 20 88			Drive screw 4X5-A2/A4	6
11	82 00 11			Hex.socket hd screw M6X12-A2-70	2
13	642 16 00			Earthing plate	1
23	94 19 82			Motor cable subcab	16.6 m
24	642 17 01	(Ex)		Entrance flange	1
26	83 04 53			Hex.socket hd screw M12X45-A4-80	2
31	82 74 63			O-ring 49.5X3 NBR	1
32	642 14 01	(Ex)		Entrance cover	1
33	82 78 35			O-ring 175X3 NBR	1
35	83 04 56			Hex.socket hd screw M10X35-A4-80	4
45	82 00 11			Hex.socket hd screw M6X12-A2-70	2
49	83 42 48			End sleeve H16/24	3
53	82 00 11			Hex.socket hd screw M6X12-A2-70	2
53	82 00 11			Hex.socket hd screw M6X12-A2-70	2
54	642 08 00			Rail	1
56	642 16 00			Earthing plate	2
60	82 56 25			Spring washer 71.5X59X0.55 MM	1
61	83 30 16			Ball bearing 30X72X30.2 MM	1
69	642 09 01	(Ex)		Stator housing	1
72	82 74 94			O-ring 209.3X5.7 NBR	1
73	641 98 06	(Ex)		Shaft unit	1
79	641 93 05			Stator 21-18-4a	1
82	608 12 01			Cooling jacket OUTER	1
83	82 78 49			O-ring 221.84X3.53 NBR	1
84	82 75 01			O-ring 279.3X5.7 NBR	1
101	650 51 00			Cable unit FLS10	1

Ordered by:

Company:.....Ref:.....Tel:.....Date:.....

Parts List

Item no	Part no	Type	Rec	Denomination	Qty/ord.
103	663 04 00	(Ex)		Level sensor FLS10	1
105	642 10 01	(Ex)		Bearing holder	1
107	82 59 06			Retaining ring SGA 40	1
108	82 44 15			Supporting washer 40X50X2.5	1
109	83 30 18			Ball bearing 40X90X36.5 MM	1
110	83 07 62			Retaining ring JB 90	1
120	642 13 00			Plug	1
122	82 76 85			O-ring 17X3 NBR	1
129	642 12 00			Seal housing cover	1
130	82 78 39			O-ring 230X3 NBR	1
131	82 75 01			O-ring 279.3X5.7 NBR	1
133	83 04 56			Hex.socket hd screw M10X35-A4-80	6
141	770 85 30			Mechanical seal	1
145	83 04 53			Hex.socket hd screw M12X45-A4-80	4
158	703 20 09			Impeller	1
162	82 38 00			Plain washer STAINLESS STEEL A4	1
169	83 04 55			Hex.socket hd screw M12X110-A4-80	1
186	702 83 00			Insert ring	1
193	83 04 56			Hex.socket hd screw M10X35-A4-80	3
200	702 81 03			Pump housing	1
200.4	83 04 56			Hex.socket hd screw M10X35-A4-80	2
200.5	82 81 93			O-ring 44,2X5,7 FPM	1
200.6	648 00 00			Cover	1
209	651 07 01			Sliding bracket	1
210	83 04 53			Hex.socket hd screw M12X45-A4-80	4
229	667 40 01			Sticker	2
232	83 53 58			Terminal clamp WDU6/10	3
233	83 53 61			Terminal clamp WDU16,1000V	8
234	83 53 67			Cross connection WQV16/2	4
235	83 53 54			End support WEW 35/2	2
236	83 53 50			Partition	1
239	734 59 00			El.lead through unit	1
240	607 48 00			Spring	1
241	82 78 35			O-ring 175X3 NBR	1
242	608 22 11	(Ex)		Adapter	1
243	83 02 97			Hex.socket hd screw M8X16-A4-70	2
245	82 75 01			O-ring 279.3X5.7 NBR	1
246	82 78 39			O-ring 230X3 NBR	1
247	82 95 69			O-ring 84.4X4 FPM	1
248	608 27 00			Strip	1
249	82 32 50			Clip	1
251	642 13 00			Plug	2
252	82 76 85			O-ring 17X3 NBR	2

Ordered by:

Company:.....Ref:.....Tel:.....Date:.....

Parts List

Item no	Part no	Type	Rec	Denomination	Qty/ord.
253	608 13 01			Cooling jacket	1
254	608 14 01			Flow diffuser	1
256	608 42 00			Wire bow	4
258	720 14 00			Sleeve unit	1
258.1	643 65 01			Sleeve	1
258.2	643 66 00			Adjustment screw	1
264	82 40 82			Plain washer (32)-34 MM	4
265	84 18 04			Seal sleeve (26)-29 MM	2
266	597 98 02			Sleeve	1
267	725 06 00			Plug	3
270	608 31 00			Lock washer	1
313	82 71 72			O-ring 71.2X3 FPM	1
335	83 53 77			Terminal clamp WPE 2,5 WS	1
336	83 42 36			End sleeve 0.75 MM2, L=6 MM	2
800	84 15 47			O-ring kit NBR	1
900	657 17 08			Basic repair kit NBR WCCR/WCCR	1
901	90 37 08			Monopropylene glycol "DOWCAL N"	3.15 l
912	82 76 85			O-ring 17X3 NBR	3
	82 70 86			Cap 6X16 PVC	1
	82 97 76			Cap 26X45 MM PVC	1
	90 29 12			Top coat	0.7 l
...	.....		.....	.....	....
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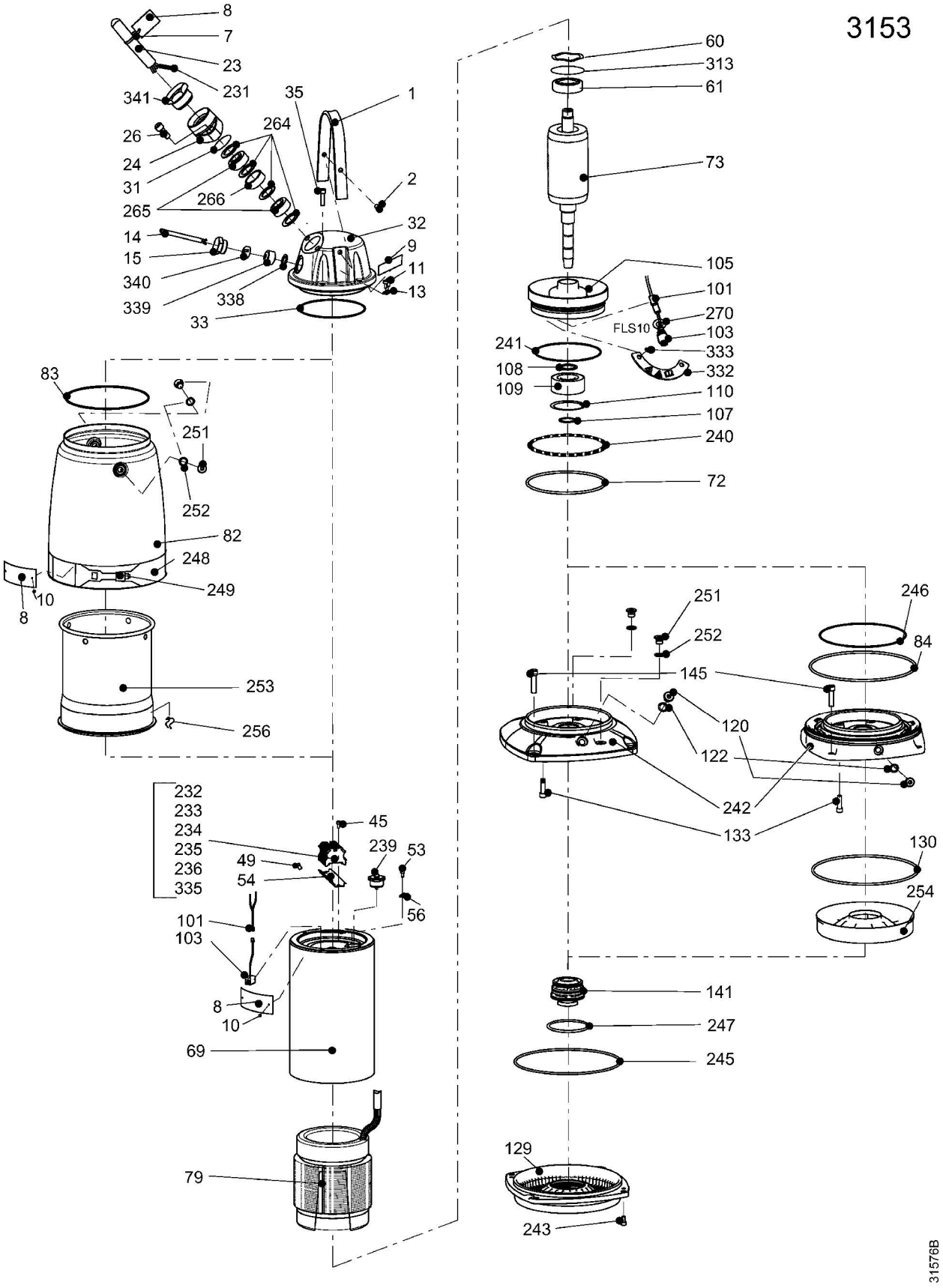
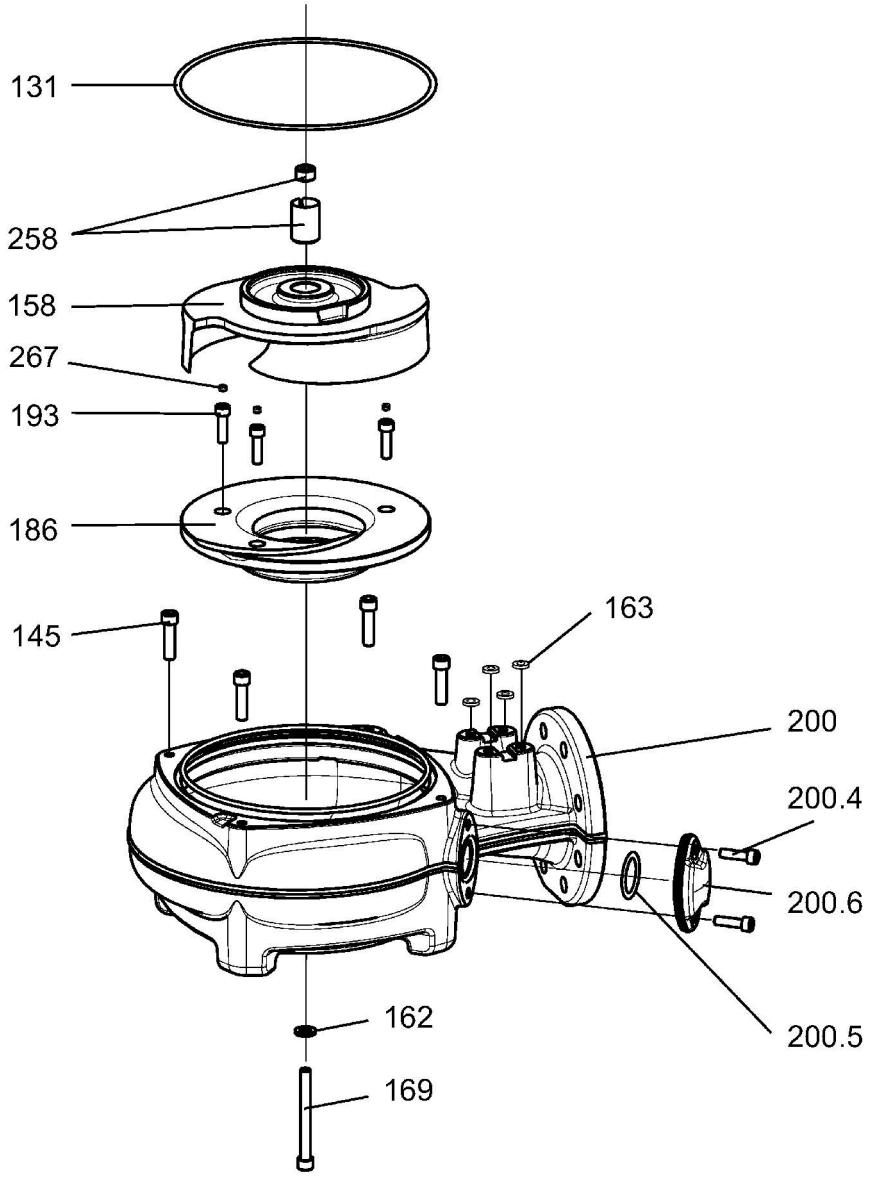
Ordered by:

Company:.....Ref:.....Tel:.....Date:.....

Exploded View



N_ 3153 HT



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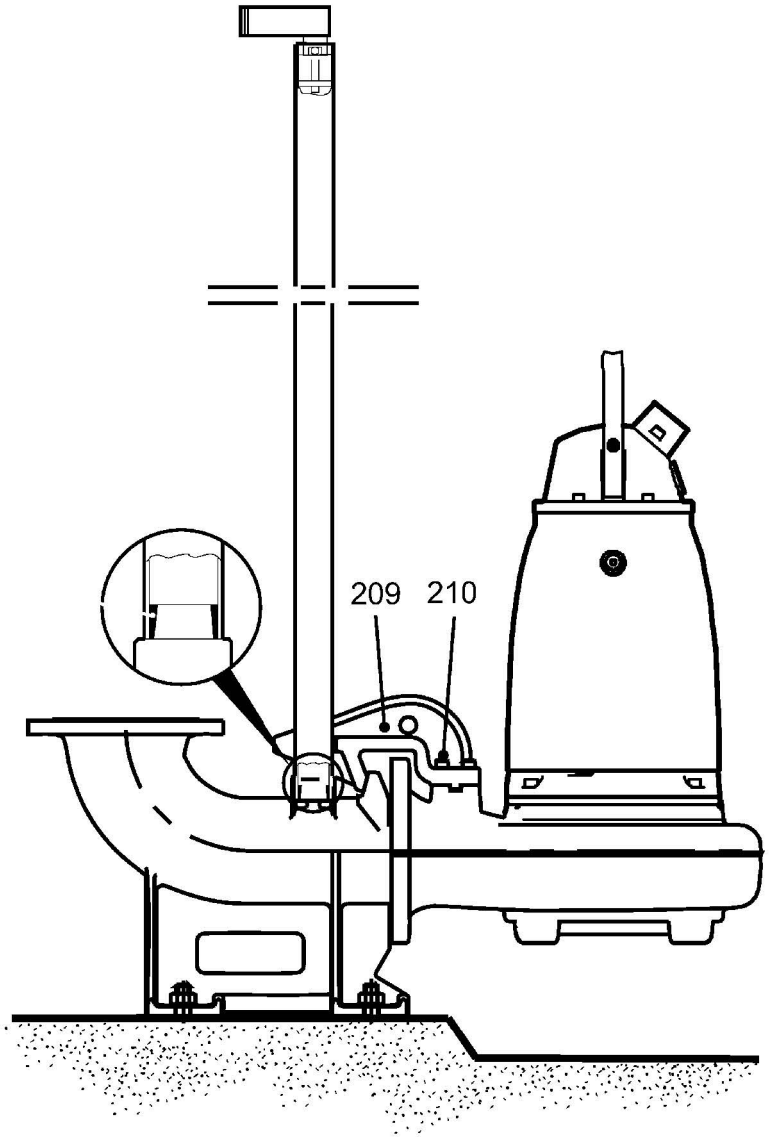

