SPE

Regulated submersible pumps with PM motors
3000 rpm

GRUNDFOS

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1. General description

SPE is a speed-controlled submersible pump system with a permanent magnet motor. It has a low running cost and can be used in changing operation conditions. The pump is suitable for a number of applications within groundwater pumping, for example the following:

- water supply
- irrigation
- groundwater lowering.

An all-stainless steel construction in three different material grades ensures that the pump can be used for both clean water as well as corrosive water.

The pump system consists of reliable hydraulics and an energy efficient IPM (Interior Permanent Magnet) type motor. The magnets are embedded in the rotor. The magnets in MS6000P are further protected as the rotor is hermetically sealed with a thin layer of metal. The motor design furthermore consists of the following:

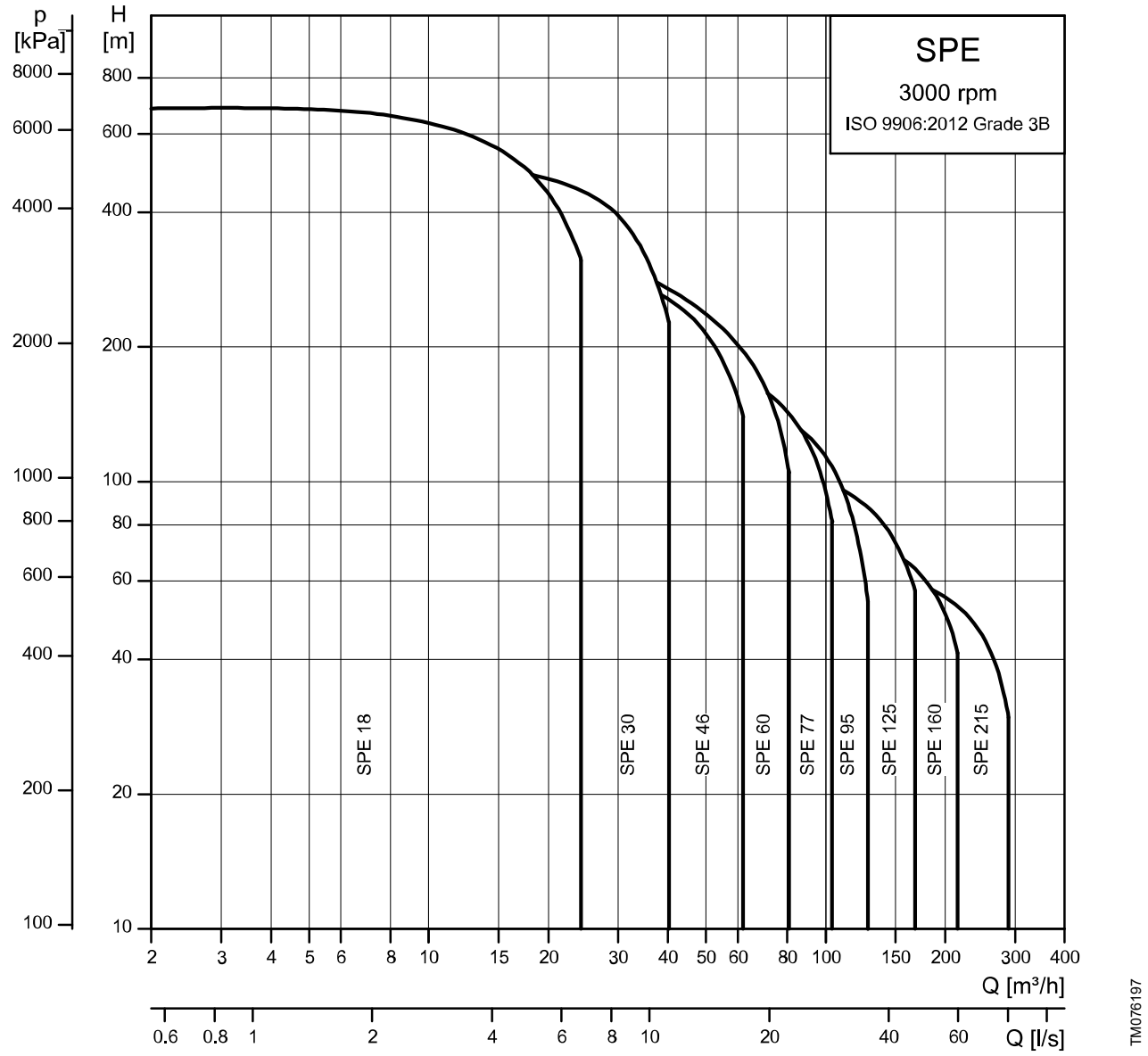
- canned stator design
- mechanical shaft seals with Silicon Carbide seal faces
- heavy duty thrust bearings.

The motor is running synchronous and needs a Variable Frequency Drive (VFD), such as the Grundfos CUE, to control the speed according to need. The CUE includes a wizard to make the setup easy. The CUE has the following predefined control modes:

- constant pressure
- constant flow
- constant level.

The CUE also features protection of the pump installation, including minimizing risk of water hammer and reducing stresses to the submersible motor during start by means of a soft starter function.

Performance range



ErP ready

The SPE pumps are energy-optimised and comply with the ErP Directive (Commission Regulation (EC) No 547/2012) which is in effect from 1 January 2013. From this date, all pumps are classified and graduated in a new energy efficiency index (MEI).

Minimum efficiency index

Minimum efficiency index (MEI) means the dimensionless scale unit for hydraulic pump efficiency at best efficiency point (BEP), part load (PL, 75 % BEP) and overload (OL, 110 % BEP). The Commission Regulation (EU) sets efficiency requirements to MEI ≥ 0.40 as from 1 January 2015. An indicative benchmark for best-performing water pump available on the market as from 1 January 2013 is determined in the Regulation.

- The benchmark for most efficient water pumps is MEI ≥ 0.70.
- The operation of the pump is efficient and economic as it is controlled by a variable frequency drive which enables the pump set to match varying performance requirements from the system.
- Information on benchmark efficiency is available at http://europump.eu/efficiencycharts.

Efficiency and MEI index for SPE pumps

Pump type	Pump size	Pump stage efficiency [%]	MEI
SPE 18	6"	78	≥ 0.70
SPE 30	6"	75	≥ 0.50
SPE 46	6"	76	≥ 0.40
SPE 60	6"	77	≥ 0.40
SPE 77	8"	78	N/A
SPE 95	8"	79	N/A
SPE 125	10"	79	N/A
SPE 160	10"	80	N/A
SPE 215	10"	83	N/A

Type key

Example	SPE125- 4 Rp6 6" 45 kW D 3000 rpm	
SPE 125	Type range (SPE)	
4	Number of impellers	
N	Stainless steel parts of material:	
		= EN 1.4301
	N	= EN 1.4401
	R	= EN 1.4539
	Rubber parts of material:	
	SPE 17- SPE 60	
		= LSR/NBR
	E	= FKM
	R	= EN 1.4539
	Rubber parts of material:	
	SPE 77- SPE 215	
		= NBR
	E	= FKM
Rp 6	Connection:	
	Rp thread (RpX)	
	R thread (RX)	
	NPT thread (XNPT)	
6"	Inlet motor size	
37 kW	Motor power [kW]	
	Number of motor cables	
		= Single
D	D	= Double
3000 rpm	rpm	

Applications

SPE pumps are developed for pumping ground water from boreholes. The pumps are installed in boreholes or wells, submerged below the water level.

For industrial purposes, the pump can be placed for example, in a tank.

The pumps are suitable for the following applications:

- raw-water supply
- irrigation
- groundwater lowering
- pressure boosting
- fountain applications
- mining applications
- offshore applications.

Pump range

Type	Steel EN 1.4301	Steel (N) EN 1.4401	Steel (R) EN 1.4539	Connection [1]
SPE 18	•	•	•	Rp 2 1/2 (R 3)
SPE 30	•	•	•	Rp 3 (R 3)
SPE 46	•	•	•	Rp 3 Rp 4 (R 4)
SPE 60	•	•	•	Rp 3 Rp 4 (R 4)
SPE 77	•	•	•	Rp 5
SPE 95	•	•	•	Rp 5
SPE 125	•	•	•	Rp 6
SPE 160	•	•	•	Rp 6
SPE 215	•	•	•	Rp 6

1) Figures in brackets ( ) indicate connection for pumps within a sleeve.

Motor range

MS6000P covers several standard motor outputs

Motor execution [kW]	7.5			18.5					30			45	
Motor output [kW]	4.0	5.5	7.5	9.2	11	13	15	18.5	22	26	30	37	45

2. Submersible pumps

Features and benefits

A wide pump range

Grundfos offers energy-efficient submersible SPE pumps ranging from 10 to 280 m^3/h. The pump range consists of pump sizes from SPE 17 to SPE 215. Each pump size is available with an optional number of stages to match a given duty point.

High pump efficiency

Often pump efficiency is a neglected factor compared to the price. However, it is important to notice that price variations are without importance to water supply economics compared to the importance of pump and motor efficiencies.

Example

If pumping 70 m^3/h at 100 m head for 10 years a normal pump set consumes approximately 2,775,000 kWh. By changing to an SPE high efficiency pump set the increased efficiency will result in a reduction of 274,200 kWh, corresponding to more than € 27,400 cost saving at a price of 0.10 €/kWh. In variable demand conditions the saving is even higher.

Material and pumped liquids

To ensure the right wear resistance and reduce the risk of corrosion, the pump ranges are available with the following steel variants:

- **SPE:** EN 1.4301
- **SPE N:** EN 1.4401
- **SPE R:** EN 1.4539

See specified material variants in Pump range.

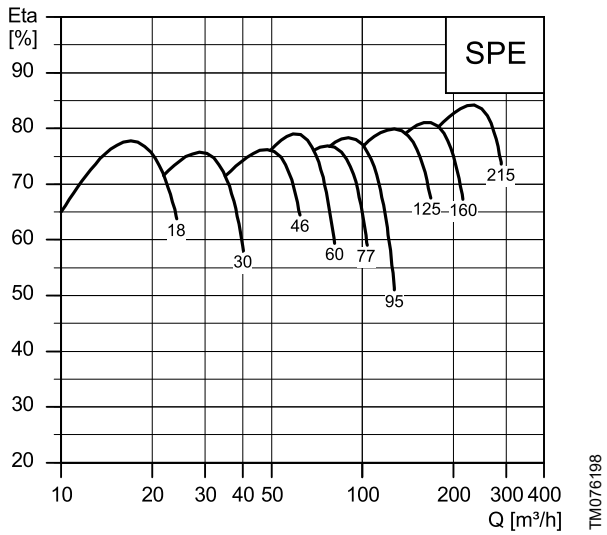
For further protection in corrosive environments, a complete range of zinc anodes for cathodic protection is available. See Zinc anodes.

Rubber components

For pumping liquid with risk of chemical residue or liquids above 60 °C, all pumps can be supplied with rubber components made of FKM elastomer.

Low installation costs

Stainless steel sheet metal means low weight. This facilitates the handling of pumps and results in low equipment costs, reduced installation and service time.



Pump efficiencies in relation to flow

Various SPE pumps

Bearings with sand channels

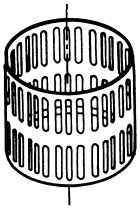
All bearings are water-lubricated and have an octagonal shape enabling sand particles to leave the pump together with the pumped liquid. The use of LSR ensures increased wear resistance, thus allowing a high limit for particles in the pumped liquid. LSR is used as standard in pumps ranging up to and including SPE 60. On SPE 77 and larger pumps the bearing material is NBR.

TM007301

Bearing

Inlet strainer

The inlet strainer prevents particles over a certain size from entering the pump. The hole size is 4 x 20 mm.



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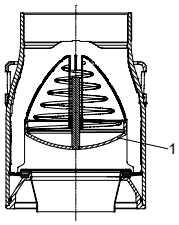
Inlet strainer

Non-return valve

All pumps have a non-return valve in the valve casing preventing backflow when the pump is stopped. Due to the short closing time of the non-return valve the risk of water hammer is reduced to a minimum. The valve casing is designed to have optimum hydraulic properties to minimise the pressure loss across the valve and thus to contribute to the high efficiency of the pump.



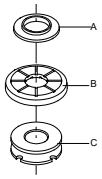
TM0124991

Non-return valve

1 - Valve flap

Stop ring

The stop ring prevents damage to the pump during transport and in case of upthrust during pump startup. The stop ring, which is designed as a thrust bearing, limits axial movements of the pump shaft. The stationary part of the stop ring (A) is secured in the upper chamber. The rotating part (B) is fitted above the split cone (C).



TM013327

Stop ring (rotating and stationary parts).

Pump functioning as turbine

In case of unintended flow of water through a non-energized pump there is a risk that the moving parts of the pump and the motor will start rotating, thereby generating voltage over the terminals. The size of the voltage depends on the speed of rotation. Due to this the motor terminals must be considered as live until proven otherwise.