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Notes

9(10)

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CHARLOTTE, NC 28273
USA

Telephone No: 704-4099700

xylem
Let’s Solve Water

Xylem Water Solutions Manufacturing AB
361 80 Emmaboda
Sweden
Tel: +46 471 24 70 00
Fax: +46 471 24 74 01

Individual Parts List

NP 3153 HT

Serial No 3153.095 1480091

FM APPROVED

6102 -

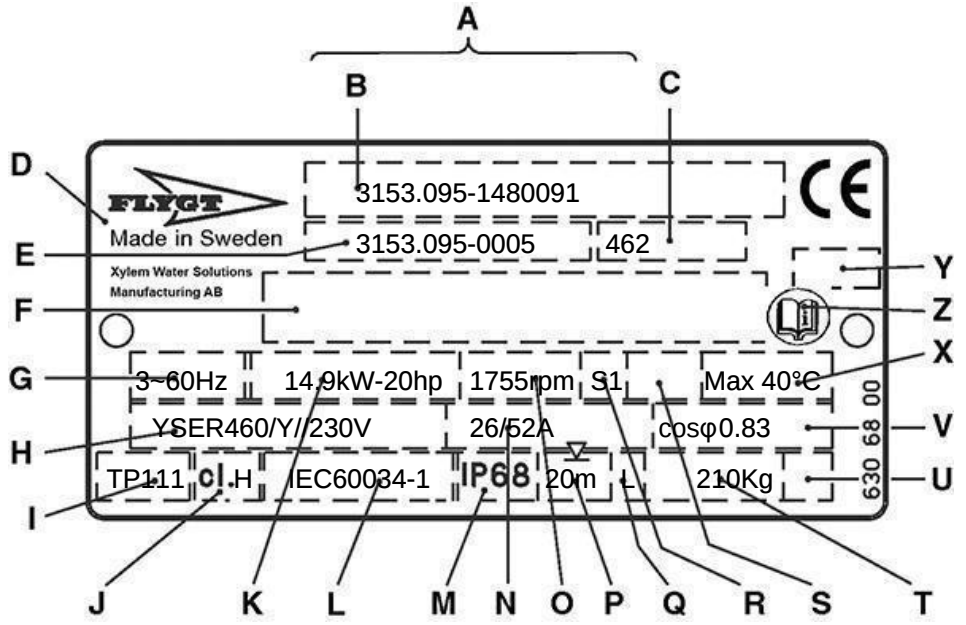
FLYGT
a xylem brand

Dataplate

Flygt NP 3153 HT

Date: 2015-04-22

Serial No: 3153.095 1480091



Dataplate interpretation:

A	Serial number	**M**	Degree of protection
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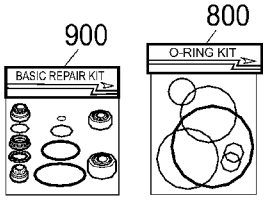
C	Curv code / Propeller code	**O**	Rated speed
D	Country of origin	**P**	Max. submergence
E	Product number	**Q**	Direction of rotation R=right, L=left
F	Additional information	**R**	Duty class
G	Phase; Type of current; Frequency	**S**	Duty factor
H	Rated voltage	**T**	Product weight
I	Thermal protection	**U**	Locked rotor code letter
J	Thermal class	**V**	Power factor
K	Rated shaft power	**X**	Max. ambient temperature
L	International standard	**Y**	Notified body Only for EN-approved Ex-products
		Z	Read Installation Manual



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Parts List

Flygt NP 3153 HT
Serial No 3153.095 1480091

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1	642 15 00			Lifting handle	1
2	83 04 56			Hex.socket hd screw M10X35-A4-80	2
7	83 45 52			Cable tie 292X3.5 MM	1
7	83 45 59			Cable tie 200X2.4 PA 6/6 -55+105	1
8	630 68 00			Data plate USE 6306801 AS SPARE PART	2
8	630 70 00			Certificate plate FM	2
9	81 65 46			Marking plate	1
9	83 93 50			Marking strip 5-GW(T1,T2,T15,T16)	1
9	83 93 51			Marking strip W5,V5,U5,V2,W1,U2,V1,W2,U	1
9	773 29 00			Connection plate	1
10	82 20 88			Drive screw 4X5-A2/A4	6
11	82 00 11			Hex.socket hd screw M6X12-A2-70	2
13	642 16 00			Earthing plate	1
23	94 19 82			Motor cable subcab	16.6 m
24	642 17 01	(Ex)		Entrance flange	1
26	83 04 53			Hex.socket hd screw M12X45-A4-80	2
31	82 74 63			O-ring 49.5X3 NBR	1
32	642 14 01	(Ex)		Entrance cover	1
33	82 78 35			O-ring 175X3 NBR	1
35	83 04 56			Hex.socket hd screw M10X35-A4-80	4
45	82 00 11			Hex.socket hd screw M6X12-A2-70	2
49	83 42 48			End sleeve H16/24	3
53	82 00 11			Hex.socket hd screw M6X12-A2-70	2
53	82 00 11			Hex.socket hd screw M6X12-A2-70	2
54	642 08 00			Rail	1
56	642 16 00			Earthing plate	2
60	82 56 25			Spring washer 71.5X59X0.55 MM	1
61	83 30 16			Ball bearing 30X72X30.2 MM	1
69	642 09 01	(Ex)		Stator housing	1
72	82 74 94			O-ring 209.3X5.7 NBR	1
73	641 98 06	(Ex)		Shaft unit	1
79	641 93 05			Stator 21-18-4a	1
82	608 12 01			Cooling jacket OUTER	1
83	82 78 49			O-ring 221.84X3.53 NBR	1
84	82 75 01			O-ring 279.3X5.7 NBR	1
101	650 51 00			Cable unit FLS10	1

Ordered by:

Company:.....Ref:.....Tel:.....Date:.....

Parts List

Item no	Part no	Type	Rec	Denomination	Qty/ord.
103	663 04 00	(Ex)		Level sensor FLS10	1
105	642 10 01	(Ex)		Bearing holder	1
107	82 59 06			Retaining ring SGA 40	1
108	82 44 15			Supporting washer 40X50X2.5	1
109	83 30 18			Ball bearing 40X90X36.5 MM	1
110	83 07 62			Retaining ring JB 90	1
120	642 13 00			Plug	1
122	82 76 85			O-ring 17X3 NBR	1
129	642 12 00			Seal housing cover	1
130	82 78 39			O-ring 230X3 NBR	1
131	82 75 01			O-ring 279.3X5.7 NBR	1
133	83 04 56			Hex.socket hd screw M10X35-A4-80	6
141	770 85 30			Mechanical seal	1
145	83 04 53			Hex.socket hd screw M12X45-A4-80	4
158	703 20 09			Impeller	1
162	82 38 00			Plain washer STAINLESS STEEL A4	1
169	83 04 55			Hex.socket hd screw M12X110-A4-80	1
186	702 83 00			Insert ring	1
193	83 04 56			Hex.socket hd screw M10X35-A4-80	3
200	702 81 03			Pump housing	1
200.4	83 04 56			Hex.socket hd screw M10X35-A4-80	2
200.5	82 81 93			O-ring 44,2X5,7 FPM	1
200.6	648 00 00			Cover	1
209	651 07 01			Sliding bracket	1
210	83 04 53			Hex.socket hd screw M12X45-A4-80	4
229	667 40 01			Sticker	2
232	83 53 58			Terminal clamp WDU6/10	3
233	83 53 61			Terminal clamp WDU16,1000V	8
234	83 53 67			Cross connection WQV16/2	4
235	83 53 54			End support WEW 35/2	2
236	83 53 50			Partition	1
239	734 59 00			El.lead through unit	1
240	607 48 00			Spring	1
241	82 78 35			O-ring 175X3 NBR	1
242	608 22 11	(Ex)		Adapter	1
243	83 02 97			Hex.socket hd screw M8X16-A4-70	2
245	82 75 01			O-ring 279.3X5.7 NBR	1
246	82 78 39			O-ring 230X3 NBR	1
247	82 95 69			O-ring 84.4X4 FPM	1
248	608 27 00			Strip	1
249	82 32 50			Clip	1
251	642 13 00			Plug	2
252	82 76 85			O-ring 17X3 NBR	2

Ordered by:

Company:.....Ref:.....Tel:.....Date:.....

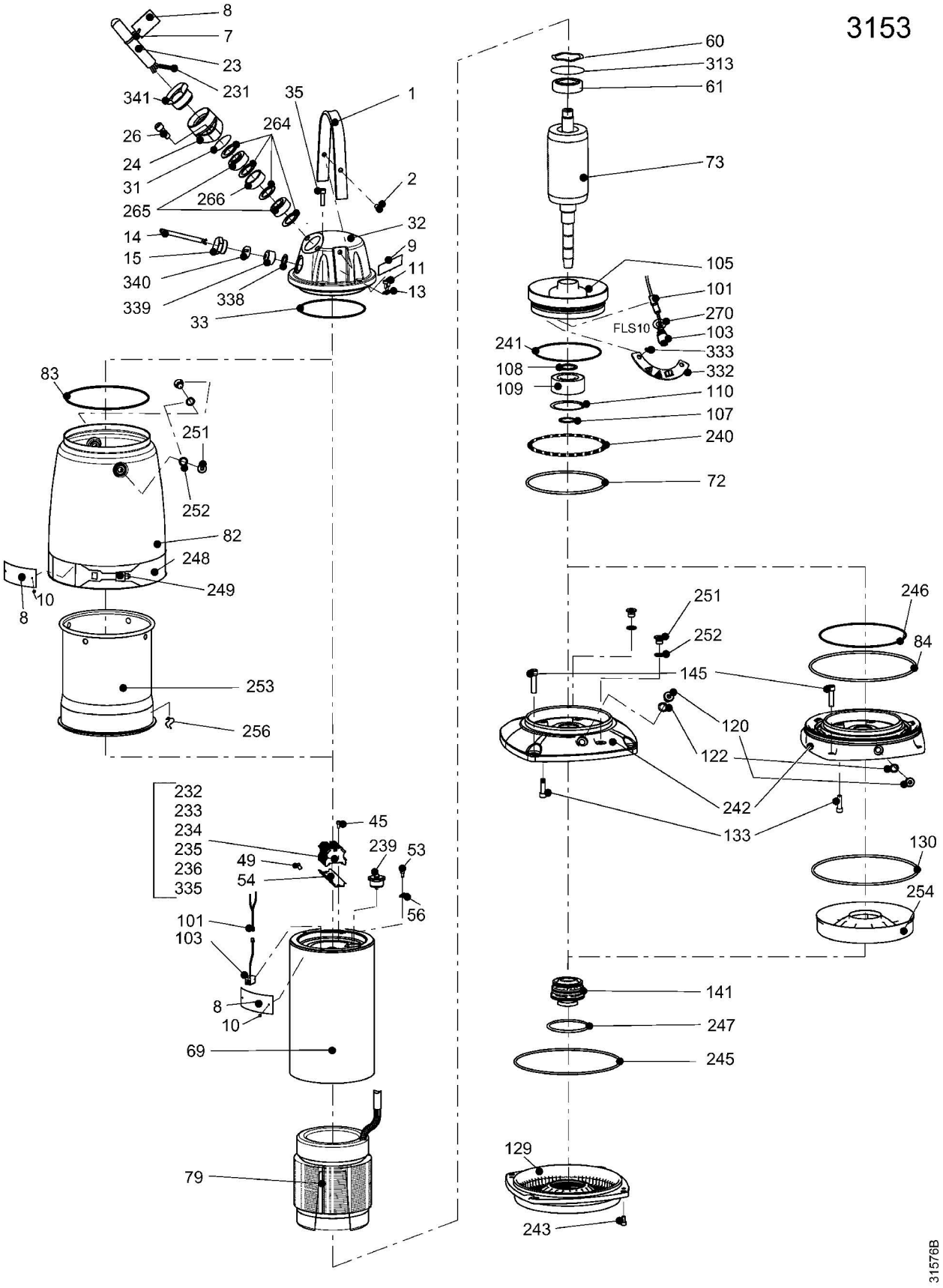
Parts List

Item no	Part no	Type	Rec	Denomination	Qty/ord.
253	608 13 01			Cooling jacket	1
254	608 14 01			Flow diffuser	1
256	608 42 00			Wire bow	4
258	720 14 00			Sleeve unit	1
258.1	643 65 01			Sleeve	1
258.2	643 66 00			Adjustment screw	1
264	82 40 82			Plain washer (32)-34 MM	4
265	84 18 04			Seal sleeve (26)-29 MM	2
266	597 98 02			Sleeve	1
267	725 06 00			Plug	3
270	608 31 00			Lock washer	1
313	82 71 72			O-ring 71.2X3 FPM	1
335	83 53 77			Terminal clamp WPE 2,5 WS	1
336	83 42 36			End sleeve 0.75 MM2, L=6 MM	2
800	84 15 47			O-ring kit NBR	1
900	657 17 08			Basic repair kit NBR WCCR/WCCR	1
901	90 37 08			Monopropylene glycol "DOWCAL N"	3.15 l
912	82 76 85			O-ring 17X3 NBR	3
	82 70 86			Cap 6X16 PVC	1
	82 97 76			Cap 26X45 MM PVC	1
	90 29 12			Top coat	0.7 l
...	.....		.....	.....	....
...	.....		.....	.....	....
...	.....		.....	.....	....
...	.....		.....	.....	....

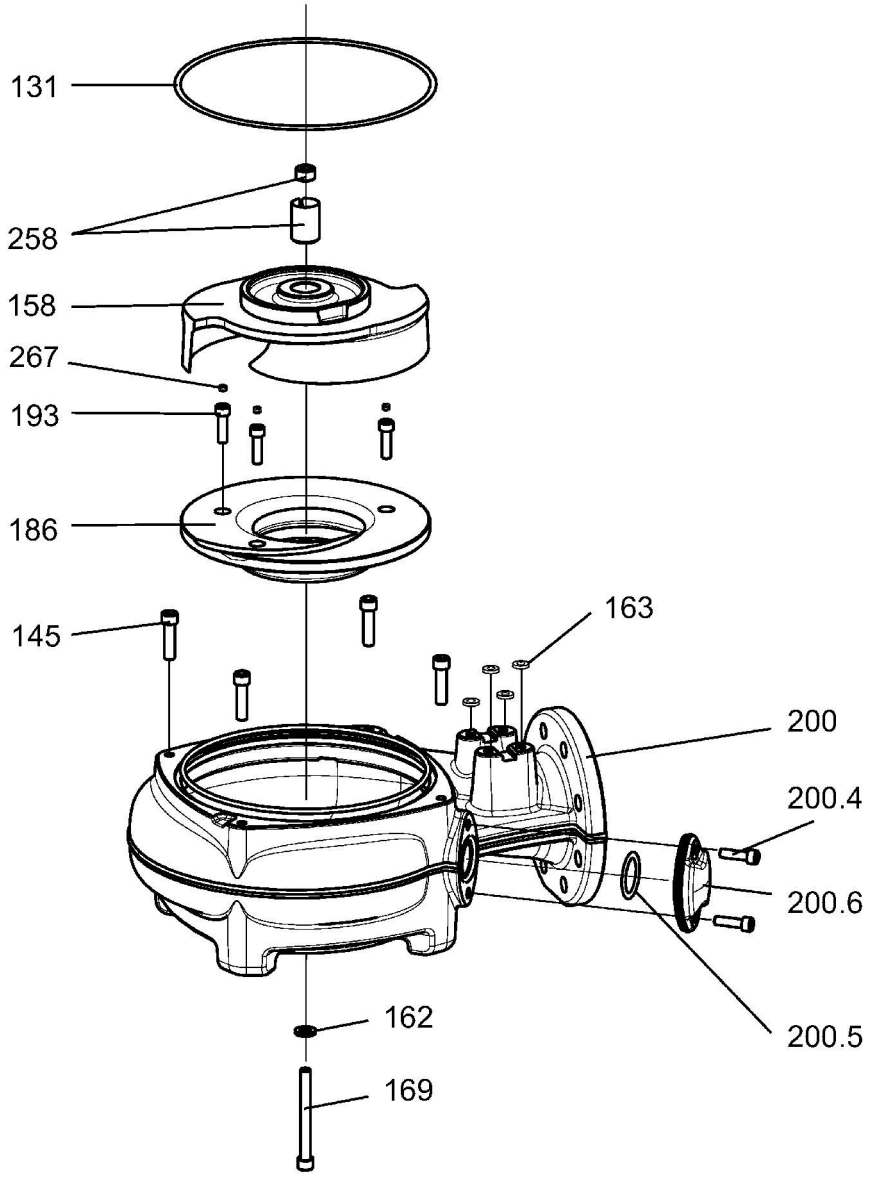
Ordered by:

Company:.....Ref:.....Tel:.....Date:.....

Exploded View

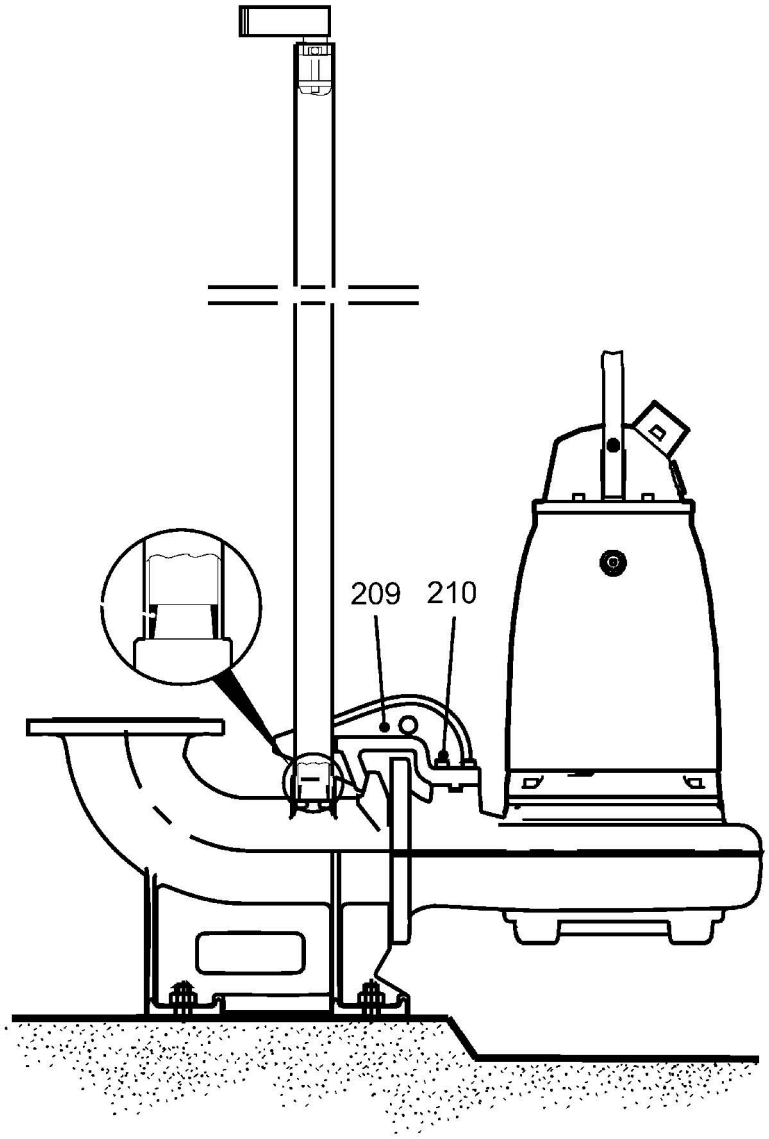


N_ 3153 HT



31259

FP/NP 3153



30582D

Notes

9(10)

Xylem |’zīləm|

1) The tissue in plants that brings water upward from the roots
2) A leading global water technology company

We're 12,900 people unified in a common purpose: creating innovative solutions to meet our world's water needs. Developing new technologies that will improve the way water is used, conserved, and reused in the future is central to our work. We move, treat, analyze, and return water to the environment, and we help people use water efficiently, in their homes, buildings, factories and farms. In more than 150 countries, we have strong, long-standing relationships with customers who know us for our powerful combination of leading product brands and applications expertise, backed by a legacy of innovation.

For more information on how Xylem can help you, go to xyleminc.com

XYLEM WATER SOLUTIONS U.S.A.INC
14125 SOUTH BRIDGE CIRCLE

CHARLOTTE, NC 28273
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Telephone No: 704-4099700

xylem
Let’s Solve Water

Xylem Water Solutions Manufacturing AB
361 80 Emmaboda
Sweden
Tel: +46 471 24 70 00
Fax: +46 471 24 74 01

Individual Parts List

NP 3153 HT

Serial No 3153.095 1480092

FM APPROVED

6102 -

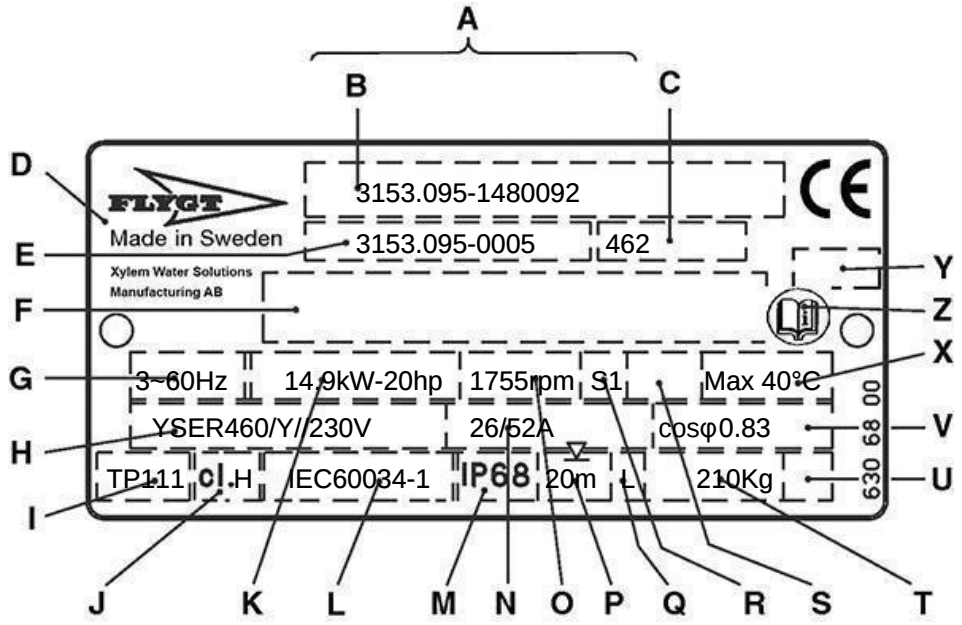
FLYGT
a xylem brand

Dataplate

Flygt NP 3153 HT

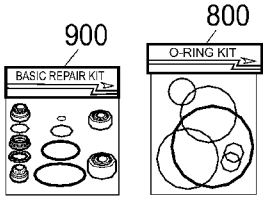
Date: 2015-04-22

Serial No: 3153.095 1480092



Dataplate interpretation:

A	Serial number	**M**	Degree of protection
B	Product code + Number	**N**	Rated current
C	Curv code / Propeller code	**O**	Rated speed
D	Country of origin	**P**	Max. submergence
E	Product number	**Q**	Direction of rotation R=right, L=left
F	Additional information	**R**	Duty class
G	Phase; Type of current; Frequency	**S**	Duty factor
H	Rated voltage	**T**	Product weight
I	Thermal protection	**U**	Locked rotor code letter
J	Thermal class	**V**	Power factor
K	Rated shaft power	**X**	Max. ambient temperature
L	International standard	**Y**	Notified body Only for EN-approved Ex-products
		Z	Read Installation Manual



(1 kg = 2.2 pound, 1 Lit=0.26 US gallon, 1 l = 0,22 UK gallon)

Recommended spare parts:

See REC. column: **A** = Parts for inspection and maintenance
B = Parts for major overhaul

For service;
To ensure long operating life use Flygt Bearing Grease 90 20 61 (Cartridge).
Lubrication kit 84 15 40 contains two 90 20 61 and one 84 15 30 (Grease gun).

The O-ring kit contains a full set of O-rings. Position no 800.

The Basic Repair kits contain both inner and outer Mechanical seals, bearings and a O-ring kit. Position no 900.

A complete set of tools can be ordered for repair and maintenance work, i.e. standard hand tools and special tools for seal change and hydraulic-end use.
Order:
This partlist can be used as an order form by marking out the number of parts in the Qty/Order column.
Please send or fax the form to your Flygt representative.

Parts List

Flygt NP 3153 HT
Serial No 3153.095 1480092

Item no	Part no	Type	Rec	Denomination	Qty/ord.
1	642 15 00			Lifting handle	1
2	83 04 56			Hex.socket hd screw M10X35-A4-80	2
7	83 45 52			Cable tie 292X3.5 MM	1
7	83 45 59			Cable tie 200X2.4 PA 6/6 -55+105	1
8	630 68 00			Data plate USE 6306801 AS SPARE PART	2
8	630 70 00			Certificate plate FM	2
9	81 65 46			Marking plate	1
9	83 93 50			Marking strip 5-GW(T1,T2,T15,T16)	1
9	83 93 51			Marking strip W5,V5,U5,V2,W1,U2,V1,W2,U	1
9	773 29 00			Connection plate	1
10	82 20 88			Drive screw 4X5-A2/A4	6
11	82 00 11			Hex.socket hd screw M6X12-A2-70	2
13	642 16 00			Earthing plate	1
23	94 19 82			Motor cable subcab	16.6 m
24	642 17 01	(Ex)		Entrance flange	1
26	83 04 53			Hex.socket hd screw M12X45-A4-80	2
31	82 74 63			O-ring 49.5X3 NBR	1
32	642 14 01	(Ex)		Entrance cover	1
33	82 78 35			O-ring 175X3 NBR	1
35	83 04 56			Hex.socket hd screw M10X35-A4-80	4
45	82 00 11			Hex.socket hd screw M6X12-A2-70	2
49	83 42 48			End sleeve H16/24	3
53	82 00 11			Hex.socket hd screw M6X12-A2-70	2
53	82 00 11			Hex.socket hd screw M6X12-A2-70	2
54	642 08 00			Rail	1
56	642 16 00			Earthing plate	2
60	82 56 25			Spring washer 71.5X59X0.55 MM	1
61	83 30 16			Ball bearing 30X72X30.2 MM	1
69	642 09 01	(Ex)		Stator housing	1
72	82 74 94			O-ring 209.3X5.7 NBR	1
73	641 98 06	(Ex)		Shaft unit	1
79	641 93 05			Stator 21-18-4a	1
82	608 12 01			Cooling jacket OUTER	1
83	82 78 49			O-ring 221.84X3.53 NBR	1
84	82 75 01			O-ring 279.3X5.7 NBR	1
101	650 51 00			Cable unit FLS10	1

Ordered by:

Company:.....Ref:.....Tel:.....Date:.....

Parts List

Item no	Part no	Type	Rec	Denomination	Qty/ord.
103	663 04 00	(Ex)		Level sensor FLS10	1
105	642 10 01	(Ex)		Bearing holder	1
107	82 59 06			Retaining ring SGA 40	1
108	82 44 15			Supporting washer 40X50X2.5	1
109	83 30 18			Ball bearing 40X90X36.5 MM	1
110	83 07 62			Retaining ring JB 90	1
120	642 13 00			Plug	1
122	82 76 85			O-ring 17X3 NBR	1
129	642 12 00			Seal housing cover	1
130	82 78 39			O-ring 230X3 NBR	1
131	82 75 01			O-ring 279.3X5.7 NBR	1
133	83 04 56			Hex.socket hd screw M10X35-A4-80	6
141	770 85 30			Mechanical seal	1
145	83 04 53			Hex.socket hd screw M12X45-A4-80	4
158	703 20 09			Impeller	1
162	82 38 00			Plain washer STAINLESS STEEL A4	1
169	83 04 55			Hex.socket hd screw M12X110-A4-80	1
186	702 83 00			Insert ring	1
193	83 04 56			Hex.socket hd screw M10X35-A4-80	3
200	702 81 03			Pump housing	1
200.4	83 04 56			Hex.socket hd screw M10X35-A4-80	2
200.5	82 81 93			O-ring 44,2X5,7 FPM	1
200.6	648 00 00			Cover	1
209	651 07 01			Sliding bracket	1
210	83 04 53			Hex.socket hd screw M12X45-A4-80	4
229	667 40 01			Sticker	2
232	83 53 58			Terminal clamp WDU6/10	3
233	83 53 61			Terminal clamp WDU16,1000V	8
234	83 53 67			Cross connection WQV16/2	4
235	83 53 54			End support WEW 35/2	2
236	83 53 50			Partition	1
239	734 59 00			El.lead through unit	1
240	607 48 00			Spring	1
241	82 78 35			O-ring 175X3 NBR	1
242	608 22 11	(Ex)		Adapter	1
243	83 02 97			Hex.socket hd screw M8X16-A4-70	2
245	82 75 01			O-ring 279.3X5.7 NBR	1
246	82 78 39			O-ring 230X3 NBR	1
247	82 95 69			O-ring 84.4X4 FPM	1
248	608 27 00			Strip	1
249	82 32 50			Clip	1
251	642 13 00			Plug	2
252	82 76 85			O-ring 17X3 NBR	2

Ordered by:

Company:.....Ref:.....Tel:.....Date:.....