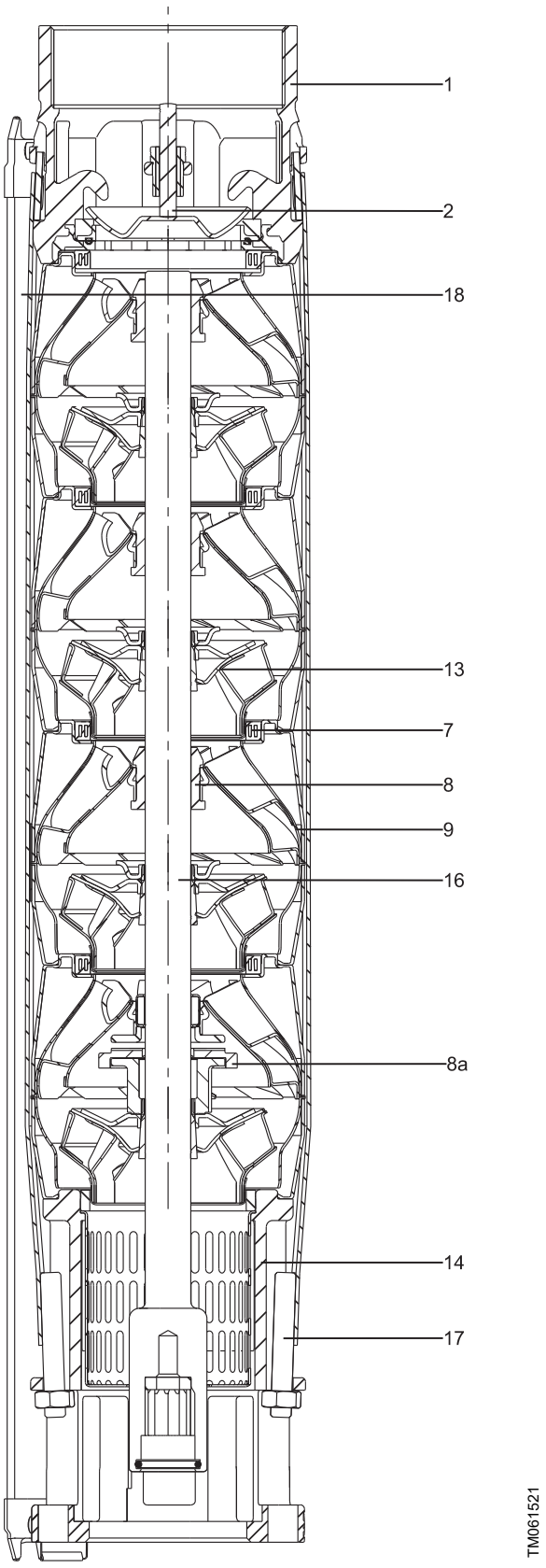
Related information

Applications

Pump range

Material specification (SPE 18 - SPE 60)

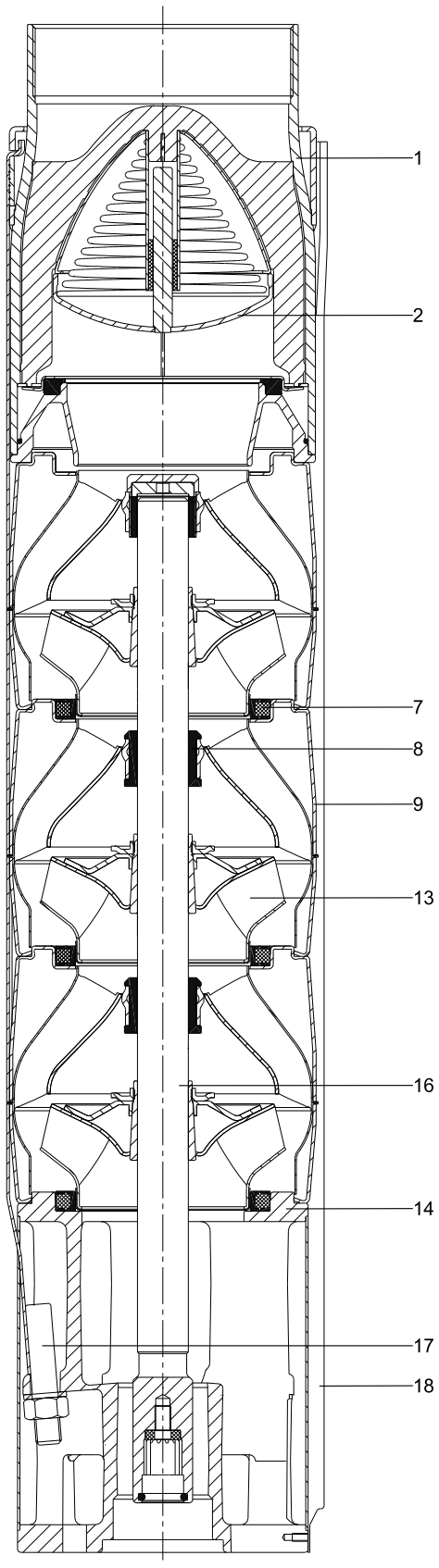
Pos.	Component	Material	Standard	N-version	R-version
			EN		
1	Valve casing	Stainless steel	1.4301	1.4401	1.4517
2	Valve cup	Stainless steel	1.4301	1.4401	1.4539
	Valve seat	NBR-FKM	NBR-FKM	NBR-FKM	NBR-FKM
7	Neck ring	NBR-FKM	NBR-FKM	NBR-FKM	NBR-FKM
8	Bearing	NBR-FKM-LSR	NBR-FKM-LSR	NBR-FKM-LSR	NBR-FKM-LSR
8a	Washer for stop ring	Carbon/ graphite HY22 in PTFE mass			
9	Chamber	Stainless steel	1.4301	1.4401	1.4539
13	Impeller	Stainless steel	1.4301	1.4401	1.4539
14	Suction interconnector	Cast stainless steel	1.4308	1.4408	1.4517
	Strainer	Stainless steel	1.4301	1.4401	1.4539
16	Shaft complete	Stainless steel	1.4057	1.4460	1.4462
17	Strap	Stainless steel	1.4301	1.4401	1.4539
18	Cable guard	Stainless steel	1.4301	1.4401	1.4539



Example SPE 46

Material specification (SPE 77 - SPE 215)

Pos.	Component	Material	Standard	N-version	R-version
			EN		
1	Valve casing	Stainless steel	1.4301	1.4401	1.4539
2	Valve cup	Stainless steel	1.4301	1.4401	1.4539
	Valve seat	NBR-FKM	NBR-FKM	NBR-FKM	NBR-FKM
7	Neck ring	NBR-FKM	NBR-FKM	NBR-FKM	NBR-FKM
8	Bearing	NBR-FKM	NBR-FKM	NBR-FKM	NBR-FKM
	Washer for stop ring	Carbon/graphite HY22 in PTFE mass			
9	Chamber	Stainless steel	1.4301	1.4401	1.4539
13	Impeller	Stainless steel	1.4301	1.4401	1.4539
14	Suction interconnector	Cast stainless steel	1.4308	1.4408	1.4517
	Strainer	Stainless steel	1.4301	1.4401	1.4539
16	Shaft complete	Stainless steel	1.4057	1.4460	1.4462
17	Strap	Stainless steel	1.4301	1.4401	1.4539
18	Cable guard	Stainless steel	1.4301	1.4401	1.4539



Example SPE 77

3. Submersible permanent magnet motors

For further information about Grundfos MS6000P submersible motors, see the MS motor literature available in Grundfos Product Center at https://product-selection.grundfos.com.

Features and benefits

Grundfos offers a complete range of 6 inch submersible motors of IPM (Interior Permanent Magnet) design, named MS6000P. These are based on the Grundfos MS6000 motor platform including the mechanical construction, thrust bearings with high thrust capability and shaft seals. The permanent magnet motor is a 4-pole synchronous motor, requiring a variable frequency drive as it cannot be directly connected to the electricity grid, contrary to the asynchronous motor.

The MS6000P permanent magnet motor offers the following advantages:

- 8-10 % higher efficiency compared to an asynchronous motor with the same output power.
- More compact design due to the high energy density of the permanent magnets, thus offering a lighter motor with a higher output.
- Reduced internal temperature in the motor, due to the high efficiency
- Strong permanent magnets. The Grundfos 6 inch version is based on 20 years of operating experience with a similar design.

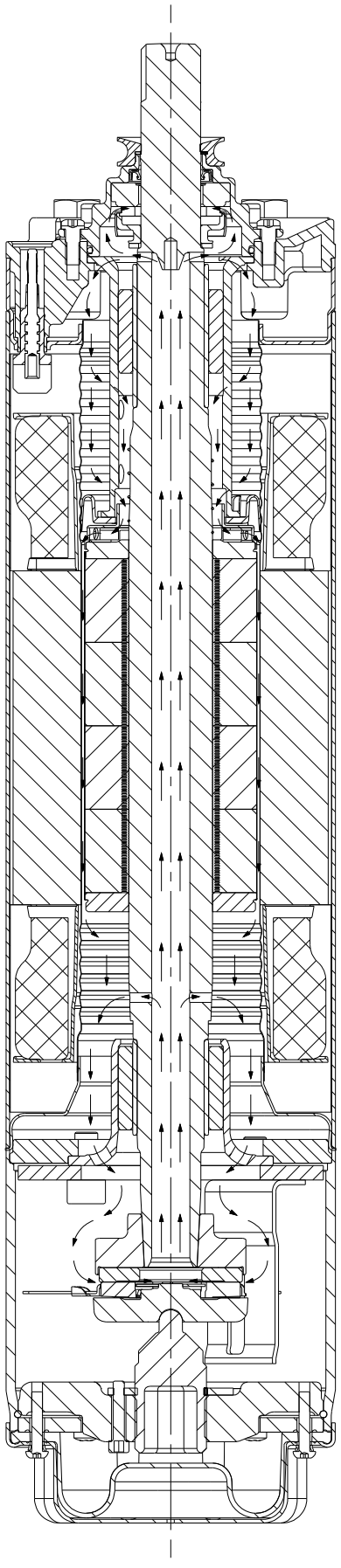
The MS6000P is available in T60 version only. This means that the motor is able to operate in applications up to 60 °C as long as a standard cooling flow of 0.15 m/s is ensured. In most applications the media temperature is less than 60 °C and the surplus temperature capacity ensures an even more robust motor.

For particularly demanding applications in corrosive media MS6000P is available in stainless steel quality 1.4539, called R version. Typical applications are the following:

- Mining dewatering
- Fish farming
- Offshore industrial applications

TM076081

MS6000P motors



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MS6000P lubrication flow

Stator

Grundfos MS6000P consists of a hermetically sealed stator withstanding external pressure up to 30 bar. It is a 4-pole construction with insulation class F winding material. All surfaces in contact with the pump media are mad of stainless steel. The following material grades are available:

- EN1.4301 for non-demanding installations (approved for drinking water).
- EN1.4539 for installations with high chloride content. The stator is filled with an epoxy filler and wound for high robustness using grade two, over coated enamel winding wire.

Shaft and rotor

The NEMA splined shaft extension is friction welded to a stainless steel shaft. Stainless steel radial bearing bushes on the shaft form the rotating part of the radial bearings. Stationary part of the radial bearing is a carbon or graphite bush. The rotor pack consists of indexed segments with integrated (buried) rare earth magnets placed as a 4-pole construction. This makes the motor an IPM type. The rotor pack is hermetically sealed by a metal cladding welded onto the shaft. This ensures a long life time and prevents corrosion of the magnets. The bottom of the shaft has the rotating part of the thrust bearing mounted and the entire shaft is gun drilled in order to ensure lubrication of the mechanical shaft seal and the radial bearings. Due to the use of permanent magnets no heat is generated in the rotor pack and subsequently the temperature rise in the motor liquid will decrease drastically. This benefits the life time of the construction and ensures more robust lubrication film in the radial and thrust bearing.

Thrust bearing

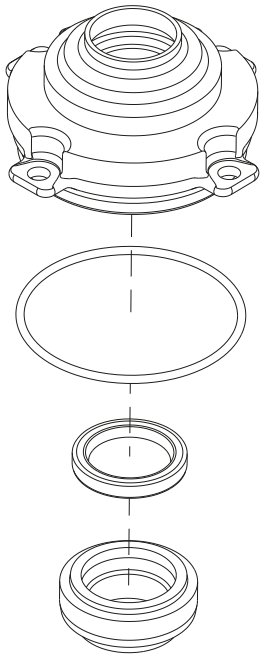
Grundfos MS6000P uses identical thrust bearing to the MS6000 series consisting of a ceramic rotating disc running against tilting pads and carbon or graphite shoes on the stationary part.

Shaft seal system

Grundfos MS6000P has a rubber sand slinger covering the top of a stainless steel shaft sealing house. When the shaft starts rotating, settled sand is removed from the shaft seal area due to the centrifugal force.

Inside the shaft seal house, a lip seal is placed above a mechanical shaft seal with SIC/SIC faces placed in NBR rubber elastomers. The shaft seal construction enables drinking water approval of the finished product.

The shaft seal is according to EN 12756.



TM076025

Shaft seal, MS6000P

Lightning protection

Use extra lightning protection or surge arrestor for the electrical panels in relation to the SPE system.

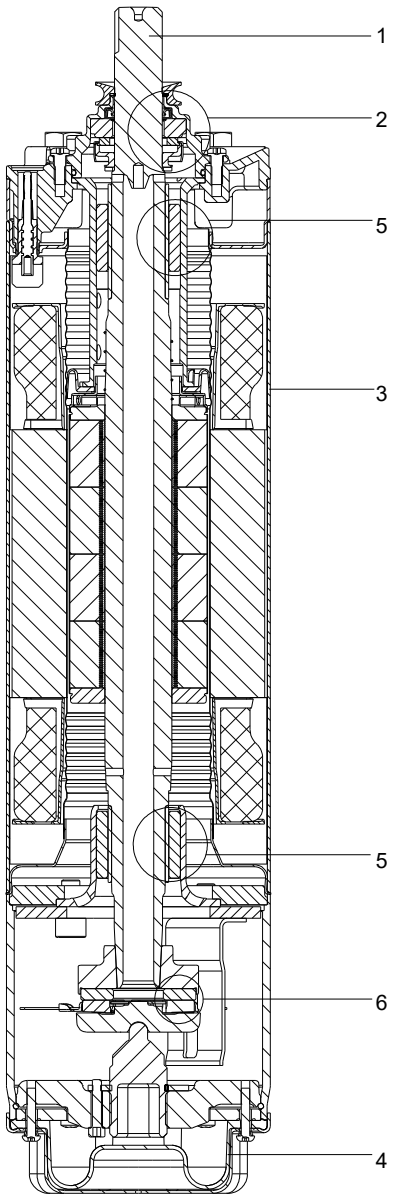
Material specification for MS6000P

Standard version motor

Pos.	Component	Material
1	Shaft	EN 1.4057
2	Shaft seal	SiC/SiC
	Rubber type	NBR
3	Motor sleeve	EN 1.4301
4	Motor end shield	EN 1.4301
	Diaphragm	NBR
5	Radial bearing	Carbon/stainless steel
6	Axial bearing	Ceramic/carbon

R-version motor

Pos.	Component	Material
1	Shaft	EN 1.4462
2	Shaft seal	SiC/SiC
	Rubber type	FKM
3	Motor sleeve	EN 1.4539
4	Motor end shield	EN 1.4539
	Diaphragm	FKM
5	Radial bearing	Carbon/stainless steel
6	Thrust bearing	Ceramic/carbon



MS6000P

4. Grundfos variable frequency drive for SPE

To operate the SPE pump, a variable frequency drive is required. Grundfos offers the CUE for this purpose.

For use in solar application, Grundfos an RSI is recommended. For further information about Grundfos RSI and Solar, see the literature available in Grundfos Product Center at https://product-selection.grundfos.com.