Parts List

Item no	Part no	Type	Rec	Denomination	Qty/ord.
253	608 13 01			Cooling jacket	1
254	608 14 01			Flow diffuser	1
256	608 42 00			Wire bow	4
258	720 14 00			Sleeve unit	1
258.1	643 65 01			Sleeve	1
258.2	643 66 00			Adjustment screw	1
264	82 40 82			Plain washer (32)-34 MM	4
265	84 18 04			Seal sleeve (26)-29 MM	2
266	597 98 02			Sleeve	1
267	725 06 00			Plug	3
270	608 31 00			Lock washer	1
313	82 71 72			O-ring 71.2X3 FPM	1
335	83 53 77			Terminal clamp WPE 2,5 WS	1
336	83 42 36			End sleeve 0.75 MM2, L=6 MM	2
800	84 15 47			O-ring kit NBR	1
900	657 17 08			Basic repair kit NBR WCCR/WCCR	1
901	90 37 08			Monopropylene glycol "DOWCAL N"	3.15 l
912	82 76 85			O-ring 17X3 NBR	3
	82 70 86			Cap 6X16 PVC	1
	82 97 76			Cap 26X45 MM PVC	1
	90 29 12			Top coat	0.7 l
...	.....		.....	.....	....
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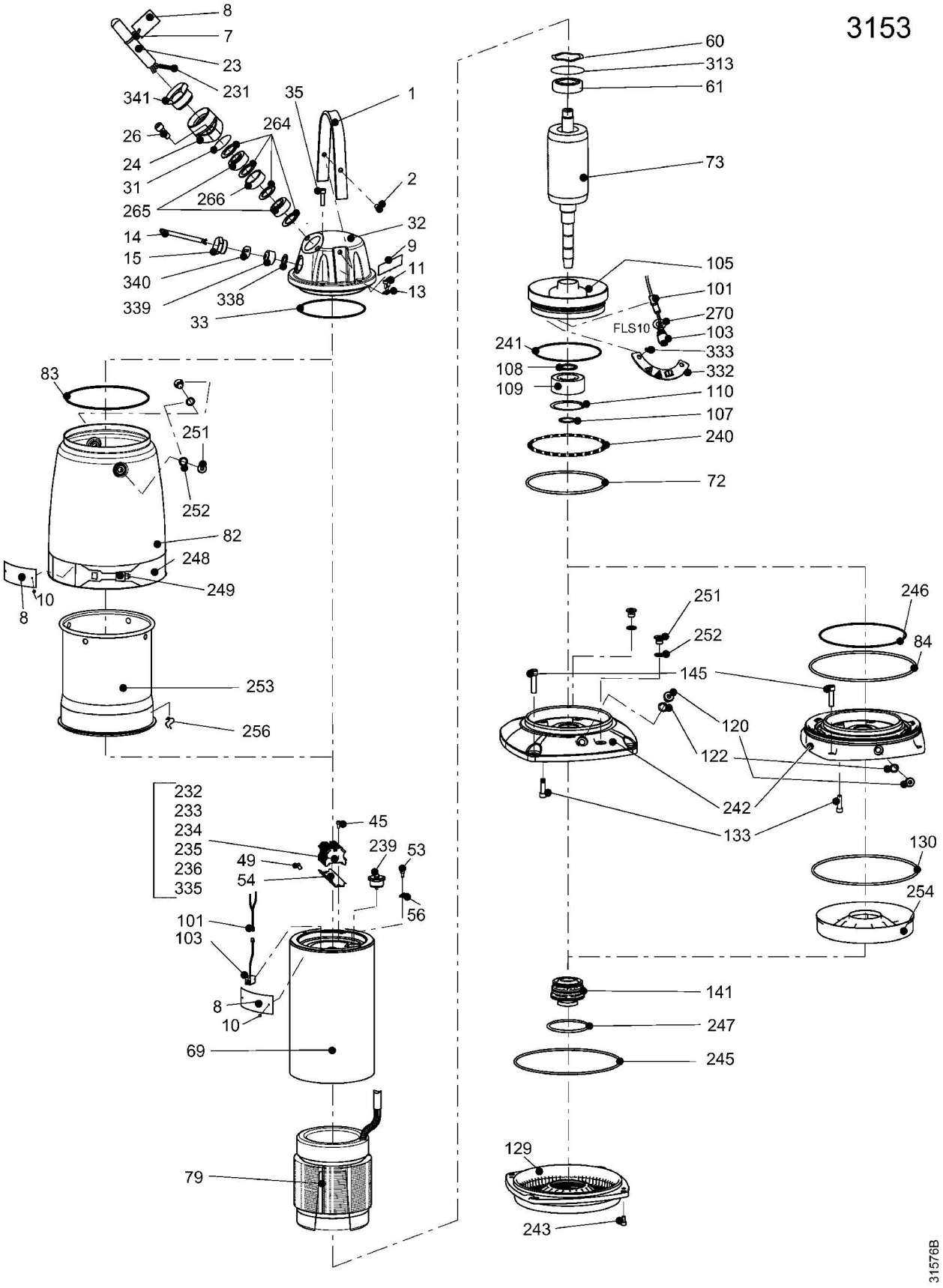
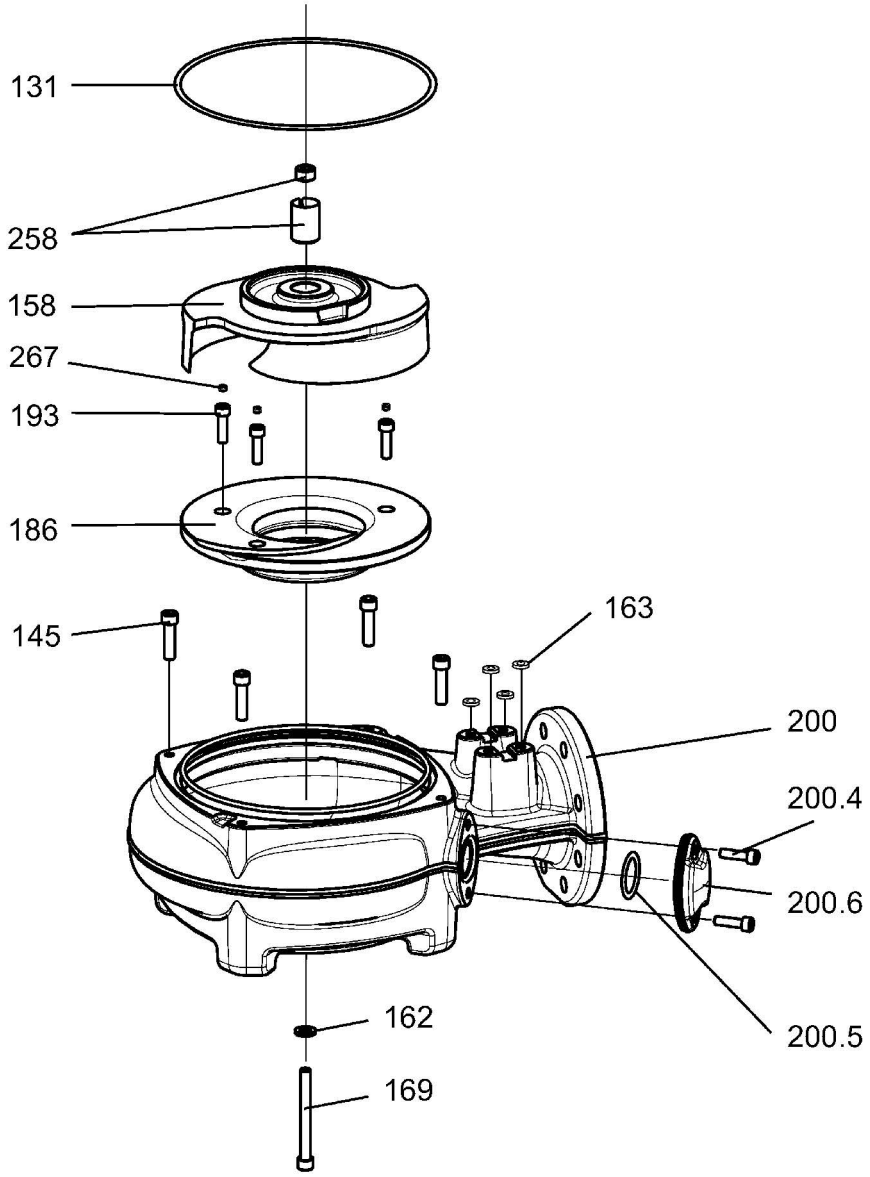
Ordered by:

Company:.....Ref:.....Tel:.....Date:.....

Exploded View



N_ 3153 HT



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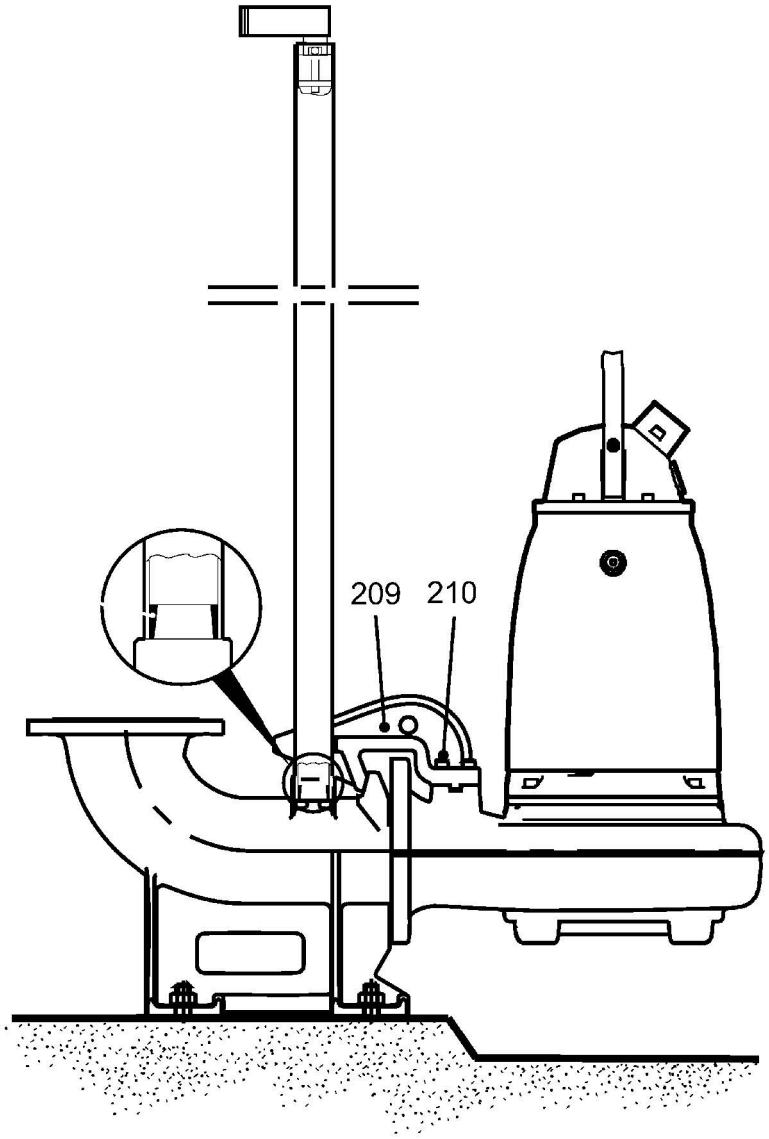
FP/NP 3153



30582D

Notes

9(10)

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XYLEM WATER SOLUTIONS U.S.A.INC
14125 SOUTH BRIDGE CIRCLE

CHARLOTTE, NC 28273
USA

Telephone No: 704-4099700

xylem
Let’s Solve Water

Xylem Water Solutions Manufacturing AB
361 80 Emmaboda
Sweden
Tel: +46 471 24 70 00
Fax: +46 471 24 74 01

Individual Parts List

NP 3153 HT

Serial No 3153.095 1480093

FM APPROVED

6102 -

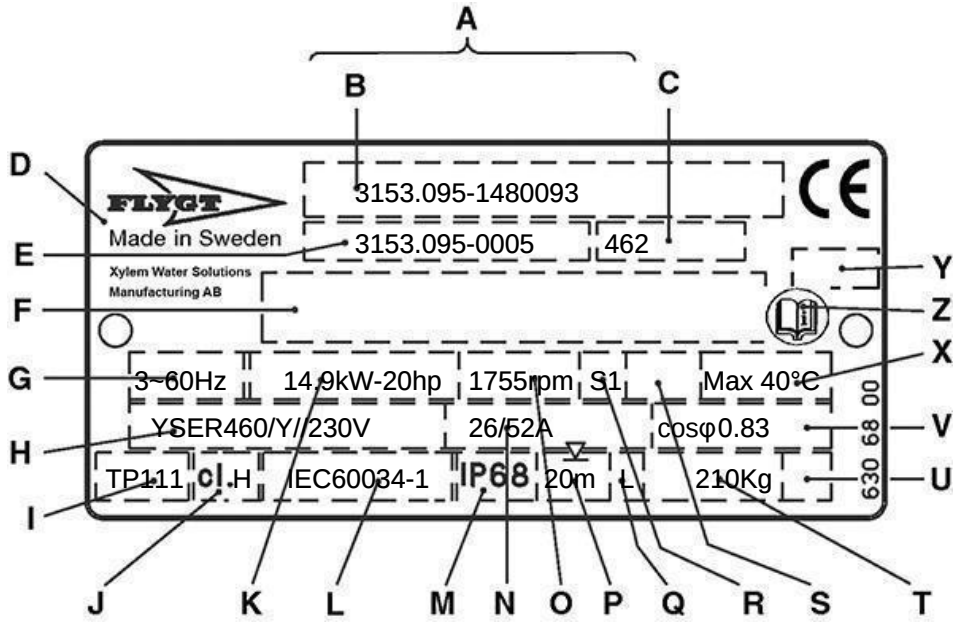
FLYGT
a xylem brand

Dataplate

Flygt NP 3153 HT

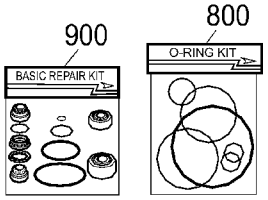
Date: 2015-04-22

Serial No: 3153.095 1480093



Dataplate interpretation:

A	Serial number	**M**	Degree of protection
B	Product code + Number	**N**	Rated current
C	Curv code / Propeller code	**O**	Rated speed
D	Country of origin	**P**	Max. submergence
E	Product number	**Q**	Direction of rotation R=right, L=left
F	Additional information	**R**	Duty class
G	Phase; Type of current; Frequency	**S**	Duty factor
H	Rated voltage	**T**	Product weight
I	Thermal protection	**U**	Locked rotor code letter
J	Thermal class	**V**	Power factor
K	Rated shaft power	**X**	Max. ambient temperature
L	International standard	**Y**	Notified body Only for EN-approved Ex-products
		Z	Read Installation Manual