CUE variable frequency drive

TM076113

The CUE range

Grundfos CUE is a series of external variable frequency drives designed for speed control of a wide range of Grundfos pumps, including SPE.

When a CUE is installed, the motor does not require further overload protection.

Pt100 or Pt1000 together with MCB 114 sensor input module can provide overheating protection of the motor windings, if needed.

CUE offers quick and easy setup and commissioning compared to a standard variable frequency drive as the startup guide is designed specifically for Grundfos pumps, including SPE.

Overview of the relevant CUE range for SPE

Supply voltage [V]	Power range [kW]				
	4.0	7.5	11	45	75
3 × 380-500	•	•	•	•	•
3 × 525-600	•	•			
3 × 525-690			•	•	•

CUE is available in the following enclosure classes:

- IP20/21
- IP54/55.

RFI filters

To meet the EMC requirements, CUE comes with the following types of built-in radio frequency interference filters (RFI).

Voltage [V]	Typical shaft power, P2 [kW]	RFI filter type	Application
3 × 380-500	4.0 - 90	C1	Domestic
3 × 525-600	4.0 - 7.5	C3	Industry
3 × 525-690	11-25	C3	

Functions

CUE has a wide range of pump-specific functions. For groundwater applications, the following are especially relevant:

- constant pressure
- constant level
- constant flow rate.

CUE features

- startup guide
- easy setup
- check of the direction of rotation
- duty and standby operation
- dry-running protection
- low-flow stop function.

The CUE startup guide is automatically activated at the first startup. Here, a number of parameters are set automatically based on the pump type. Other parameters are set manually based oin the data indicated on the motor and pump nameplates. The startup guide can be repeated, if necessary.

Due to the startup guide, the installer can quickly set central parameters and put CUE into operation.

Sensors

The following sensors can be used in connection with CUE:

- pressure sensors, up to 25 bar
- temperature sensors
- differential-pressure sensors
- differential-temperature sensors
- flowmeters
- potentiometer box for external setpoint setting.

All sensors are with 4-20 mA output signal.

SPE and sine-wave filter

Grundfos SPE pump systems, consisting of one SP, one MS6000P and one CUE, meet the VFD and motor input requirements in the table below. When application and grid requirements are fulfilled, a sine-wave filter is not required.

Requirements for the MS6000P to operate without sine-wave filter

	Value	Unit	Grundfos SPE systems
Application requirements			
Max. media temperature	60/140	[°C/°F]	Must be met
Max. cable length	300/1000	[m/ft]	Must be met
Grid requirements			
Max. line-line voltage	460	[V RMS]	Must be met
Phases	3	[-]	Must be met
VFD requirements			
Max. DC voltage	620	[V_{DC}]	✓
Max. peak voltage at inverter terminals	650	[V_{LL}]	✓
Min. rise time at VFD terminals (10-90 % V_{DC})	100	[ns]	✓
Max. dU/dt at VFD terminals	5	[V/ns]	✓
Max. switching frequency	4	[kHz]	✓
Grid voltage rectification	Passive rectifier bridge		✓
Motor input requirements			
Max. peak voltage at terminals	1500	[V_{LL}]	✓
Max. dU/dt at motor terminals	6	[V/ns]	✓

Sine-wave filter

If the above VFD requirements are not met, the use of output sine-wave filters is required for SPE pumps.

The purpose of the output filters is the following:

- protect the motor from overvoltage and increased operating temperature.
- reduce voltage stress on the motor windings and stress on the motor insulation system
- decrease acoustic noise from the motor that is driven by a variable frequency drive.

Sine-wave filters have a particularly high degree of filtering, resulting in high reduction of motor insulation stress and elimination of switching acoustic noise from the motor. The motor losses are reduced as the motor is fed with a sine-wave voltage and the filter eliminates the pulse reflections in the motor cable.

Sine wave filter selection

Filters used with SPE must be selected according to motor current and filter rating at 100 Hz (3000 RPM).

Part number	Enclosure degree	Minimum switching frequency	Filter current rating at 200-500 V and motor frequency [2]			
			50 Hz	60 Hz	100 Hz	120 Hz
		[kHz]	[A]	[A]	[A]	[A]
96754976	**IP20**	5	17	16	13	12
96754977	**IP20**	4	24	23	18	17
96754978	**IP20**	4	38	36	26.5	24
96755019	**IP20**	4	48	45.5	36	34
96755021	**IP20**	3	62	59	46.5	44
96755032	**IP20**	3	75	71	56	53
97774436	**IP23**	3	115	109	86	72
97775142	**IP23**	3	180	170	135	112

2) Max ambient temperature 45 °C

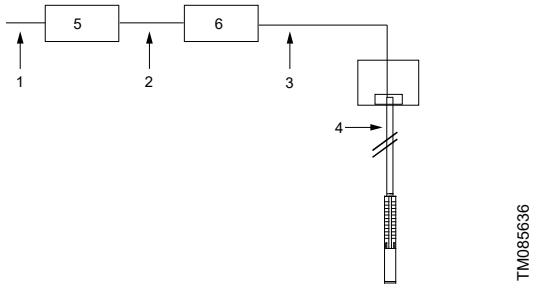
Cables in CUE installations

When CUE is used with SPE pumps, Grundfos distinguishes between two types of installation:

- installation in EMC-insensitive sites. See the figures below.
- installation in EMC-sensitive sites. See the figures below.

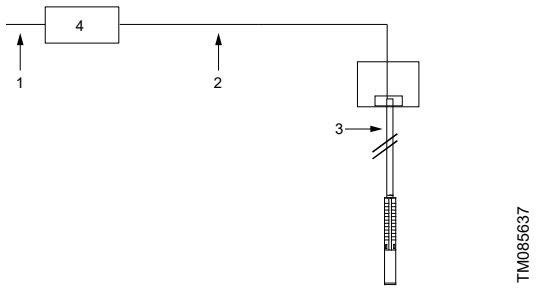
The two types of installation are different when it comes to the use of screened cable.

Note: Drop cables are always unscreened.



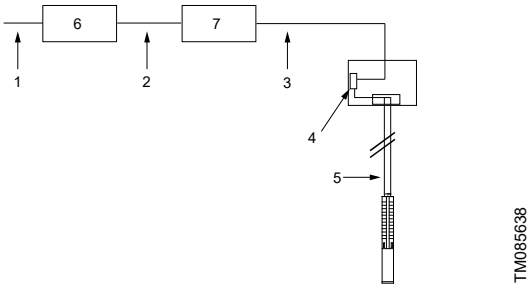
Example of normal installation

Pos.	Description
1	Mains cable, unscreened
2	Screened cable
3	Unscreened cable
4	Drop cable, unscreened
5	CUE
6	Sine-wave filter



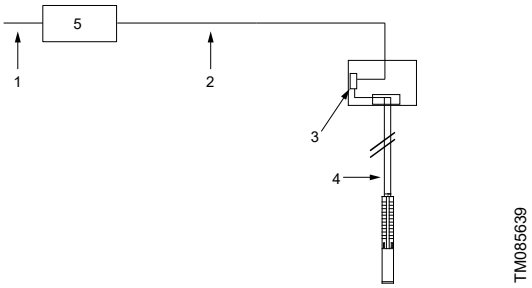
Example of normal installation without filter

Pos.	Description
1	Mains cable, unscreened
2	Unscreened cable
3	Drop cable, unscreened
4	CUE



Example of installation in EMC-sensitive sites

Pos.	Description
1	Mains cable, unscreened
2	Screened cable
3	Screened cable
4	Connection box
5	Drop cable, unscreened
6	CUE
7	Sine-wave Filter



Example of installation without filter in EMC-sensitive sites

Pos.	Description
1	Mains cable, unscreened
2	Screened cable
3	Connection box
4	Drop cable, unscreened
5	CUE

Screened cables are required in parts of the installation where the surroundings must be protected against EMC.

CUE is the right choice of variable frequency drive in SPE installations as it meets all basic issues.

CUE has a pre-installed startup guide which takes the installer through all the necessary settings.

The table below shows the different issues to be considered when using variable frequency drive in SPE installations.

Issues	Explanation
Ramp (up and down): Maximum 3 seconds.	The journal bearings must be lubricated in order to limit wear and overheating of windings.
Temperature monitoring by a Pt sensor.	Overheating of the motor leads to low insulation resistance which is sensitive to voltage peaks. Tempcon sensors do not work with variable frequency drive operation.
Reduce peak voltages (maximum 800 V peaks).	Never exceed peak voltages of 850 V at motor leads.
Remember output filter.	Cables act as an amplifier therefore measure peaks at the motor.
Rise time (dU/dt) must be limited to a maximum of 1000 V/µs. It is determined by the equipment in CUE.	As the time between switches is an expression of losses, the limit of 1000 V/µs can be exceeded. The solution is not higher insulation of the motor, but filter in the output from CUE.
Constant operation at minimum 55 Hz.	Too low speed results in low flow and thereby poor lubrication of journal bearings.
Size CUE in respect of the current, not the power output.	Can end up with a too small CUE.
Size cooling provision for stator tube at duty point with lowest flow rate.	Flow minimum m/s along the stator housing must be considered.
Ensure that the pump is used within the range of the pump curve.	Focus on outlet pressure and sufficient Net Positive Suction Head, as vibrations can damage or destroy the motor.

Using variable frequency drives of other brands.

The following parameters are relevant when using variable frequency drives of other brands.

Data for 100 Hz / 3 × 380 V motor voltage

	Power range [kW]			
	7.5	**18.5**	**30**	**45**
PM back EMF at 100 Hz [V]	266	260	270	246
PM d-axis inductance (Ld) [mH]	11.0	4.6	3.4	2.1
PM q-axis inductance (Lq) [mH]	26.4	11.7	8.0	5.5
PM type designation	IPM			
Frequency [Hz]	100			
Number of poles	4			

Grundfos offering, easy selection

MS6000P			CUE (100 Hz)			Sine wave filter (100 Hz)		Motor cable
Motor voltage 3 × 350 V (3000 RPM)			3 × 380-440 V			3 × 200-500 V		
Part number	Output [kW]	Current [A]	Part number	Output [kW]	Current [A]	Part number	Current [A]	Part number
76207712	4.0	9.6	99616713	4.0	10	96754976	13	96164209 [3]
	5.5	12.6	99616714	5.5	13			
	7.5	16.6	99616716	11	24	96754977	18	
76207717	9.2	21.4				96754978	26.5	
	11	25.0	99616717	15	32			
	13	29.2				96755019	36	
	15	33.4	99616718	18.5	37.5			
	18.5	40.6	99616719	22	44	96755021	46.5	
76207720	22	46.2	99616720	30	61	96755032	56	96164214 [4]
	26	54.0						
	30	61.8	99616721	37	73	97774436	86	
76207722	37	85.6	99616722	45	90	97775142	135	2 × 96164215 [5]
	45	103.0	99616723	55	106			

[3] 96164209: 4G 6.0 mm^2 (5 m)

[4] 96164214: 4G 10 mm^2 (5 m)

[5] 96164215: 4G 10 mm^2 (10 m)

5. Selection and sizing

Grundfos Product Center can calculate the exact duty point and energy consumption.

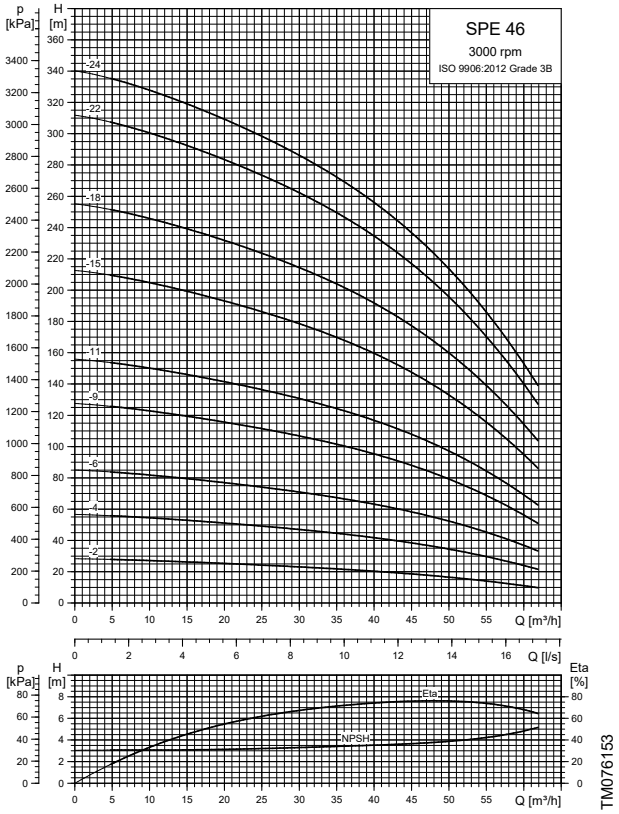
For further information see Grundfos Product Center at: https://product-selection.grundfos.com

Select the pump based on the following parameters:

- the duty point of the pump (see below)
- friction loss in the pipes, pump efficiency (see below)
- pump materials (see (SPE 17 - SPE 60))
- pump connections (see (SPE 17 - SPE 60))

Duty point of the pump

With the help of a duty point, it is possible to select a pump on the basis of the curve charts in section Performance curves and technical data.



Example of a curve chart

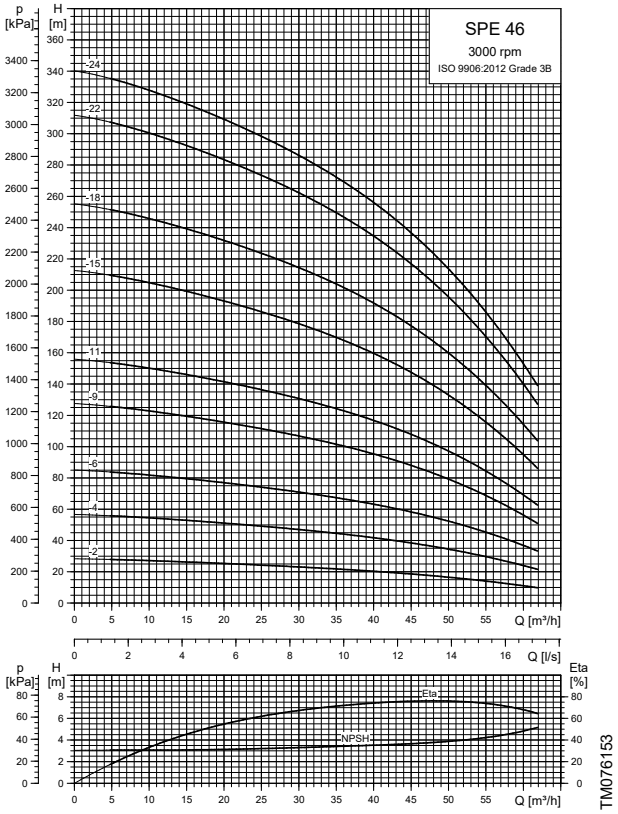
Dimensional data

When sizing a pump, take the following parameters into account:

- required flow and pressure at the draw-off point
- friction loss in the pipes (H_f)
- pressure loss in for example, long pipes, bends, valves
- best efficiency at the estimated duty point
- NPSH value. For calculation of the NPSH value, see Grundfos Product Center or Cavitation.