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Parts List

Flygt NP 3153 HT
Serial No 3153.095 1480093

Item no	Part no	Type	Rec	Denomination	Qty/ord.
1	642 15 00			Lifting handle	1
2	83 04 56			Hex.socket hd screw M10X35-A4-80	2
7	83 45 52			Cable tie 292X3.5 MM	1
7	83 45 59			Cable tie 200X2.4 PA 6/6 -55+105	1
8	630 68 00			Data plate USE 6306801 AS SPARE PART	2
8	630 70 00			Certificate plate FM	2
9	81 65 46			Marking plate	1
9	83 93 50			Marking strip 5-GW(T1,T2,T15,T16)	1
9	83 93 51			Marking strip W5,V5,U5,V2,W1,U2,V1,W2,U	1
9	773 29 00			Connection plate	1
10	82 20 88			Drive screw 4X5-A2/A4	6
11	82 00 11			Hex.socket hd screw M6X12-A2-70	2
13	642 16 00			Earthing plate	1
23	94 19 82			Motor cable subcab	16.6 m
24	642 17 01	(Ex)		Entrance flange	1
26	83 04 53			Hex.socket hd screw M12X45-A4-80	2
31	82 74 63			O-ring 49.5X3 NBR	1
32	642 14 01	(Ex)		Entrance cover	1
33	82 78 35			O-ring 175X3 NBR	1
35	83 04 56			Hex.socket hd screw M10X35-A4-80	4
45	82 00 11			Hex.socket hd screw M6X12-A2-70	2
49	83 42 48			End sleeve H16/24	3
53	82 00 11			Hex.socket hd screw M6X12-A2-70	2
53	82 00 11			Hex.socket hd screw M6X12-A2-70	2
54	642 08 00			Rail	1
56	642 16 00			Earthing plate	2
60	82 56 25			Spring washer 71.5X59X0.55 MM	1
61	83 30 16			Ball bearing 30X72X30.2 MM	1
69	642 09 01	(Ex)		Stator housing	1
72	82 74 94			O-ring 209.3X5.7 NBR	1
73	641 98 06	(Ex)		Shaft unit	1
79	641 93 05			Stator 21-18-4a	1
82	608 12 01			Cooling jacket OUTER	1
83	82 78 49			O-ring 221.84X3.53 NBR	1
84	82 75 01			O-ring 279.3X5.7 NBR	1
101	650 51 00			Cable unit FLS10	1

Ordered by:

Company:.....Ref:.....Tel:.....Date:.....

Parts List

Item no	Part no	Type	Rec	Denomination	Qty/ord.
103	663 04 00	(Ex)		Level sensor FLS10	1
105	642 10 01	(Ex)		Bearing holder	1
107	82 59 06			Retaining ring SGA 40	1
108	82 44 15			Supporting washer 40X50X2.5	1
109	83 30 18			Ball bearing 40X90X36.5 MM	1
110	83 07 62			Retaining ring JB 90	1
120	642 13 00			Plug	1
122	82 76 85			O-ring 17X3 NBR	1
129	642 12 00			Seal housing cover	1
130	82 78 39			O-ring 230X3 NBR	1
131	82 75 01			O-ring 279.3X5.7 NBR	1
133	83 04 56			Hex.socket hd screw M10X35-A4-80	6
141	770 85 30			Mechanical seal	1
145	83 04 53			Hex.socket hd screw M12X45-A4-80	4
158	703 20 09			Impeller	1
162	82 38 00			Plain washer STAINLESS STEEL A4	1
169	83 04 55			Hex.socket hd screw M12X110-A4-80	1
186	702 83 00			Insert ring	1
193	83 04 56			Hex.socket hd screw M10X35-A4-80	3
200	702 81 03			Pump housing	1
200.4	83 04 56			Hex.socket hd screw M10X35-A4-80	2
200.5	82 81 93			O-ring 44,2X5,7 FPM	1
200.6	648 00 00			Cover	1
209	651 07 01			Sliding bracket	1
210	83 04 53			Hex.socket hd screw M12X45-A4-80	4
229	667 40 01			Sticker	2
232	83 53 58			Terminal clamp WDU6/10	3
233	83 53 61			Terminal clamp WDU16,1000V	8
234	83 53 67			Cross connection WQV16/2	4
235	83 53 54			End support WEW 35/2	2
236	83 53 50			Partition	1
239	734 59 00			El.lead through unit	1
240	607 48 00			Spring	1
241	82 78 35			O-ring 175X3 NBR	1
242	608 22 11	(Ex)		Adapter	1
243	83 02 97			Hex.socket hd screw M8X16-A4-70	2
245	82 75 01			O-ring 279.3X5.7 NBR	1
246	82 78 39			O-ring 230X3 NBR	1
247	82 95 69			O-ring 84.4X4 FPM	1
248	608 27 00			Strip	1
249	82 32 50			Clip	1
251	642 13 00			Plug	2
252	82 76 85			O-ring 17X3 NBR	2

Ordered by:

Company:.....Ref:.....Tel:.....Date:.....

Parts List

Item no	Part no	Type	Rec	Denomination	Qty/ord.
253	608 13 01			Cooling jacket	1
254	608 14 01			Flow diffuser	1
256	608 42 00			Wire bow	4
258	720 14 00			Sleeve unit	1
258.1	643 65 01			Sleeve	1
258.2	643 66 00			Adjustment screw	1
264	82 40 82			Plain washer (32)-34 MM	4
265	84 18 04			Seal sleeve (26)-29 MM	2
266	597 98 02			Sleeve	1
267	725 06 00			Plug	3
270	608 31 00			Lock washer	1
313	82 71 72			O-ring 71.2X3 FPM	1
335	83 53 77			Terminal clamp WPE 2,5 WS	1
336	83 42 36			End sleeve 0.75 MM2, L=6 MM	2
800	84 15 47			O-ring kit NBR	1
900	657 17 08			Basic repair kit NBR WCCR/WCCR	1
901	90 37 08			Monopropylene glycol "DOWCAL N"	3.15 l
912	82 76 85			O-ring 17X3 NBR	3
	82 70 86			Cap 6X16 PVC	1
	82 97 76			Cap 26X45 MM PVC	1
	90 29 12			Top coat	0.7 l
...	.....		.....	.....	....
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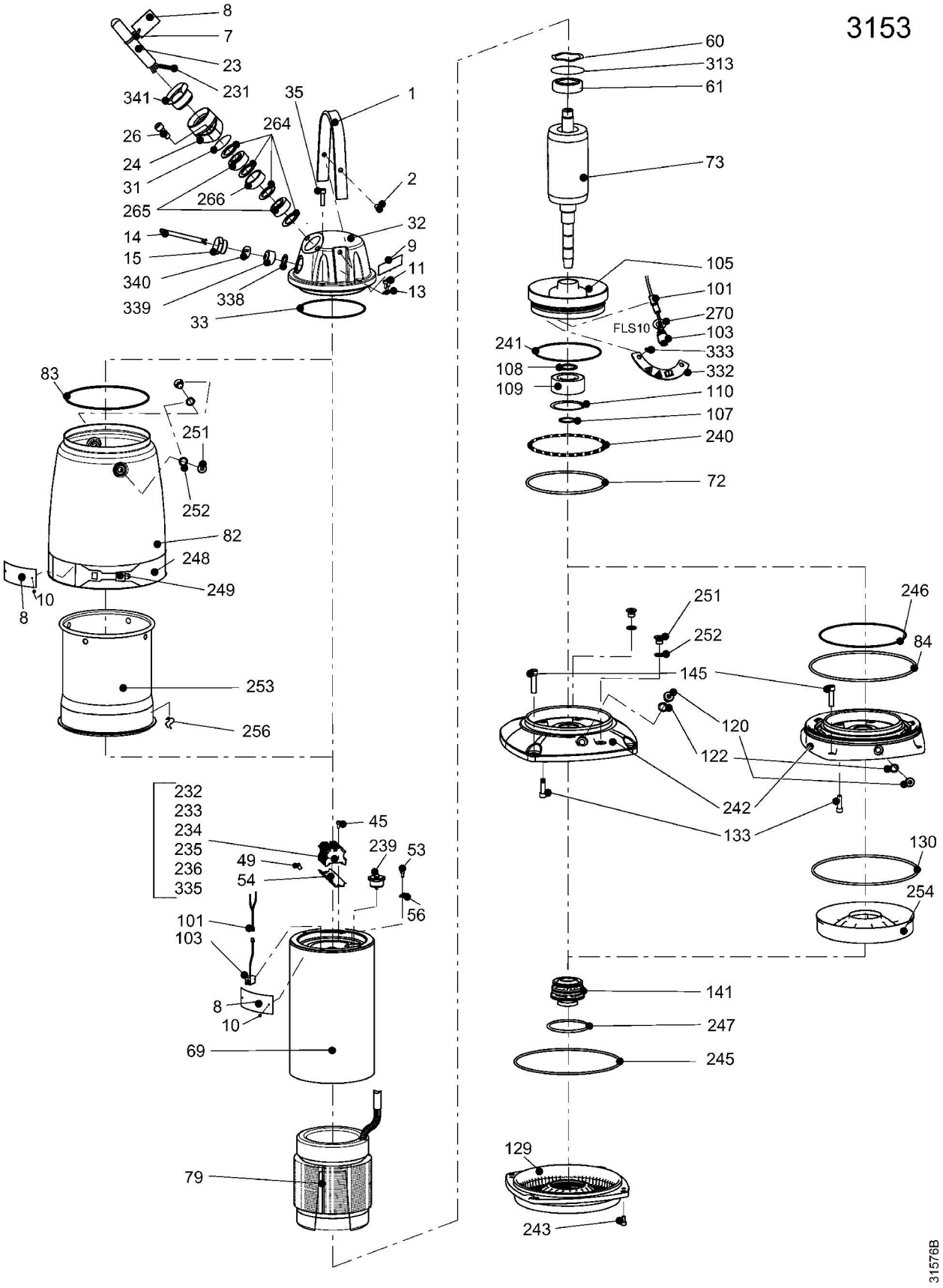
Ordered by:

Company:.....Ref:.....Tel:.....Date:.....

Exploded View



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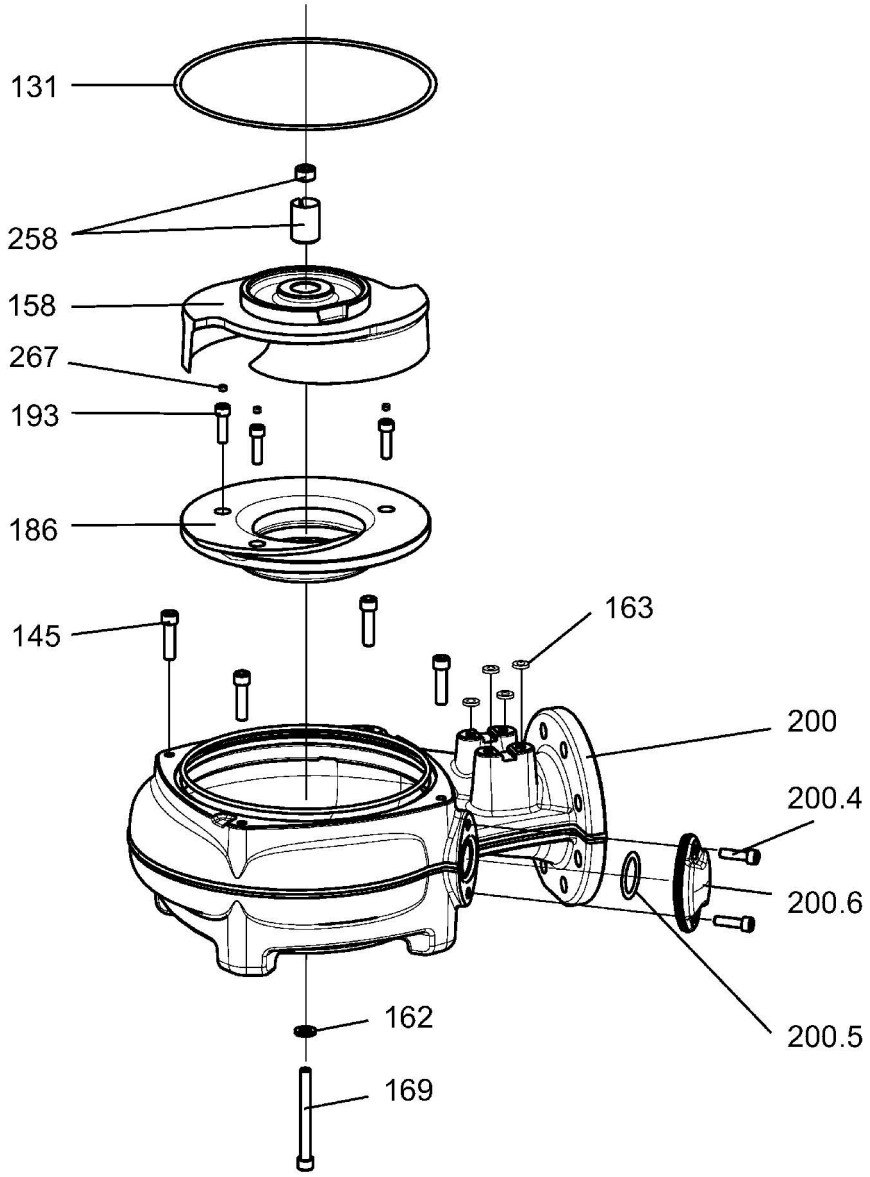
N_ 3153 HT