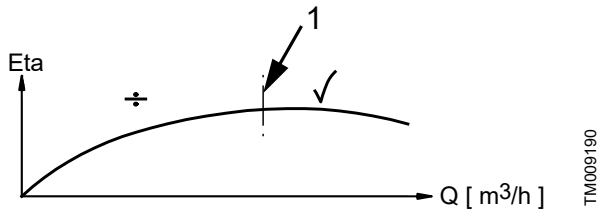
Pump efficiency

Before determining the best efficiency point, identify the operation pattern of the pump. If the pump is expected to operate at the same duty point, select a pump which operates at a duty point corresponding to the best efficiency of the pump.



Example of an SPE pump's duty point

As the pump is sized on the basis of the highest possible flow, it is important always to have the duty point to the right on the efficiency curve (Eta) in order to keep the efficiency high when the flow drops.



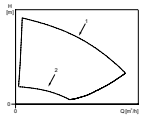
Best efficiency

E-pumps are used in applications characterised by a variable flow. Consequently, it is not possible to select a pump that is constantly operating at optimum efficiency.

In order to achieve optimum operating economy, select the pump based on the following criteria:

- The maximum duty point required must be as close as possible to the QH curve of the pump.
- The flow rate at the duty point required must be close to the optimum efficiency (Eta) for most operating hours.

Between the minimum and maximum performance curves, E-pumps have an large number of performance curves, each representing a specific speed. Therefore, it may not be possible to select a duty point close to the Max. curve.



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Min. and max. performance curves

Pos.	Description
1	Max. curve
2	Min. curve

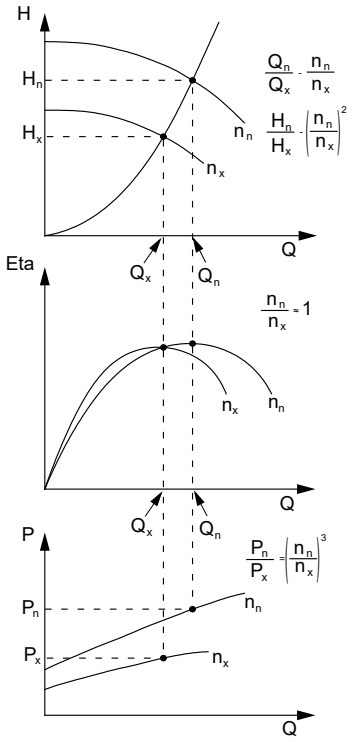
In situations where it is not possible to select a duty point close to the Max. curve, the below affinity equations can be used. The following are the appropriate variables for the motor speed (n):

- head (H)
- flow (Q)
- input power (P).

The approximated formulas only apply when the system characteristic remains unchanged for n_n and n_x and when it is based on the formula $H = k \times Q^2$ where k is a constant.

The power equation implies that the pump efficiency is unchanged at the two speeds. In practice, this is an acceptable approximation.

To obtain a precise calculation of the power savings resulting from a reduction of pump speed, the efficiencies of the variable frequency drive and the motor must be taken into account.



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Affinity equations

H_n	Rated head [m]
H_x	Actual head [m]
Q_n	Rated flow rate [m^3/h]
Q_x	Actual flow rate [m^3/h]
P_n	Rated input power [kW]
P_x	Actual input power [kW]
n_n	Rated motor speed [min^{-1}] (n_n = 3000 min^{-1})
n_x	Actual motor speed [min^{-1}]
η_n	Rated efficiency [%]
η_x	Actual efficiency [%]

See Grundfos Product Center for further information at https://product-selection.grundfos.com.

Related information

Cavitation

6. Operating conditions

Observe the following to ensure the efficient and long lifespan of the product.

Inlet pressure

The minimum inlet pressure is indicated by the NPSH-curves in the single-stage curve charts.

The minimum safety margin of the NPSH-curves must always be 0.5 m head.

Min. flow rate

To ensure sufficient cooling of the motor, the pump must not run continuously at a flow rate below 0.1 × nominal flow rate.

Operation against a closed valve must be limited to a maximum of 30 seconds to minimize the risk of the pumped liquid heating up and damaging the pump and the motor.

Max. flow rate

The pump must not run continuously at a flow rate above 1.3 × nominal flow rate due to the risk of upthrust and cavitation.

Pumped liquids

SPE pumps are capable of pumping clean, thin, non-aggressive liquids, not containing solid particles or fibres larger than sand grains.

Pump type	Maximum content of sand [ppm]
SPE 18 - SPE 60	100
SPE 77 - SPE 215	50

Special liquids

A larger content of sand will reduce pump life.

The following versions are available for applications involving aggressive liquids:

- SPE-N made of stainless steel EN 1.4401
- SPE-R made of stainless steel EN 1.4539.

Pumping of liquids with a higher density than that of water requires a motor with a correspondingly higher output.

Pumping of liquids with a higher viscosity than that of water may result in the following:

- increased pressure loss
- reduced hydraulic performance
- increased pump power input.

In case of doubt, contact Grundfos.

Liquid temperature

For protection of pump and motor rubber parts, the liquid temperature must not exceed 60 °C.

Maximum liquid temperature

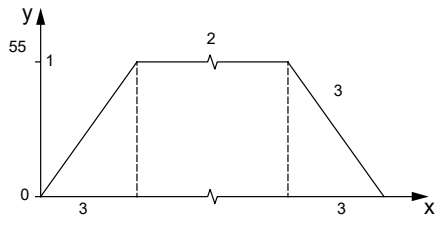
The maximum liquid temperature of 60 °C requires a flow velocity of the liquid past the motor of 0.15 m/s.

Max. operating pressure

Maximum operating pressure is 3 MPa (30 bar).

Ramp times

A maximum of 3 seconds for start 0-55 Hz and for stop 55-0 Hz.



Ramp times

Pos.	Description
1	Start
2	Operation
3	Stop
x	Time [s]
y	Frequency [Hz]

Service

Contact Grundfos with details about the pumped liquid before returning the product for service. Otherwise Grundfos can refuse to accept the pump. Possible costs of returning the pump are paid by the customer.

Any application for service must include details about the pumped liquid. The product is classified as contaminated if it is used for contagious or toxic liquid.

Clean the product in the best possible way before returning it.

Important: Make sure to mention that it is a permanent magnet motor.

Pump functioning as turbine

In case of unintended water flow through a non-energized pump, there is a risk that the moving parts of the pump and the motor start rotating, and generating voltage over the terminals. The size of the voltage depends on the speed of rotation. The motor terminals must be considered as live until proven otherwise.

Start/stop

The SPE pump is suitable for continuous as well as intermittent operation.

- Minimum one start per year is recommended.
- Maximum 120 starts per hour.
- Maximum 360 starts per day.
- If a switch or a sensor is used to start and stop the pump set, the signal has to be connected correctly to the variable frequency drive.
- The variable frequency drive can be disconnected from the mains maximum two times per minute.

Sound pressure level

The sound pressure level has been measured in accordance with the rules laid down in the EC machinery directive 2006/42/EC.

Sound pressure level of pumps

The values apply to pumps submerged in water without an external regulating valve.

Pump type	L_{pA} [dB(A)]
SP 1A	< 70
SP 2A	< 70
SP 3A	< 70
SP 5A	< 70
SP 7	< 70
SP 9	< 70
SP 11	< 70
SP 14	< 70
SP 18	< 70
SP 30	< 70
SP 46	< 70
SP 60	< 70
SP 77	< 70
SP 95	< 70
SP 125	79
SP 160	79
SP 215	82

Sound pressure level of motors

The sound pressure level of Grundfos MS and MMS motors is lower than 70 dB(A).

Other motor makes: See installation and operating instructions for these motors.

Moment of inertia

Calculate the moment of inertia by using one of the formulas below. Choose the formula according to the pump type and insert the number of stages.

Pump type	Moment of inertia [kgm^2]
SPE 17	$(4.0 + n \times 2.0) \times 10^{-4}$
SPE 30	$(4.0 + n \times 5.1) \times 10^{-4}$
SPE 46	$(4.0 + n \times 3.6) \times 10^{-4}$
SPE 60	$(4.0 + n \times 4.1) \times 10^{-4}$
SPE 77	$(5.5 + n \times 19) \times 10^{-4}$
SPE 95	$(5.5 + n \times 22) \times 10^{-4}$
SPE 125	$(5.5 + n \times 33) \times 10^{-4}$
SPE 160	$(5.5 + n \times 33) \times 10^{-4}$
SPE 215	$(25 + n \times 100) \times 10^{-4}$

n = number of stages.

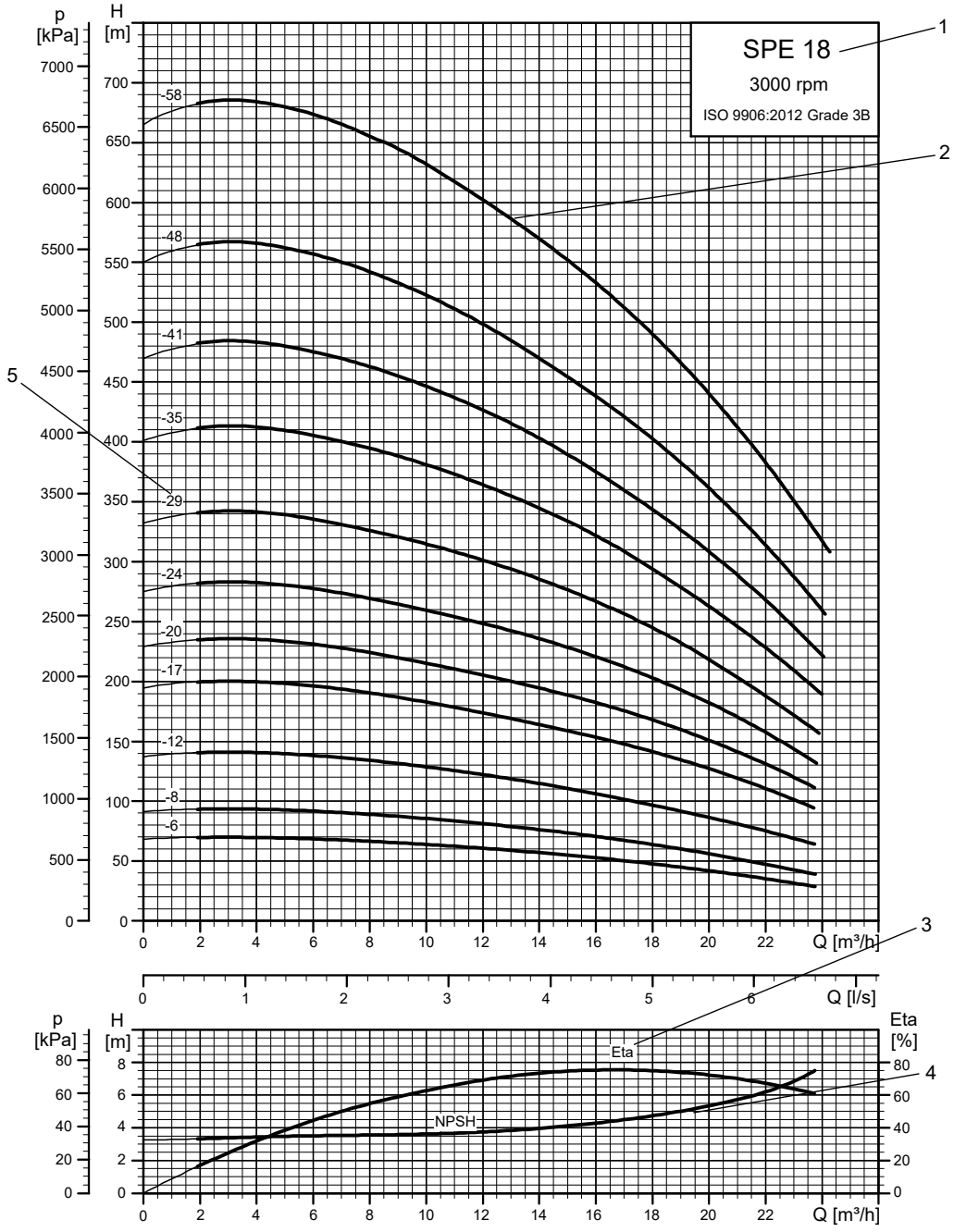
Recommended minimum borehole diameter

If you use a connecting piece in the installation, the recommended minimum borehole diameter is the largest diameter of either pump or connecting piece.

The following table shows the recommended minimum borehole diameter of SPE pumps with standard connections.

Pumps size	Number of cables	Sleeve	Minimum borehole diameter [mm]				
			Rp 2 1/2"	Rp 3"	Rp 4"	Rp 5"	Rp 6"
SPE 18 / SPE 30	1	-	147	147	-	-	-
		●	-	180	-	-	-
	2	●	-	186	-	-	-
SPE 46 / SPE 60	1	-	-	153	153	-	-
	2	-	-	156	156	-	-
SPE 77 / SPE 95	1	-	-	-	183	183	-
	2	-	-	-	191	191	-
SPE 125 / SPE 160	1	-	-	-	-	216	216
	2	-	-	-	-	220	220
SPE 215	1	-	-	-	-	-	241
	2	-	-	-	-	-	244

How to read the curve charts



How to read the curve charts

Pos.	Description
1	Pump type
2	QH curve for the individual pump. The bold curves indicate the recommended duty range for best efficiency.
3	The Eta curve shows the stage efficiency. The pumps with fewer stages will have a lower efficiency than the curve shows.
4	The NPSH curve is an average curve for all the variants shown. When sizing the pumps, add a safety margin of at least 0.5 m.
5	Number of stages.

Curve conditions

The conditions below apply to the curves at Performance curves and technical data.

General conditions

- Curve tolerances according to ISO 9906: 2012 - Grade 3B.
- The performance curves show pump performance at n = 3000 min^{-1}.
- The measurements were made with airless water at a temperature of 20 °C. The curves apply to a kinematic viscosity of 1 mm^2/s (1 cSt). When pumping liquids with a density higher than that of water, use motors with correspondingly higher outputs.
- The bold curves indicate the recommended performance range.
- The performance curves include possible losses such as non-return valve loss.

Curves

- **Q/H:** The curves include valve and inlet losses at the actual speed. Operations without a non-return valve increase the actual head at rated performance by 0.5 to 1.0 m.
- **NPSH:** The curve includes pressure loss in the suction interconnector and shows the required inlet pressure.
- **Power curve:** P2 shows the pump power input of each stage for the individual pump size when the pump is running at the rated speed.
- **Efficiency curve:** Eta shows pump stage efficiency. If Eta for the actual pump size is needed, consult Grundfos or visit Grundfos Product Center https://product-selection.grundfos.com.

Certificates

For more information about SPE certificates, see Certificates.

Related information

11. Certificates

Cavitation

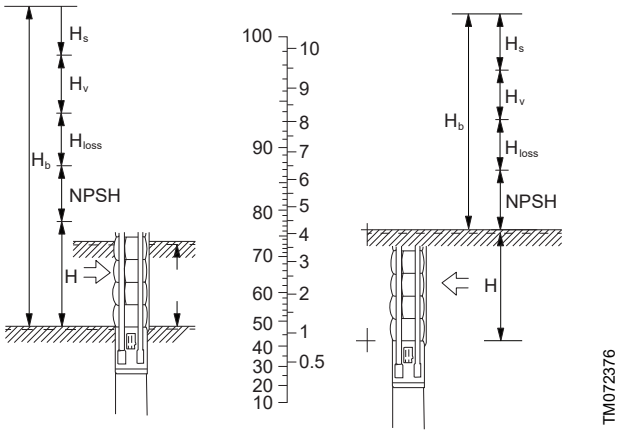
Cavitation does not normally take place in submersible pumps. If the following two factors occur at the same time, cavitational damage on both pump and motor can occur at low installation depths:

- Invasive air bubbles
- Reduction of counter pressure caused for instance, by pipe fracture, severe corrosion of riser main and extremely high consumption.

To calculate the required installation depth to prevent cavitation, the following formula is applied:

H	**=**	**H_b - NPSH - H_{loss} - H_v- H_s**
H_b	=	barometric pressure
NPSH	=	Net Positive Suction Head
H_{loss}	=	pressure loss in suction pipe
H_v	=	vapour pressure
H_s	=	safety factor

When the formula gives a positive H value, the pump is able to operate at suction lift. In that case, the standard indication of minimum installation depth is valid.



Installation depth

Example:

An SPE 60 at a flow of 78 m^3/h.

H_b	10.0 m
NPSH from data sheet	4.2 m
H_{loss}	0.0 m
H_v at 32 °C	0.5 m
H_s	1.0 m

H = 10 - 4.2 - 0 - 0.5 - 1.0 = 4.3 m

As H is positive, the pump is able to create a vacuum of 0.43 bar without being damaged and no special precautions have to be taken. In case of corrosion of the riser main resulting in a 20 mm hole, there is no counter pressure and the pump flow increases to more than 90 m^3/h.

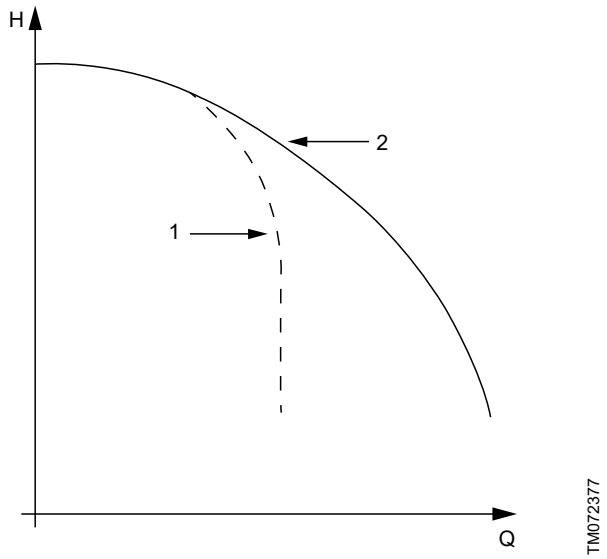
H_b is unchanged	10.0 m
NPSH will increase to	8.0 m
H_{loss}	0.0 m
H_v will increase due to recirculation in well to	4.6 m
H_s is unchanged	1.0 m

This will give

H = 10 - 8 - 0 - 4.6 - 1.0 = -3.6 m

This value of H means that the pump inlet must be at least 3.6 m below the dynamic water level, otherwise the pump cavitates.

When a pump cavitates, it does not give full performance, see figure below.

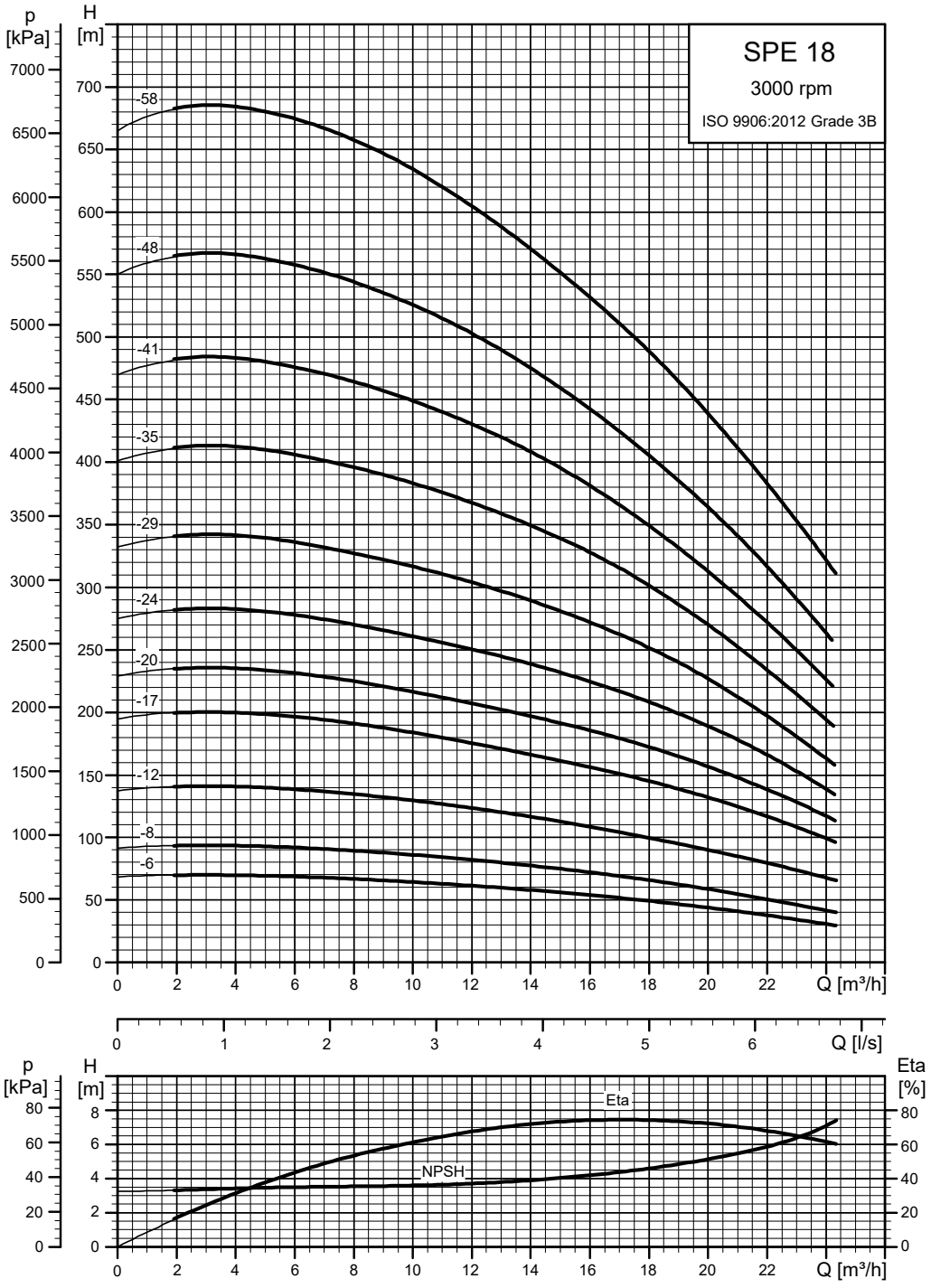


Pos.	Description
1	Performance at full capacity
2	Performance according to data sheet

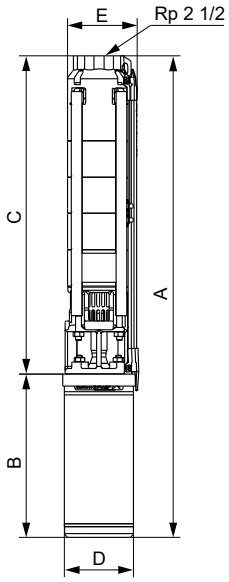
7. Performance curves and technical data

SPE 18

Performance curves



Dimensions and weights



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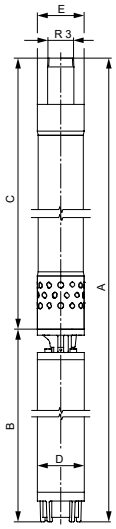


TM014197

Pump type	Motor power [kW]	Dimensions [mm]					Net weight [kg]
		C	B	A	D	E	
SPE 18-6	4.0	644	547	1191	139.5	142	47.8
SPE 18-8	5.5	765	547	1312	139.5	142	50.5
SPE 18-12	7.5	1007	547	1554	139.5	142	56.0
SPE 18-17	11	1310	667	1977	139.5	142	76.2
SPE 18-20	13	1491	667	2158	139.5	142	80.4
SPE 18-24	15	1733	667	2400	139.5	142	87.0
SPE 18-29	18.5	2036	667	2703	139.5	142	93.9
SPE 18-35	22	2399	817	3216	139.5	142	117.1
SPE 18-41 [6]	26	3133	817	3950	139.5	175	156.3
SPE 18-48 [6]	30	3556	817	4373	139.5	175	168.0
SPE 18-58 [6]	37	4161	947	5108	139.5	181 [7]	201.8
The pump types listed are also available in N- and R-versions. See Material specification (SPE 18 - SPE 60).							
Other types of connection are possible by means of connecting pieces. See section Mechanical accessories.							

6) SPE 18-41, SPE 18-48 and SPE 18-58 are mounted in sleeve for R 3 connection. Pumps mounted in sleeve are only available in standard and N-versions.

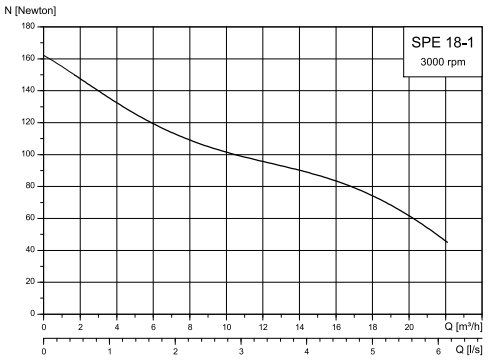
7) Maximum diameter of pump with two motor cables.

Related information

Material specification (SPE 18 - SPE 60)