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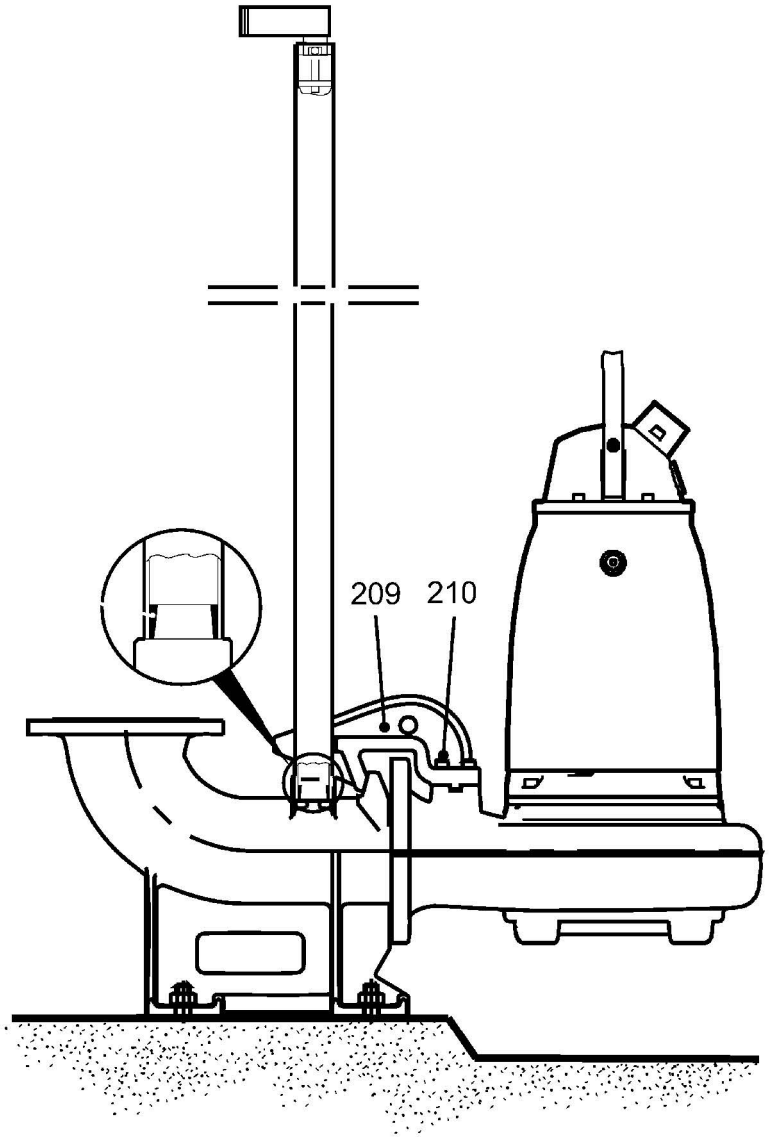
FP/NP 3153



30582D

Notes

9(10)

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2) A leading global water technology company

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XYLEM WATER SOLUTIONS U.S.A.INC
14125 SOUTH BRIDGE CIRCLE

CHARLOTTE, NC 28273
USA

Telephone No: 704-4099700

xylem
Let’s Solve Water

Xylem Water Solutions Manufacturing AB
361 80 Emmaboda
Sweden
Tel: +46 471 24 70 00
Fax: +46 471 24 74 01

Individual Parts List

NP 3153 HT

Serial No 3153.095 1480100

FM APPROVED

6102 -

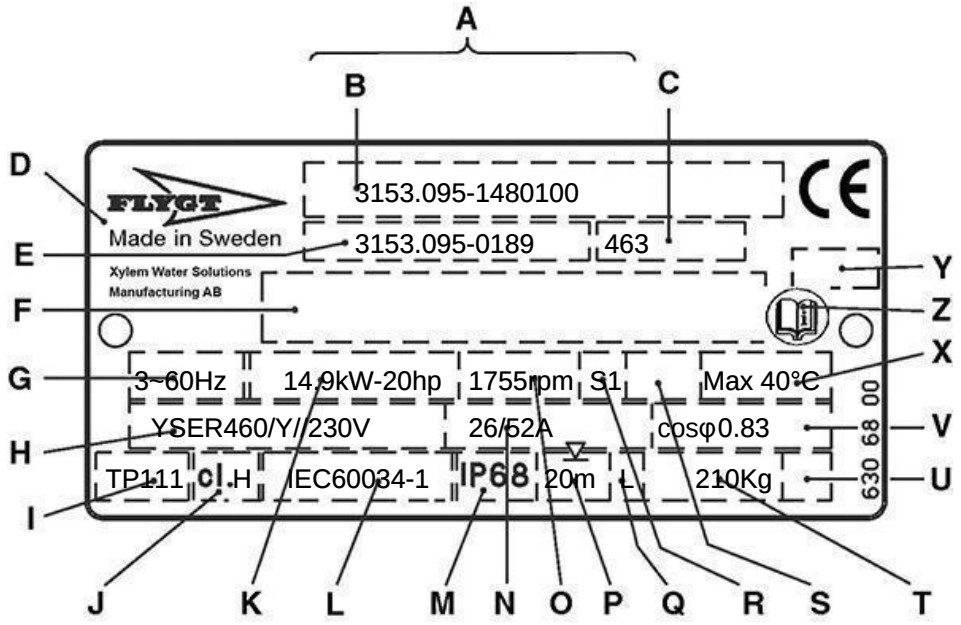
FLYGT
a xylem brand

Dataplate

Flygt NP 3153 HT

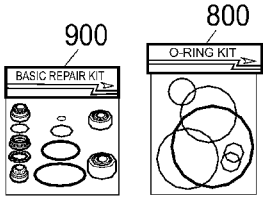
Date: 2015-04-22

Serial No: 3153.095 1480100



Dataplate interpretation:

A	Serial number	**M**	Degree of protection
B	Product code + Number	**N**	Rated current
C	Curv code / Propeller code	**O**	Rated speed
D	Country of origin	**P**	Max. submergence
E	Product number	**Q**	Direction of rotation R=right, L=left
F	Additional information	**R**	Duty class
G	Phase; Type of current; Frequency	**S**	Duty factor
H	Rated voltage	**T**	Product weight
I	Thermal protection	**U**	Locked rotor code letter
J	Thermal class	**V**	Power factor
K	Rated shaft power	**X**	Max. ambient temperature
L	International standard	**Y**	Notified body Only for EN-approved Ex-products
		Z	Read Installation Manual



(1 kg = 2.2 pound, 1 Lit=0.26 US gallon, 1 l = 0,22 UK gallon)

Recommended spare parts:

See REC. column: **A** = Parts for inspection and maintenance
B = Parts for major overhaul

For service;
To ensure long operating life use Flygt Bearing Grease 90 20 61 (Cartridge).
Lubrication kit 84 15 40 contains two 90 20 61 and one 84 15 30 (Grease gun).

The O-ring kit contains a full set of O-rings. Position no 800.

The Basic Repair kits contain both inner and outer Mechanical seals, bearings and a O-ring kit. Position no 900.

A complete set of tools can be ordered for repair and maintenance work, i.e. standard hand tools and special tools for seal change and hydraulic-end use.
Order:
This partlist can be used as an order form by marking out the number of parts in the Qty/Order column.
Please send or fax the form to your Flygt representative.

Parts List

Flygt NP 3153 HT
Serial No 3153.095 1480100

Item no	Part no	Type	Rec	Denomination	Qty/ord.
1	642 15 00			Lifting handle	1
2	83 04 56			Hex.socket hd screw M10X35-A4-80	2
7	83 45 52			Cable tie 292X3.5 MM	1
7	83 45 59			Cable tie 200X2.4 PA 6/6 -55+105	1
8	630 68 00			Data plate USE 6306801 AS SPARE PART	2
8	630 70 00			Certificate plate FM	2
9	81 65 46			Marking plate	1
9	83 93 50			Marking strip 5-GW(T1,T2,T15,T16)	1
9	83 93 51			Marking strip W5,V5,U5,V2,W1,U2,V1,W2,U	1
9	773 29 00			Connection plate	1
10	82 20 88			Drive screw 4X5-A2/A4	6
11	82 00 11			Hex.socket hd screw M6X12-A2-70	2
13	642 16 00			Earthing plate	1
23	94 19 82			Motor cable subcab	16.6 m
24	642 17 01	(Ex)		Entrance flange	1
26	83 04 53			Hex.socket hd screw M12X45-A4-80	2
31	82 74 63			O-ring 49.5X3 NBR	1
32	642 14 01	(Ex)		Entrance cover	1
33	82 78 35			O-ring 175X3 NBR	1
35	83 04 56			Hex.socket hd screw M10X35-A4-80	4
45	82 00 11			Hex.socket hd screw M6X12-A2-70	2
49	83 42 48			End sleeve H16/24	3
53	82 00 11			Hex.socket hd screw M6X12-A2-70	2
53	82 00 11			Hex.socket hd screw M6X12-A2-70	2
54	642 08 00			Rail	1
56	642 16 00			Earthing plate	2
60	82 56 25			Spring washer 71.5X59X0.55 MM	1
61	83 30 16			Ball bearing 30X72X30.2 MM	1
69	642 09 01	(Ex)		Stator housing	1
72	82 74 94			O-ring 209.3X5.7 NBR	1
73	641 98 06	(Ex)		Shaft unit	1
79	641 93 05			Stator 21-18-4a	1
82	608 12 01			Cooling jacket OUTER	1
83	82 78 49			O-ring 221.84X3.53 NBR	1
84	82 75 01			O-ring 279.3X5.7 NBR	1
101	650 51 00			Cable unit FLS10	1

Ordered by:

Company:.....Ref:.....Tel:.....Date:.....

Parts List

Item no	Part no	Type	Rec	Denomination	Qty/ord.
103	663 04 00	(Ex)		Level sensor FLS10	1
105	642 10 01	(Ex)		Bearing holder	1
107	82 59 06			Retaining ring SGA 40	1
108	82 44 15			Supporting washer 40X50X2.5	1
109	83 30 18			Ball bearing 40X90X36.5 MM	1
110	83 07 62			Retaining ring JB 90	1
120	642 13 00			Plug	1
122	82 76 85			O-ring 17X3 NBR	1
129	642 12 00			Seal housing cover	1
130	82 78 39			O-ring 230X3 NBR	1
131	82 75 01			O-ring 279.3X5.7 NBR	1
133	83 04 56			Hex.socket hd screw M10X35-A4-80	6
141	770 85 30			Mechanical seal	1
145	83 04 53			Hex.socket hd screw M12X45-A4-80	4
158	703 20 22			Impeller	1
162	82 38 00			Plain washer STAINLESS STEEL A4	1
169	83 04 55			Hex.socket hd screw M12X110-A4-80	1
186	702 83 00			Insert ring	1
193	83 04 56			Hex.socket hd screw M10X35-A4-80	3
200	702 81 03			Pump housing	1
200.4	83 04 56			Hex.socket hd screw M10X35-A4-80	2
200.5	82 81 93			O-ring 44,2X5,7 FPM	1
200.6	648 00 00			Cover	1
209	651 07 01			Sliding bracket	1
210	83 04 53			Hex.socket hd screw M12X45-A4-80	4
229	667 40 01			Sticker	2
232	83 53 58			Terminal clamp WDU6/10	3
233	83 53 61			Terminal clamp WDU16,1000V	8
234	83 53 67			Cross connection WQV16/2	4
235	83 53 54			End support WEW 35/2	2
236	83 53 50			Partition	1
239	734 59 00			El.lead through unit	1
240	607 48 00			Spring	1
241	82 78 35			O-ring 175X3 NBR	1
242	608 22 11	(Ex)		Adapter	1
243	83 02 97			Hex.socket hd screw M8X16-A4-70	2
245	82 75 01			O-ring 279.3X5.7 NBR	1
246	82 78 39			O-ring 230X3 NBR	1
247	82 95 69			O-ring 84.4X4 FPM	1
248	608 27 00			Strip	1
249	82 32 50			Clip	1
251	642 13 00			Plug	2
252	82 76 85			O-ring 17X3 NBR	2

Ordered by:

Company:.....Ref:.....Tel:.....Date:.....

Parts List

Item no	Part no	Type	Rec	Denomination	Qty/ord.
253	608 13 01			Cooling jacket	1
254	608 14 01			Flow diffuser	1
256	608 42 00			Wire bow	4
258	720 14 00			Sleeve unit	1
258.1	643 65 01			Sleeve	1
258.2	643 66 00			Adjustment screw	1
264	82 40 82			Plain washer (32)-34 MM	4
265	84 18 04			Seal sleeve (26)-29 MM	2
266	597 98 02			Sleeve	1
267	725 06 00			Plug	3
270	608 31 00			Lock washer	1
313	82 71 72			O-ring 71.2X3 FPM	1
335	83 53 77			Terminal clamp WPE 2,5 WS	1
336	83 42 36			End sleeve 0.75 MM2, L=6 MM	2
800	84 15 47			O-ring kit NBR	1
900	657 17 08			Basic repair kit NBR WCCR/WCCR	1
901	90 37 08			Monopropylene glycol "DOWCAL N"	3.15 l
912	82 76 85			O-ring 17X3 NBR	3
	82 70 86			Cap 6X16 PVC	1
	82 97 76			Cap 26X45 MM PVC	1
	90 29 12			Top coat	0.7 l
...	.....		.....	.....	....
...	.....		.....	.....	....
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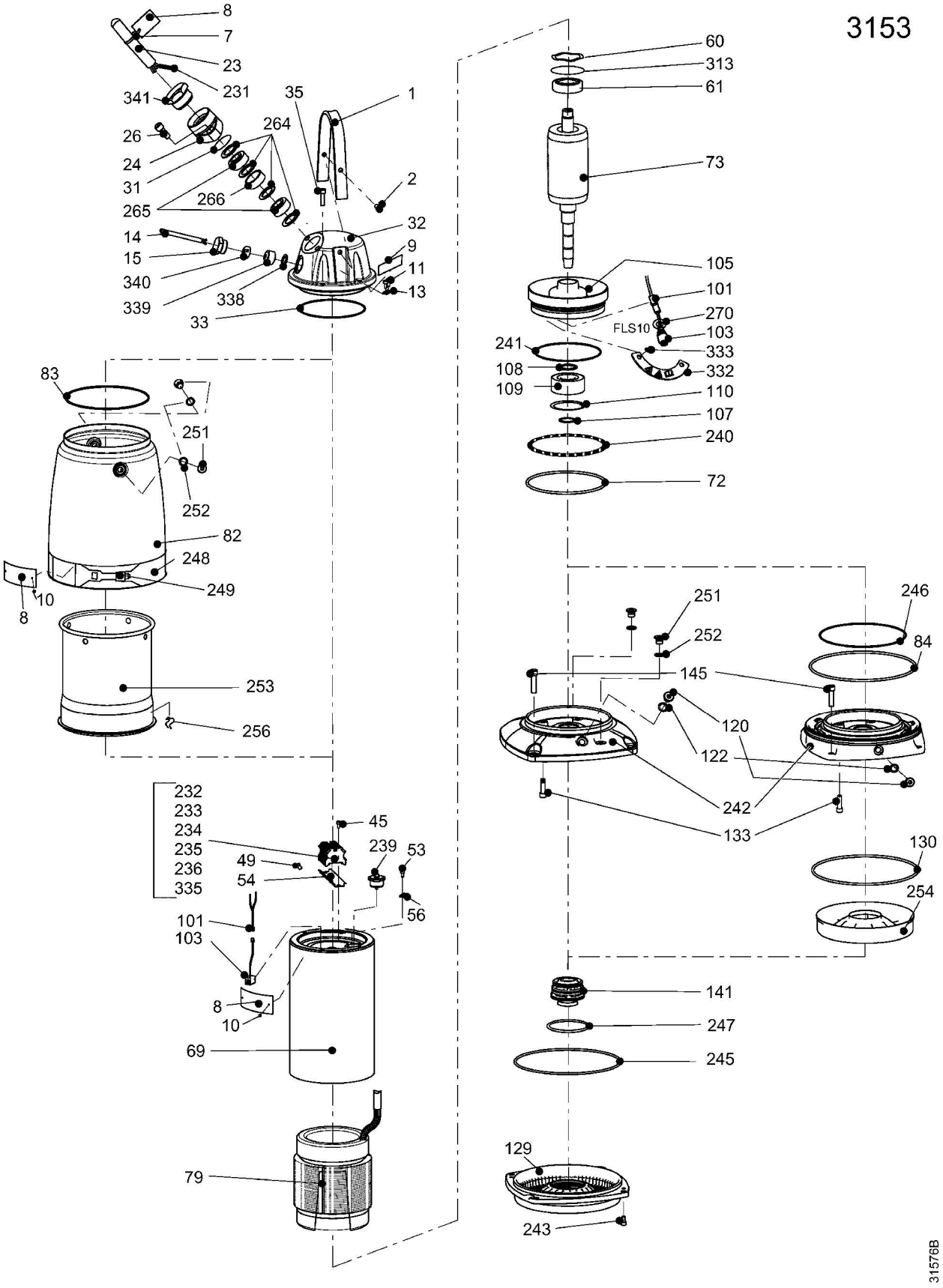
...	.....		.....	.....	....