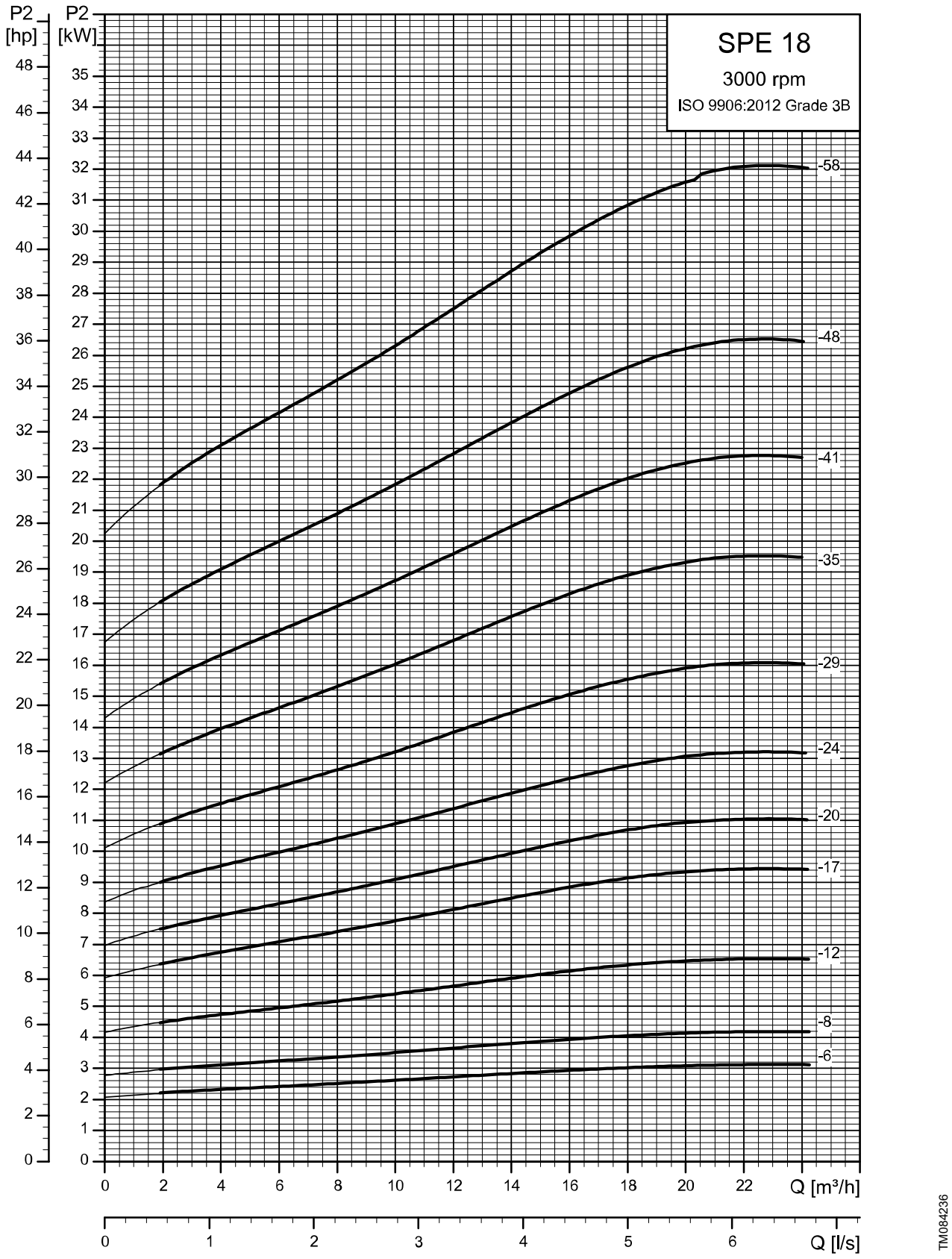
Connecting pieces / Adaptors

Single-stage curve, axial thrust



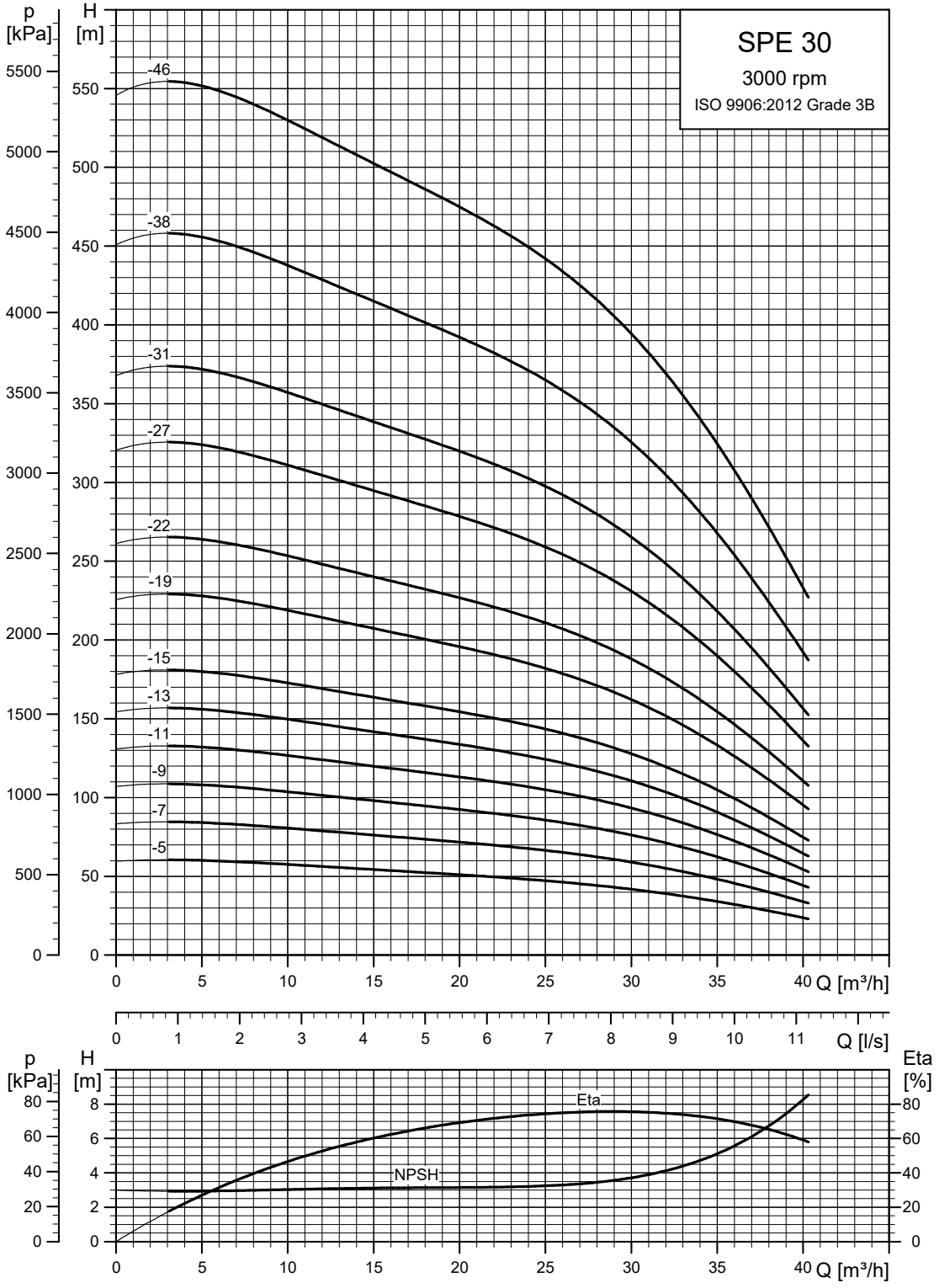
TM084368

Power curves



SPE 30

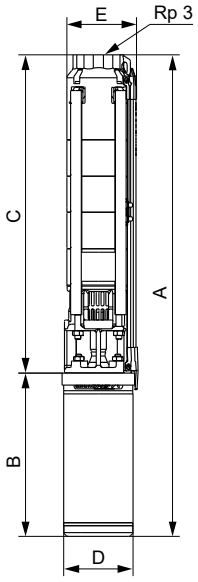
Performance curves



Related information

How to read the curve charts

Dimensions and weights



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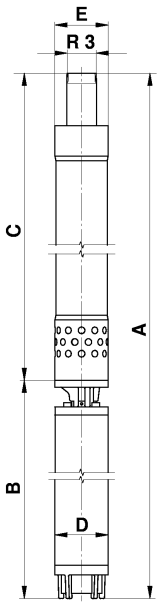


TM014197

Pump type	Motor	Dimensions [mm]					Net weight [kg]
	Power [kW]	C	B	A	D	E	
SPE 30-5	5.5	761	547	1308	139.5	142	46.8
SPE 30-7	7.5	953	547	1500	139.5	142	50.7
SPE 30-9	9.2	1145	667	1812	139.5	142	67.6
SPE 30-11	11	1337	667	2004	139.5	142	71.4
SPE 30-13	13	1529	667	2196	139.5	142	75.3
SPE 30-15	15	1721	667	2388	139.5	142	79.2
SPE 30-19	18.5	2121	667	2788	139.5	142	87.0
SPE 30-22	22	2409	817	3226	139.5	142	107.8
SPE 30-27	26	2889	817	3706	139.5	142	117.5
SPE 30-31	30	3273	817	4090	139.5	142	125.2
SPE 30-38 [8]	37	4300	947	5247	139.5	181 [9]	201.5
SPE 30-46 [8]	45	5068	947	6015	139.5	181 [9]	222.8
The pump types listed are also available in N- and R-versions. See Material specification (SPE 18 - SPE 60).							
Other types of connection are possible by means of connecting pieces. See Mechanical accessories.							

8) SPE 30-38 and 30-46 are mounted in sleeve for R 3 connection. Pumps mounted in sleeve are only available in standard and N-versions.

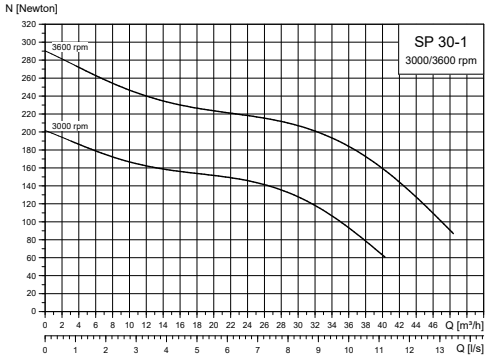
9) Maximum diameter of pump with two motor cables.

Related information

Material specification (SPE 18 - SPE 60)

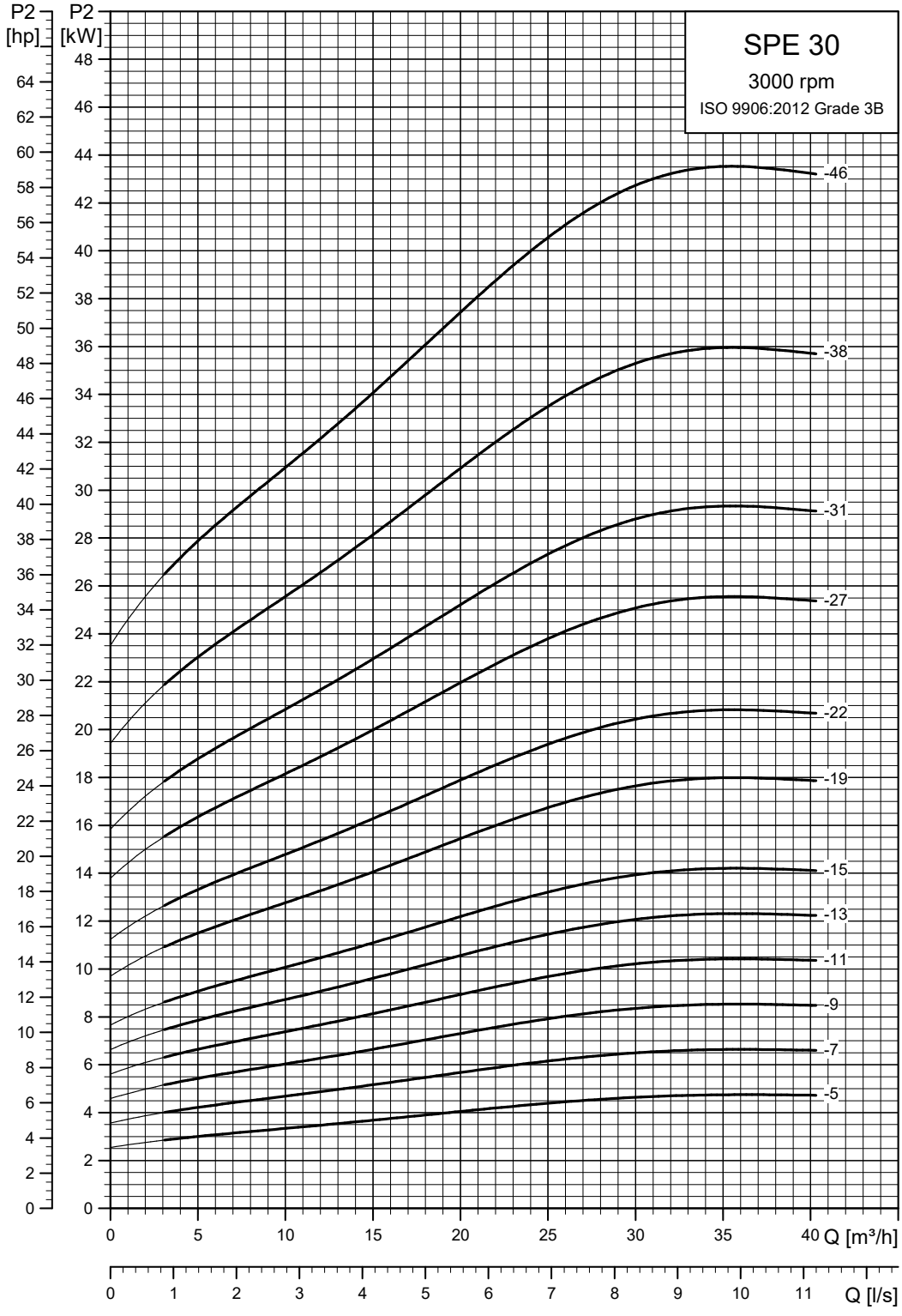
Connecting pieces / Adaptors

Single-stage curves, axial thrust



TM076261

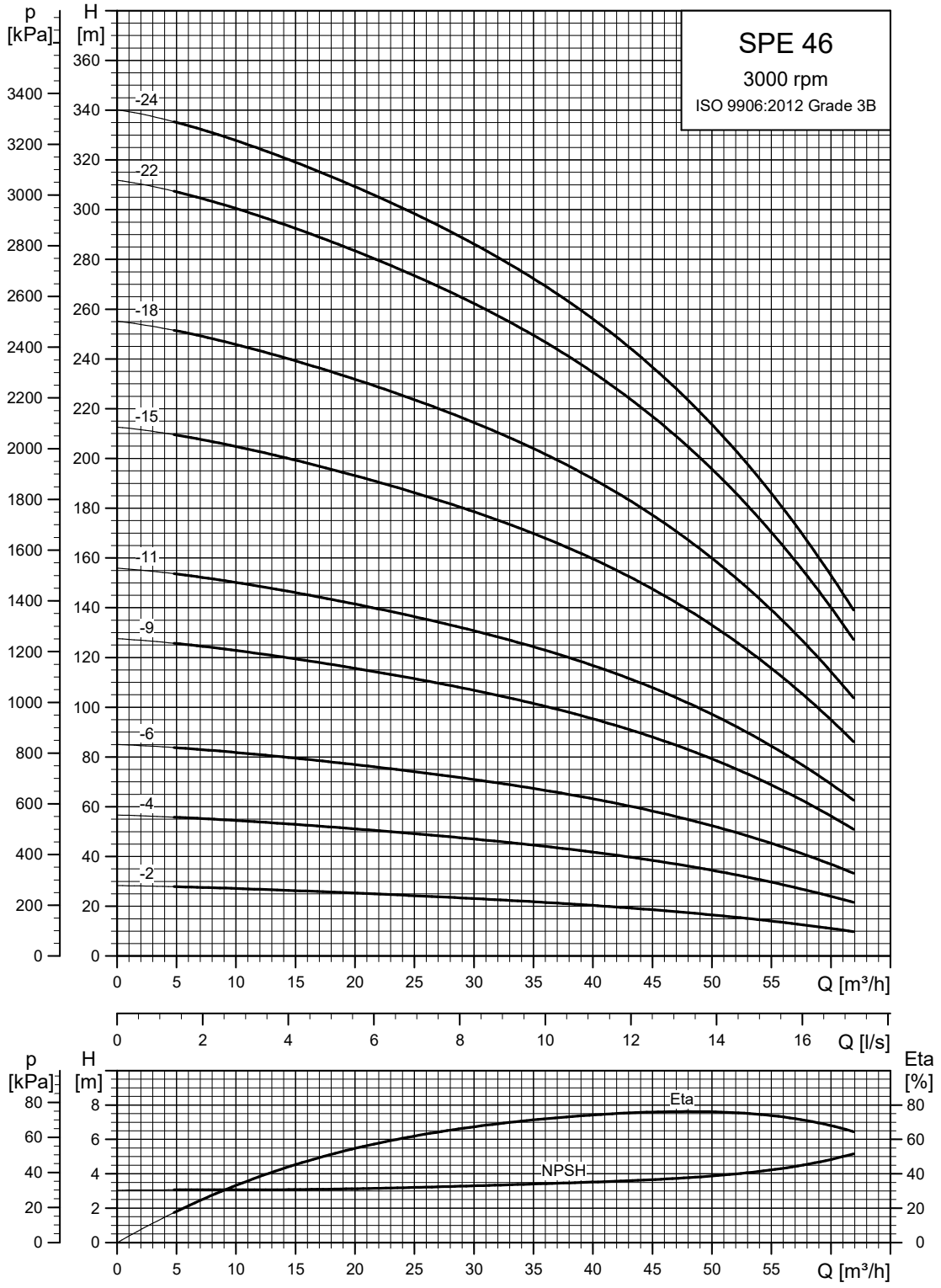
Power curves



TM076152

SPE 46

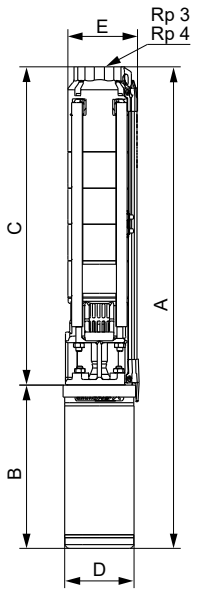
Performance curves



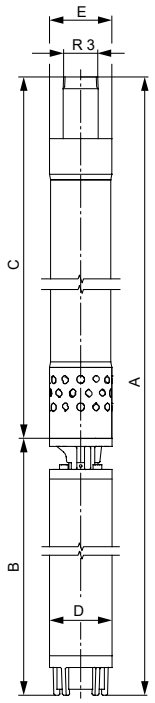
Related information

How to read the curve charts

Dimensions and weights



TM080209



TM014197

Pump type	Motor Power [kW]	Dimensions [mm]					Net weight [kg]
		C	B	A	D	E	
SPE 46-2	4.0	507	547	1054	139.5	148	43.0
SPE 46-4	7.5	733	547	1280	139.5	148	47.8
SPE 46-6	11	959	667	1626	139.5	148	65.6
SPE 46-9	15	1298	667	1965	139.5	148	72.8
SPE 46-11	18.5	1524	667	2191	139.5	148	77.6
SPE 46-15	22	1992	817	2809	139.5	148	102.2
SPE 46-18	30	2331	817	3148	139.5	148	109.4
SPE 46-22	37	2783	947	3730	139.5	151 [10)]	134.0
SPE 46-24	45	3009	947	3956	139.5	151 [10)]	138.8
The pump types listed are also available in N- and R-versions. See Material specification (SPE 18 - SPE 60).							
Other types of connection are possible by means of connecting pieces. See Mechanical accessories.							

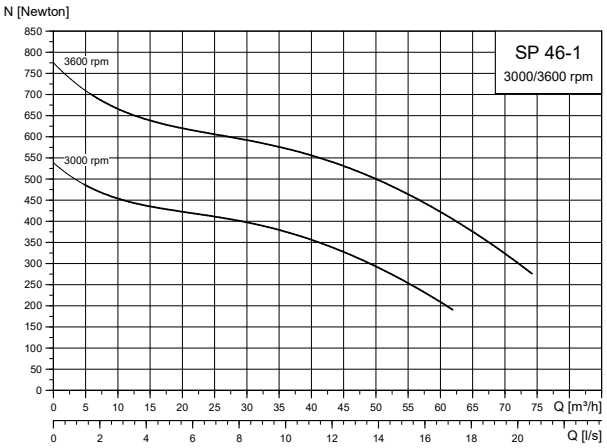
[10)] Maximum diameter of pump with two motor cables.

Related information

Material specification (SPE 18 - SPE 60)

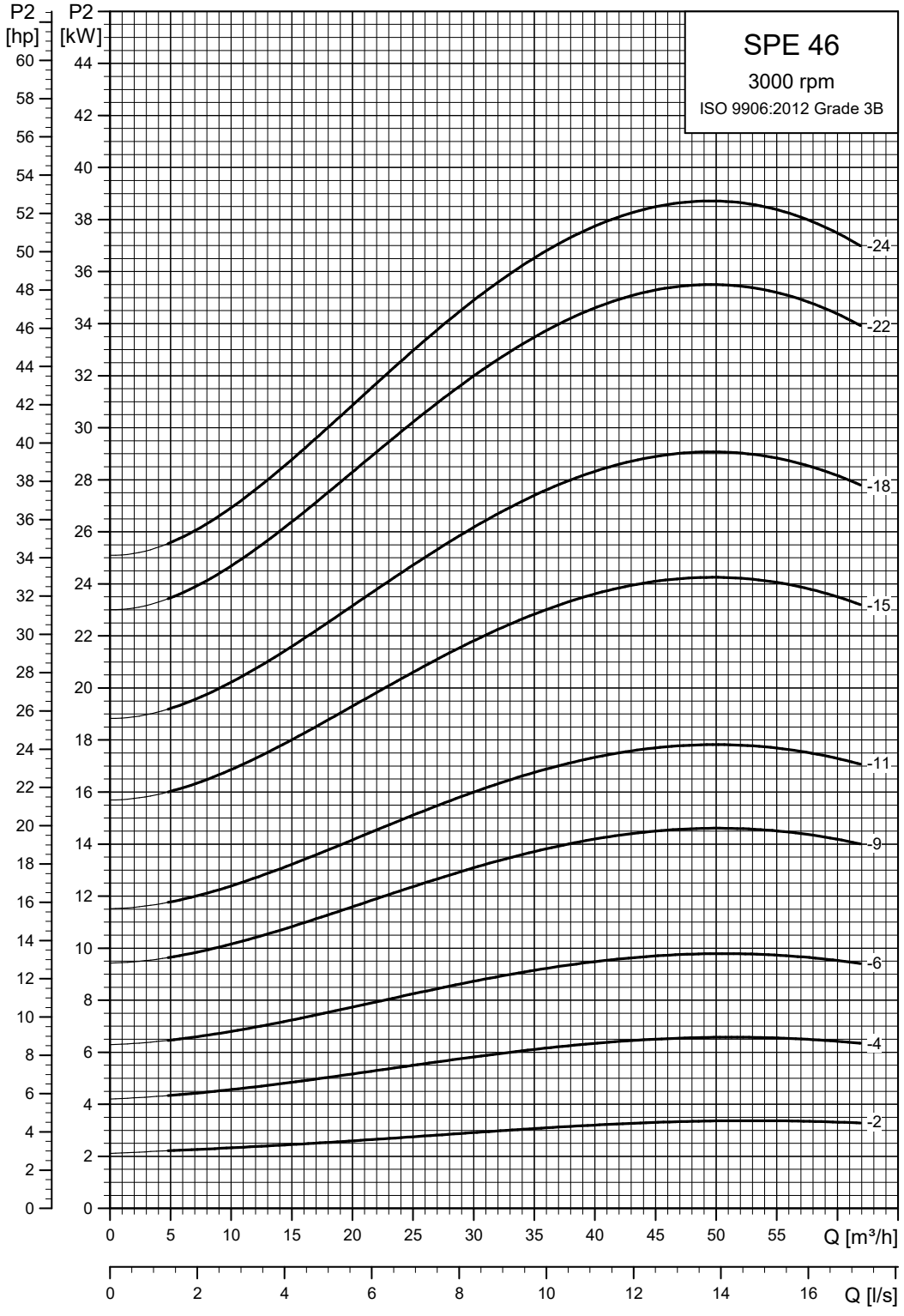
Connecting pieces / Adaptors

Single-stage curves, axial thrust



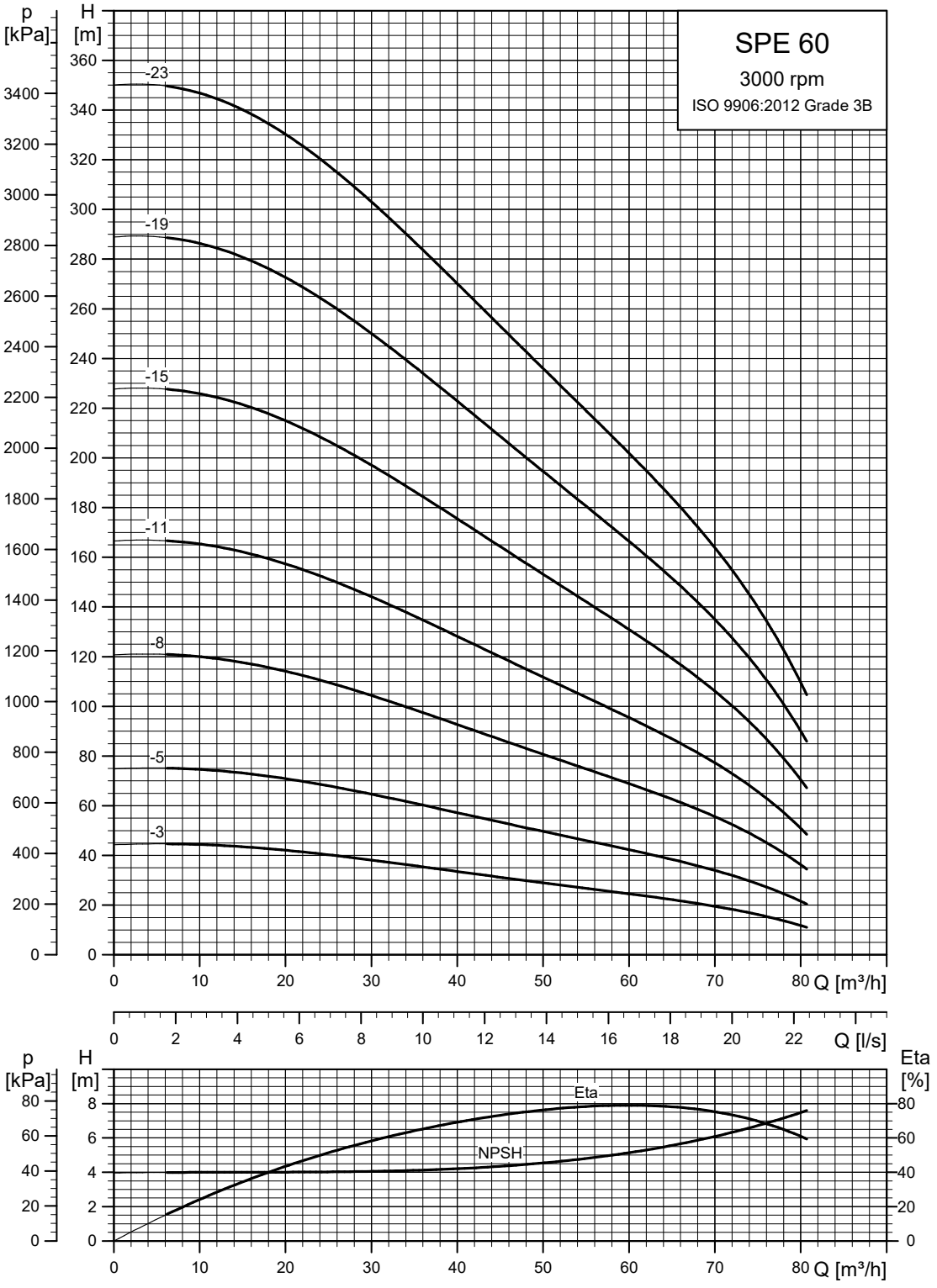
TM076262

Power curves



SPE 60

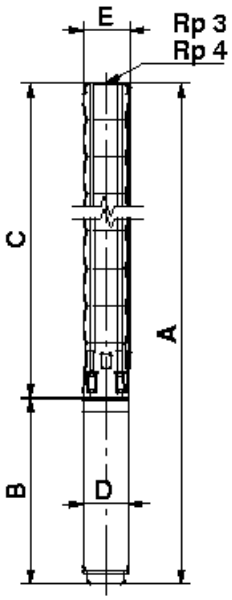
Performance curves



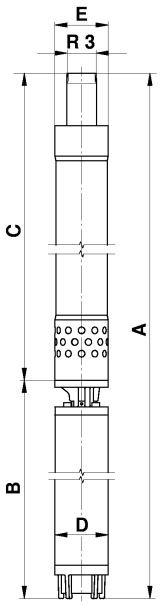
Related information

How to read the curve charts

Dimensions and weights



TM000961



TM014197

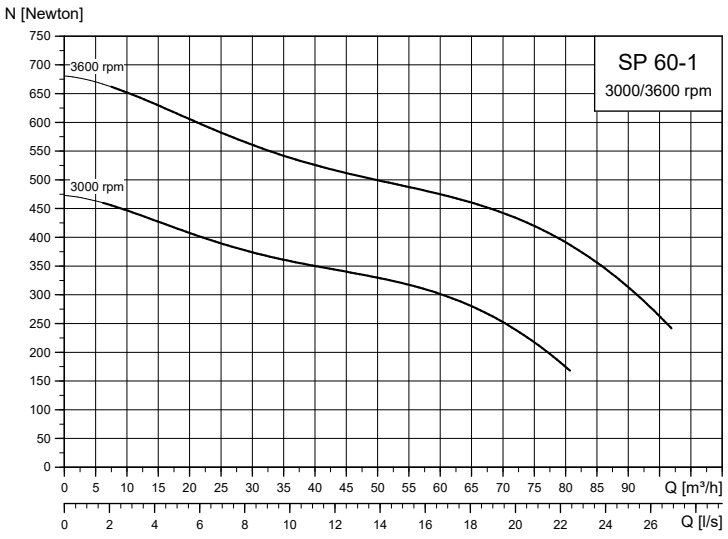
Pump type	Motor Power [kW]	Dimensions [mm]					Net weight [kg]
		C	B	A	D	E	
SPE 60-3	7.5	620	547	1167	139.5	148	45.4
SPE 60-5	11	846	667	1513	139.5	148	63.2
SPE 60-8	18.5	1185	667	1852	139.5	148	70.4
SPE 60-11	22	1524	817	2341	139.5	148	92.6
SPE 60-15	26	1992	817	2809	139.5	148	102.2
SPE 60-19	37	2444	947	3391	139.5	151 [11)]	126.8
SPE 60-23	45	2896	947	3843	139.5	151 [11)]	136.4
The pump types listed are also available in N- and R-versions. See Material specification (SPE 18 - SPE 60).							
Other types of connection are possible by means of connecting pieces. See Mechanical accessories.							