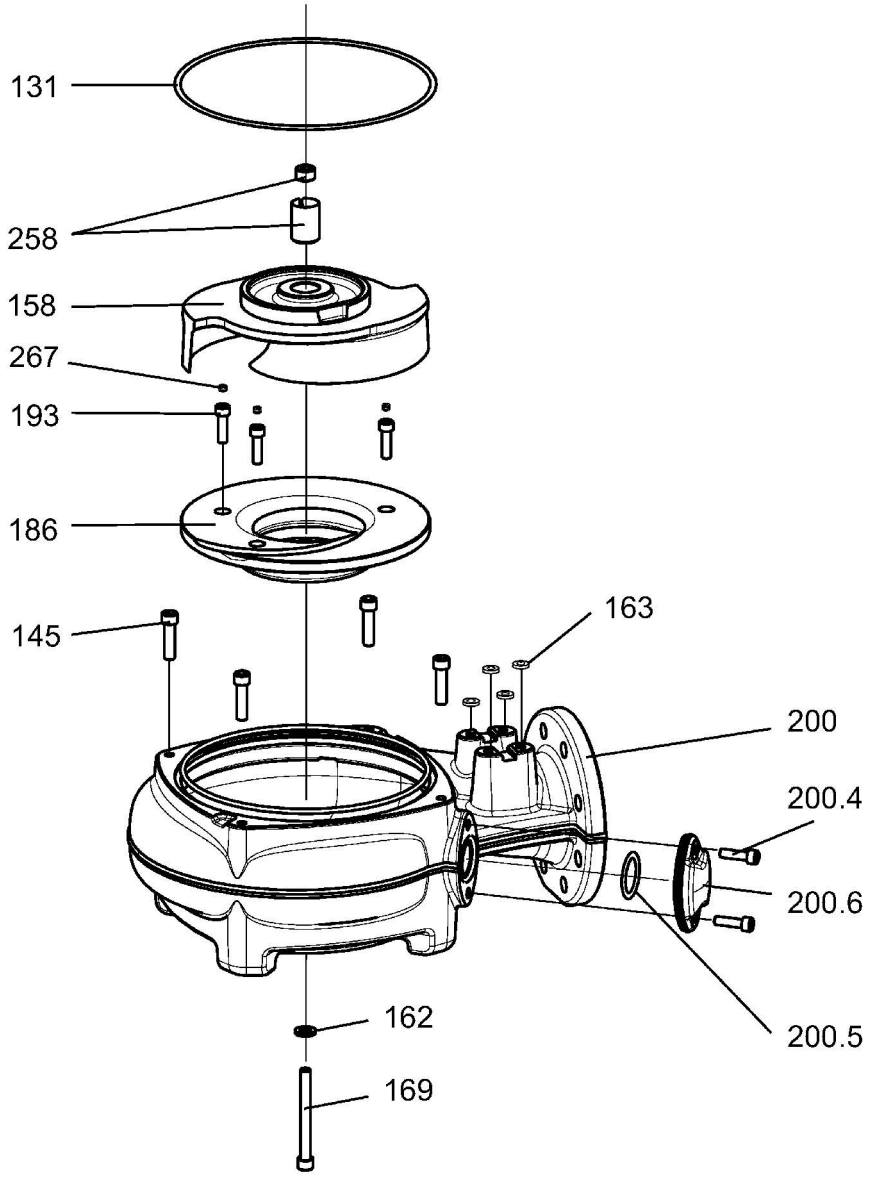
Ordered by:

Company:.....Ref:.....Tel:.....Date:.....

Exploded View



N_ 3153 HT



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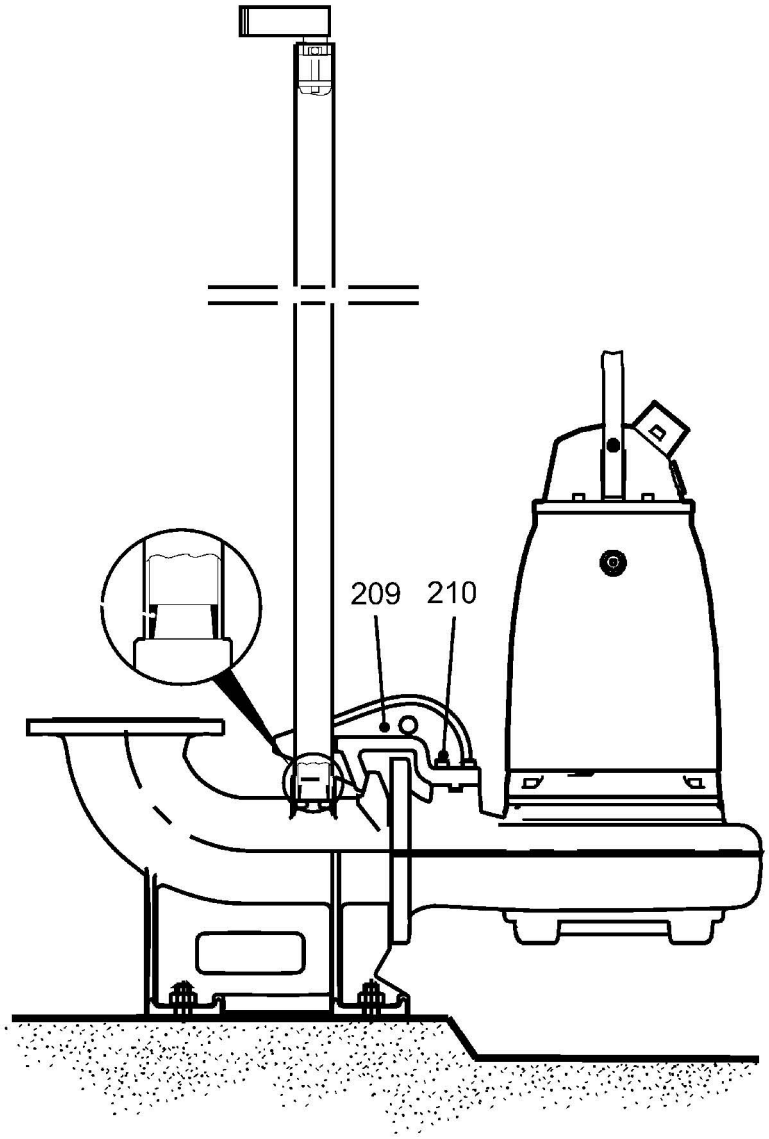
FP/NP 3153



30582D

Notes

9(10)

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Serial No 3153.095 1480101

FM APPROVED

6102 -

FLYGT
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Dataplate

Flygt NP 3153 HT

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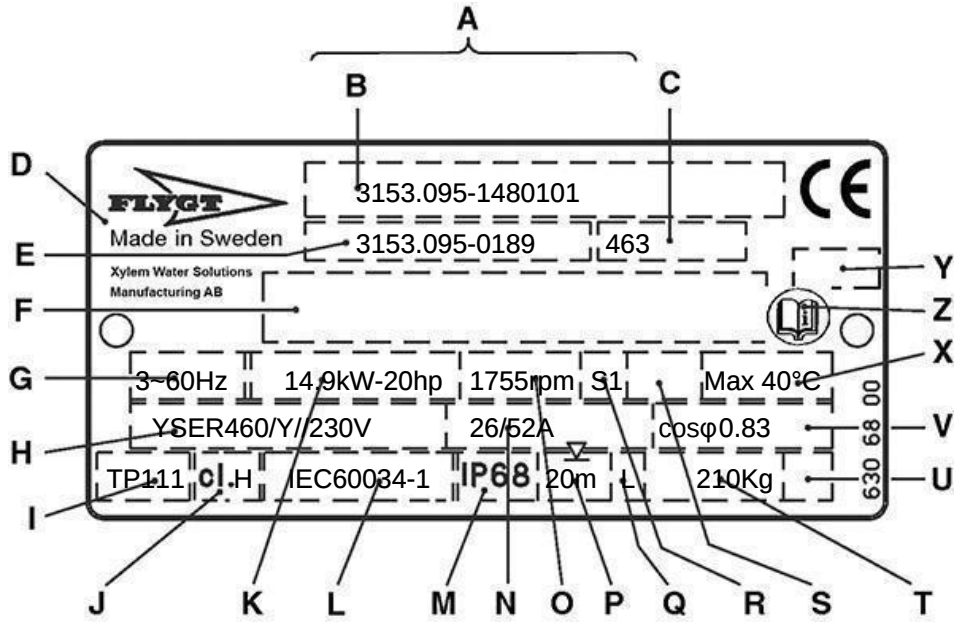
Serial No: 3153.095 1480101



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E	Product number	**Q**	Direction of rotation R=right, L=left
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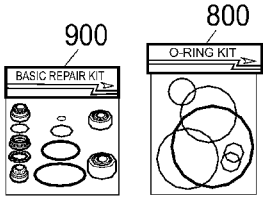
G	Phase; Type of current; Frequency	**S**	Duty factor
H	Rated voltage	**T**	Product weight
I	Thermal protection	**U**	Locked rotor code letter
J	Thermal class	**V**	Power factor
K	Rated shaft power	**X**	Max. ambient temperature
L	International standard	**Y**	Notified body Only for EN-approved Ex-products
		Z	Read Installation Manual



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7	83 45 52			Cable tie 292X3.5 MM	1
7	83 45 59			Cable tie 200X2.4 PA 6/6 -55+105	1
8	630 68 00			Data plate USE 6306801 AS SPARE PART	2
8	630 70 00			Certificate plate FM	2
9	81 65 46			Marking plate	1
9	83 93 50			Marking strip 5-GW(T1,T2,T15,T16)	1
9	83 93 51			Marking strip W5,V5,U5,V2,W1,U2,V1,W2,U	1
9	773 29 00			Connection plate	1
10	82 20 88			Drive screw 4X5-A2/A4	6
11	82 00 11			Hex.socket hd screw M6X12-A2-70	2
13	642 16 00			Earthing plate	1
23	94 19 82			Motor cable subcab	16.6 m
24	642 17 01	(Ex)		Entrance flange	1
26	83 04 53			Hex.socket hd screw M12X45-A4-80	2
31	82 74 63			O-ring 49.5X3 NBR	1
32	642 14 01	(Ex)		Entrance cover	1
33	82 78 35			O-ring 175X3 NBR	1
35	83 04 56			Hex.socket hd screw M10X35-A4-80	4
45	82 00 11			Hex.socket hd screw M6X12-A2-70	2
49	83 42 48			End sleeve H16/24	3
53	82 00 11			Hex.socket hd screw M6X12-A2-70	2
53	82 00 11			Hex.socket hd screw M6X12-A2-70	2
54	642 08 00			Rail	1
56	642 16 00			Earthing plate	2
60	82 56 25			Spring washer 71.5X59X0.55 MM	1
61	83 30 16			Ball bearing 30X72X30.2 MM	1
69	642 09 01	(Ex)		Stator housing	1
72	82 74 94			O-ring 209.3X5.7 NBR	1
73	641 98 06	(Ex)		Shaft unit	1
79	641 93 05			Stator 21-18-4a	1
82	608 12 01			Cooling jacket OUTER	1
83	82 78 49			O-ring 221.84X3.53 NBR	1
84	82 75 01			O-ring 279.3X5.7 NBR	1
101	650 51 00			Cable unit FLS10	1

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105	642 10 01	(Ex)		Bearing holder	1
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108	82 44 15			Supporting washer 40X50X2.5	1
109	83 30 18			Ball bearing 40X90X36.5 MM	1
110	83 07 62			Retaining ring JB 90	1
120	642 13 00			Plug	1
122	82 76 85			O-ring 17X3 NBR	1
129	642 12 00			Seal housing cover	1
130	82 78 39			O-ring 230X3 NBR	1
131	82 75 01			O-ring 279.3X5.7 NBR	1
133	83 04 56			Hex.socket hd screw M10X35-A4-80	6
141	770 85 30			Mechanical seal	1
145	83 04 53			Hex.socket hd screw M12X45-A4-80	4
158	703 20 22			Impeller	1
162	82 38 00			Plain washer STAINLESS STEEL A4	1
169	83 04 55			Hex.socket hd screw M12X110-A4-80	1
186	702 83 00			Insert ring	1
193	83 04 56			Hex.socket hd screw M10X35-A4-80	3
200	702 81 03			Pump housing	1
200.4	83 04 56			Hex.socket hd screw M10X35-A4-80	2
200.5	82 81 93			O-ring 44,2X5,7 FPM	1
200.6	648 00 00			Cover	1
209	651 07 01			Sliding bracket	1
210	83 04 53			Hex.socket hd screw M12X45-A4-80	4
229	667 40 01			Sticker	2
232	83 53 58			Terminal clamp WDU6/10	3
233	83 53 61			Terminal clamp WDU16,1000V	8
234	83 53 67			Cross connection WQV16/2	4
235	83 53 54			End support WEW 35/2	2
236	83 53 50			Partition	1
239	734 59 00			El.lead through unit	1
240	607 48 00			Spring	1
241	82 78 35			O-ring 175X3 NBR	1
242	608 22 11	(Ex)		Adapter	1
243	83 02 97			Hex.socket hd screw M8X16-A4-70	2
245	82 75 01			O-ring 279.3X5.7 NBR	1
246	82 78 39			O-ring 230X3 NBR	1
247	82 95 69			O-ring 84.4X4 FPM	1
248	608 27 00			Strip	1
249	82 32 50			Clip	1
251	642 13 00			Plug	2
252	82 76 85			O-ring 17X3 NBR	2

Ordered by:

Company:.....Ref:.....Tel:.....Date:.....

Parts List

Item no	Part no	Type	Rec	Denomination	Qty/ord.
253	608 13 01			Cooling jacket	1
254	608 14 01			Flow diffuser	1
256	608 42 00			Wire bow	4
258	720 14 00			Sleeve unit	1
258.1	643 65 01			Sleeve	1
258.2	643 66 00			Adjustment screw	1
264	82 40 82			Plain washer (32)-34 MM	4
265	84 18 04			Seal sleeve (26)-29 MM	2
266	597 98 02			Sleeve	1
267	725 06 00			Plug	3
270	608 31 00			Lock washer	1
313	82 71 72			O-ring 71.2X3 FPM	1
335	83 53 77			Terminal clamp WPE 2,5 WS	1
336	83 42 36			End sleeve 0.75 MM2, L=6 MM	2
800	84 15 47			O-ring kit NBR	1
900	657 17 08			Basic repair kit NBR WCCR/WCCR	1
901	90 37 08			Monopropylene glycol "DOWCAL N"	3.15 l
912	82 76 85			O-ring 17X3 NBR	3
	82 70 86			Cap 6X16 PVC	1
	82 97 76			Cap 26X45 MM PVC	1
	90 29 12			Top coat	0.7 l
...	.....		.....	.....	....
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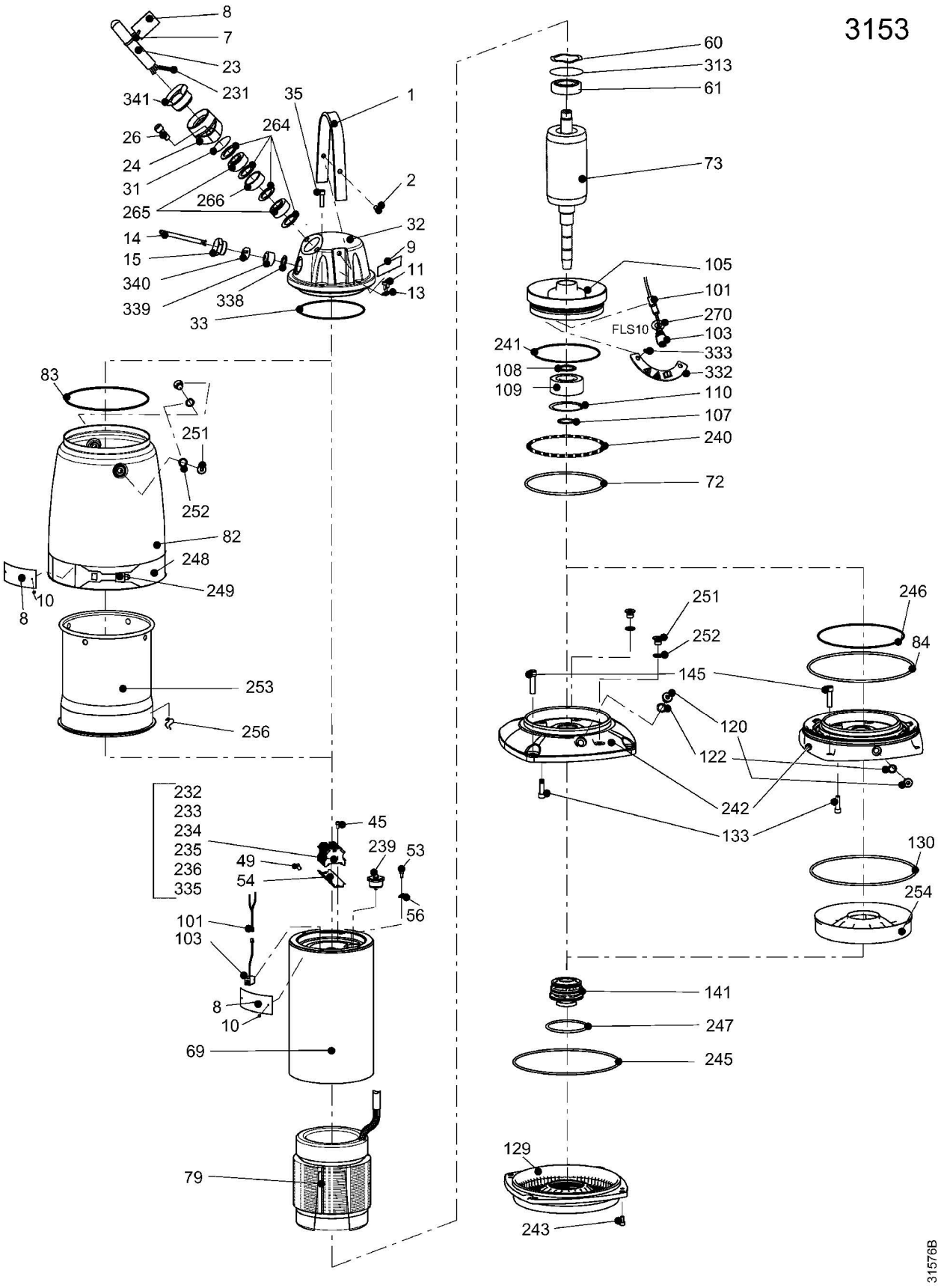
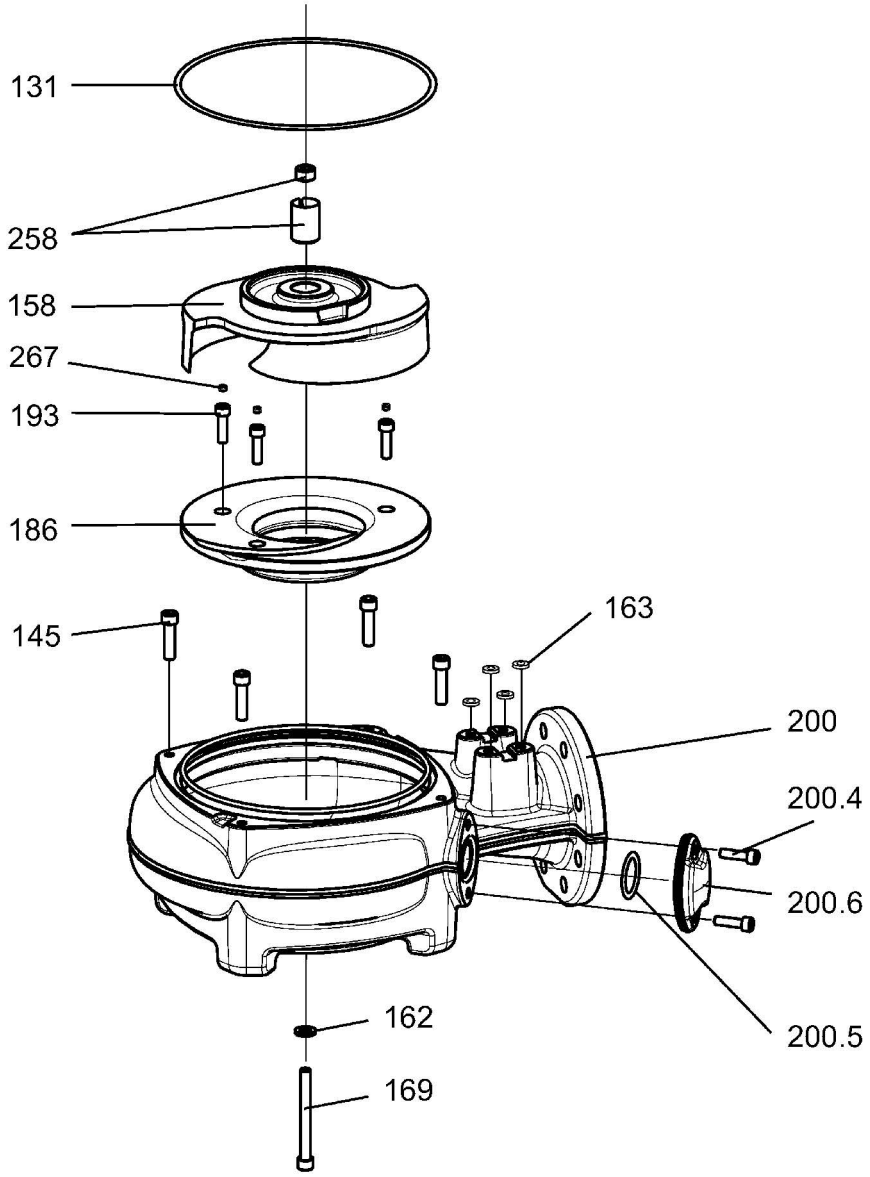
Ordered by:

Company:.....Ref:.....Tel:.....Date:.....

Exploded View



N_ 3153 HT



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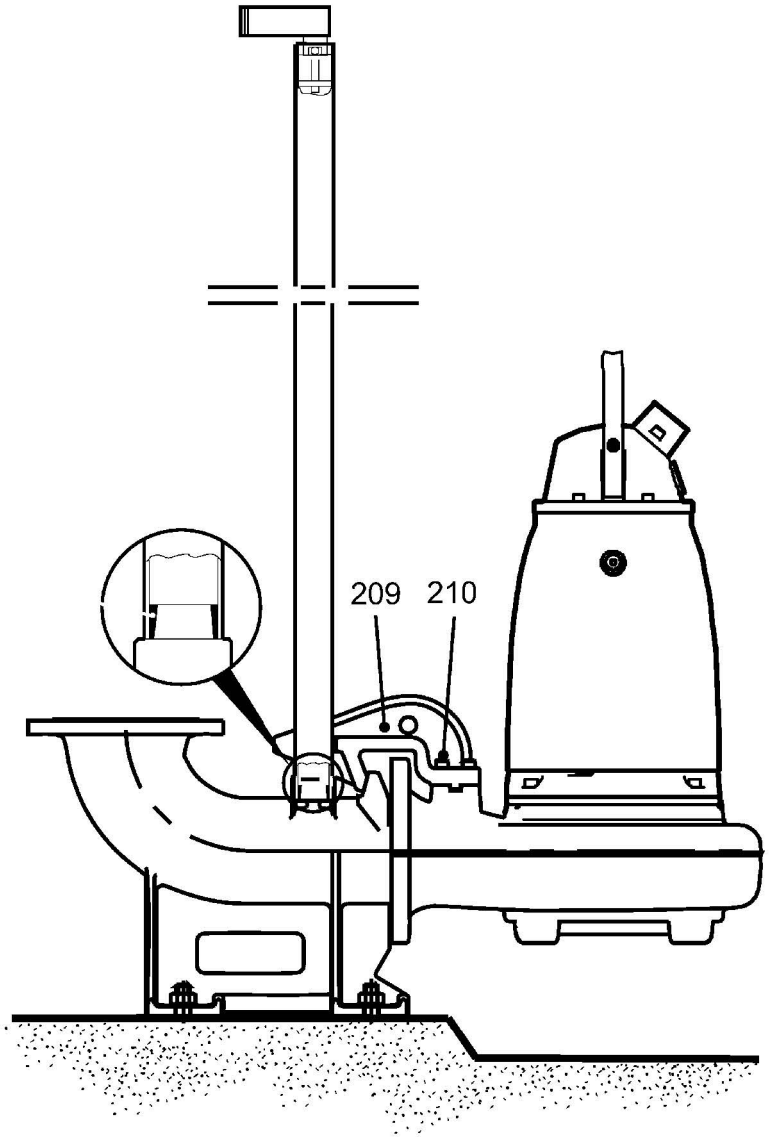
FP/NP 3153



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Notes

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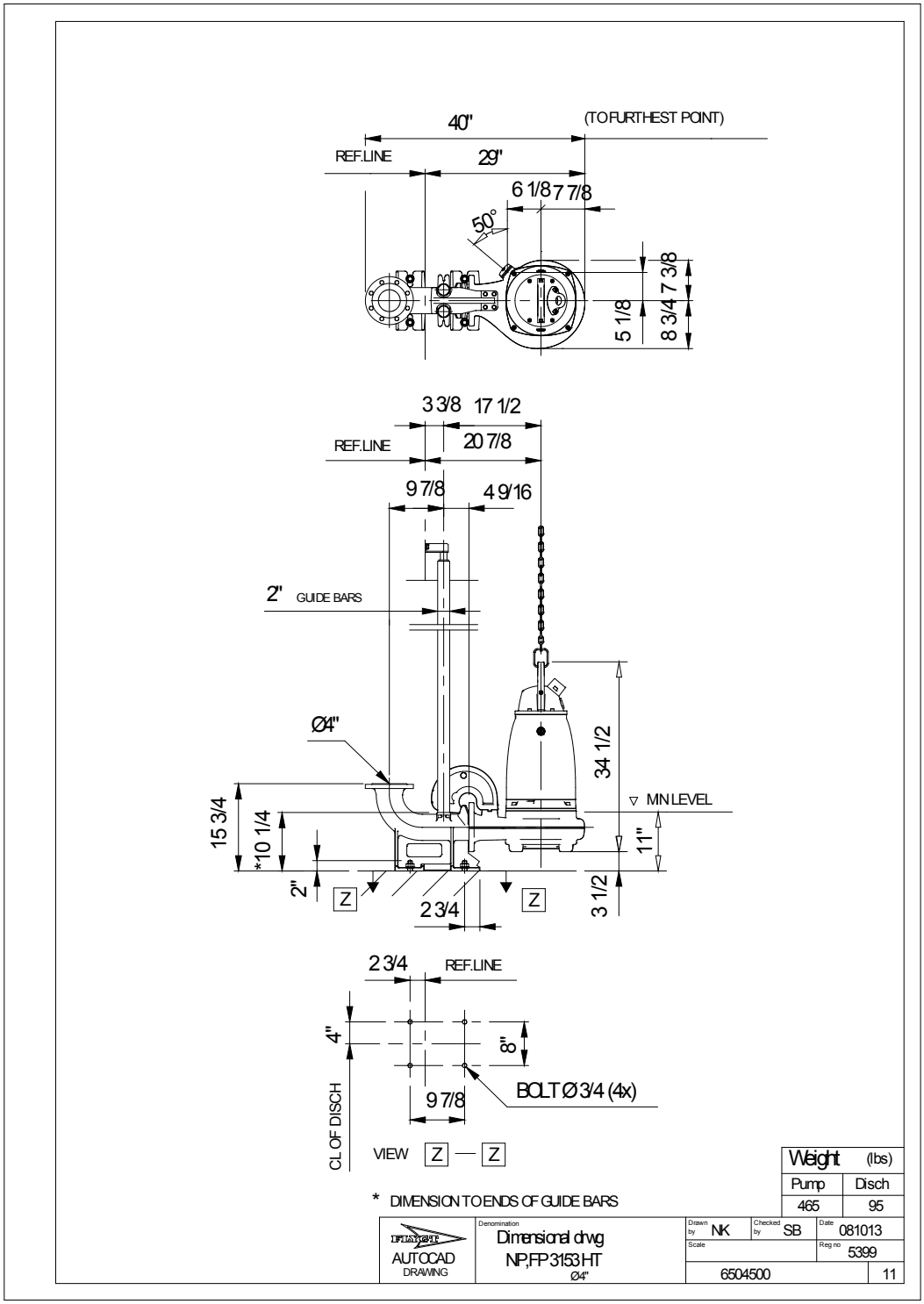
TAB 4

AS-BUILTS AND SUPPLEMENTAL

NP 3153 HT 3~ 463

Dimensional drawing



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