11) Maximum diameter of pump with two motor cables.

Related information

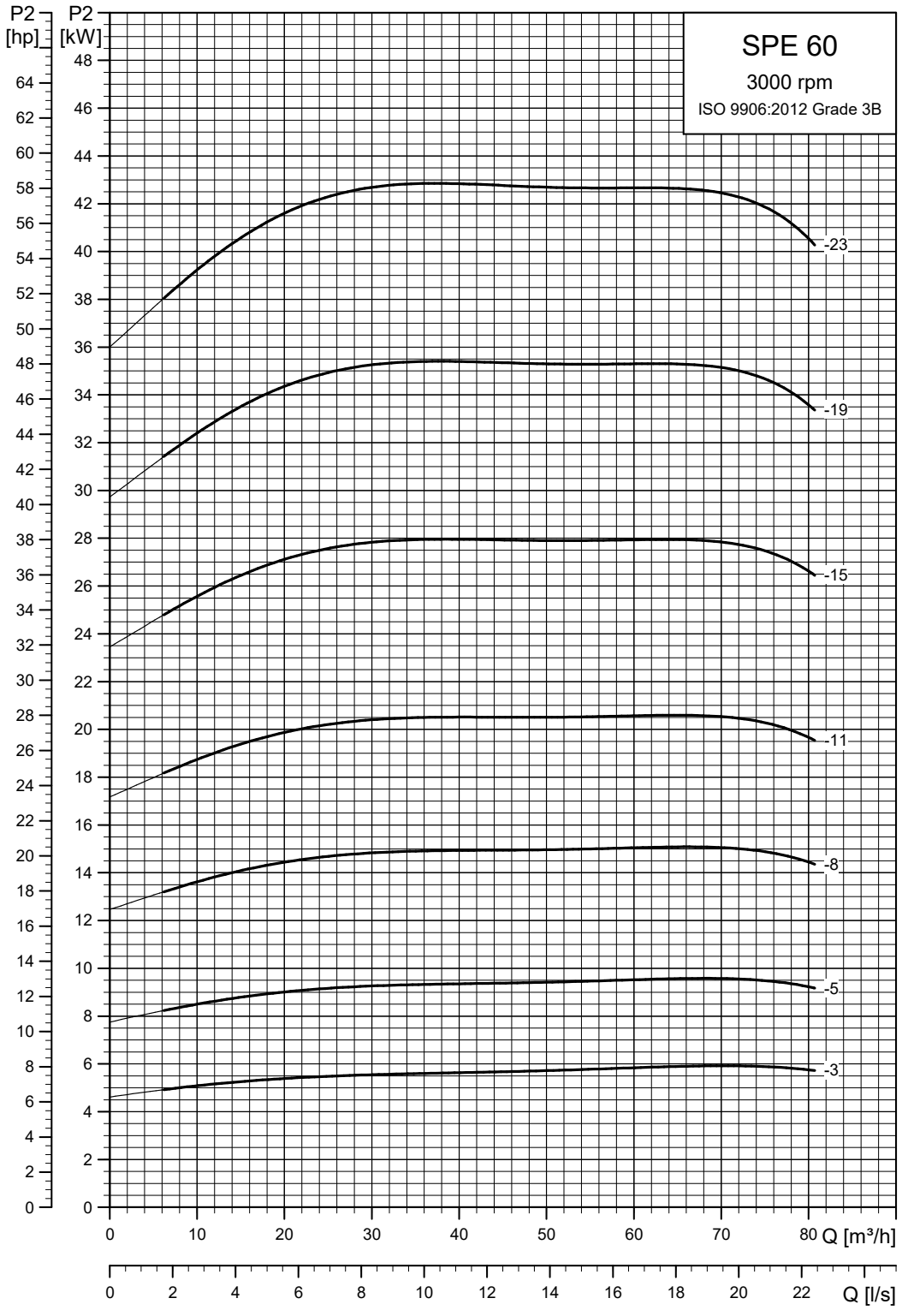
Material specification (SPE 18 - SPE 60)
Connecting pieces / Adaptors

Single-stage curves, axial thrust



TM076263

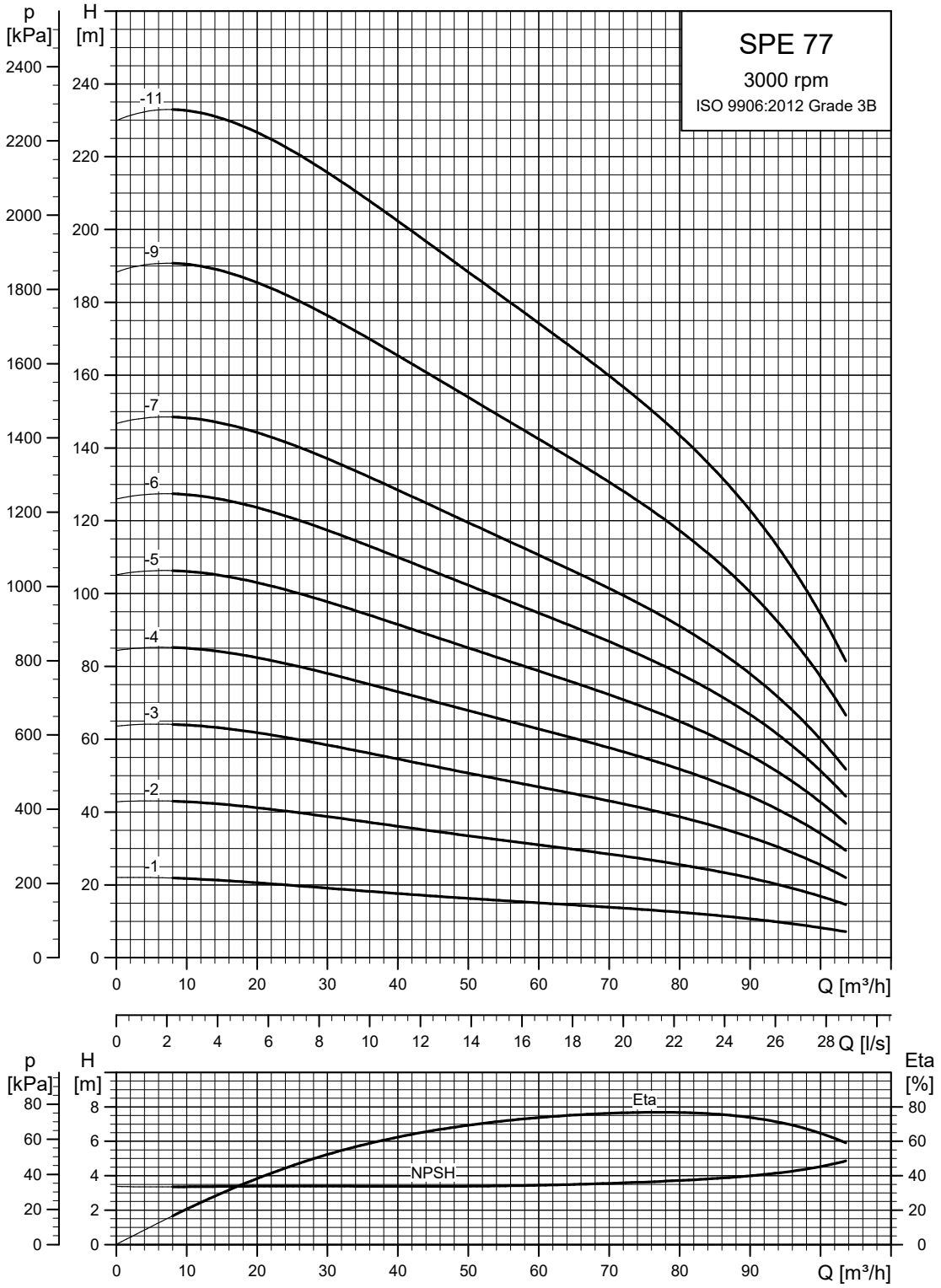
Power curves



TM076156

SPE 77

Performance curves

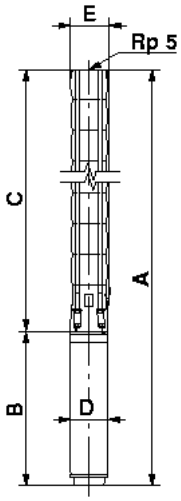


TM076157

Related information

How to read the curve charts

Dimensions and weights



TM007872

Pump type	Motor Power [kW]	Dimensions					Net weight [kg]
		C	B	A	D	E	
SPE 77-1	4.0	619	547	1166	139.5	178	56.2
SPE 77-2	9.2	747	667	1414	139.5	178	73.4
SPE 77-3	13	875	667	1542	139.5	178	77.6
SPE 77-4	18.5	1003	667	1670	139.5	178	81.8
SPE 77-5	22	1131	817	1948	139.5	178	101.0
SPE 77-6	26	1259	817	2076	139.5	178	105.2
SPE 77-7	30	1387	817	2204	139.5	178	109.4
SPE 77-9	37	1643	947	2590	139.5	186 [12)]	132.8
SPE 77-11	45	1899	947	2846	139.5	186 [12)]	141.2
The pump types above are also available in N- and R-versions. See Material specification (SPE 77 - SPE 215).							
Other types of connection are possible by means of connecting pieces. See Mechanical accessories.							

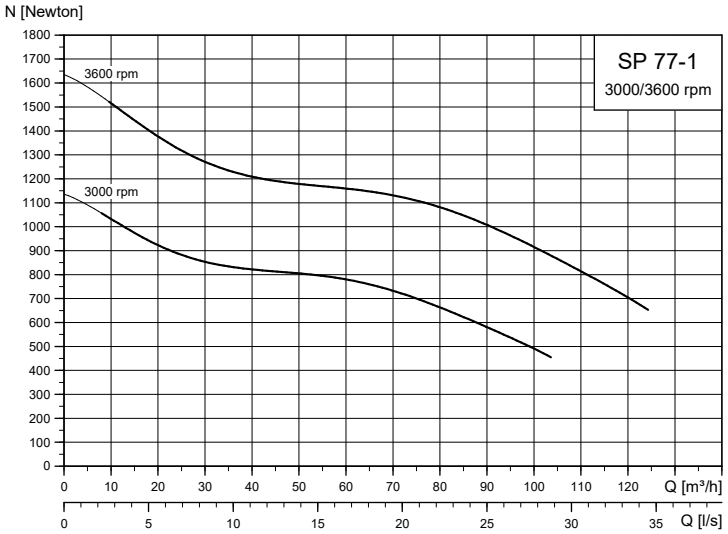
12) Maximum diameter of pump with two motor cables.

Related information

Material specification (SPE 77 - SPE 215)

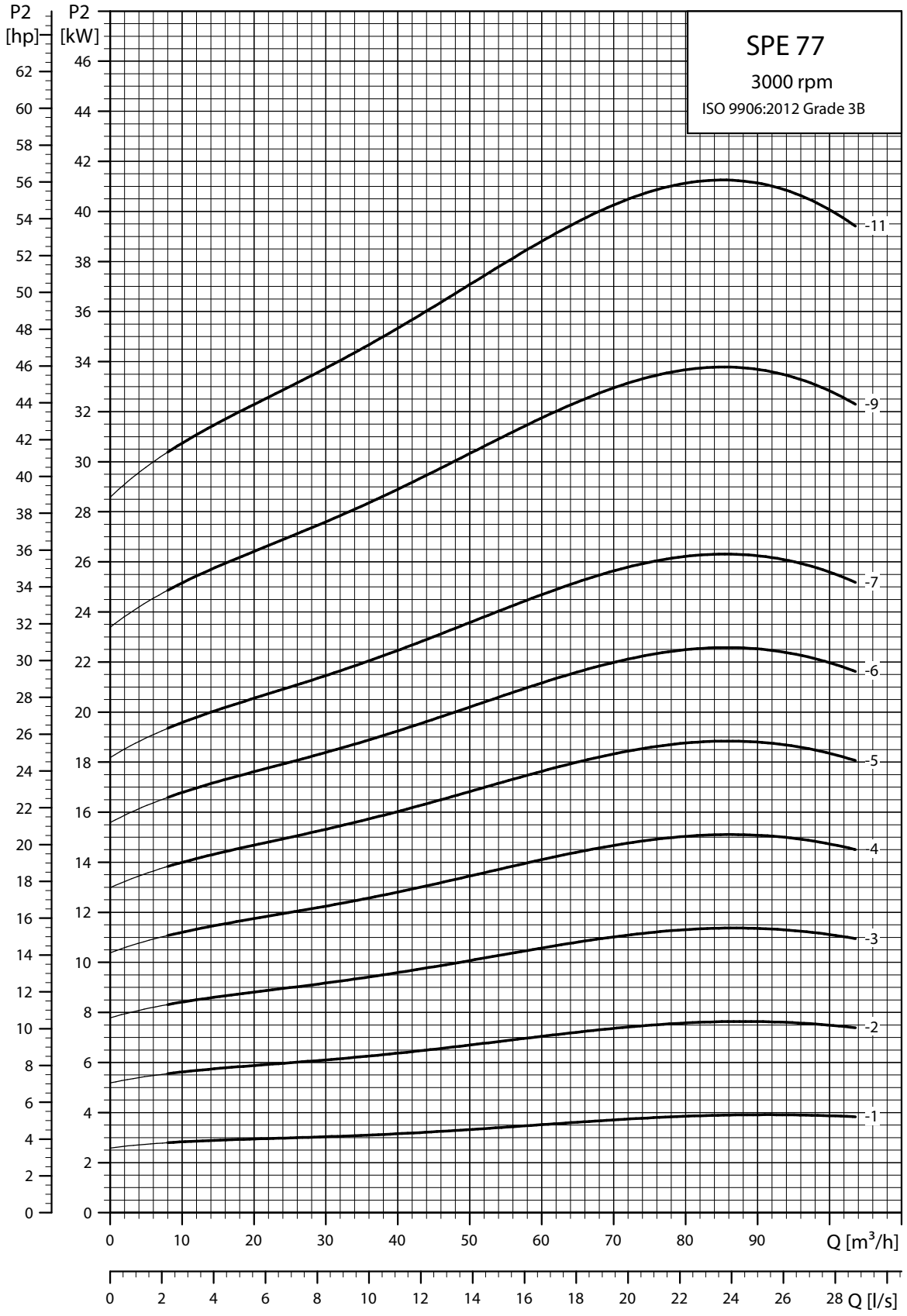
Connecting pieces / Adaptors

Single-stage curves, axial thrust



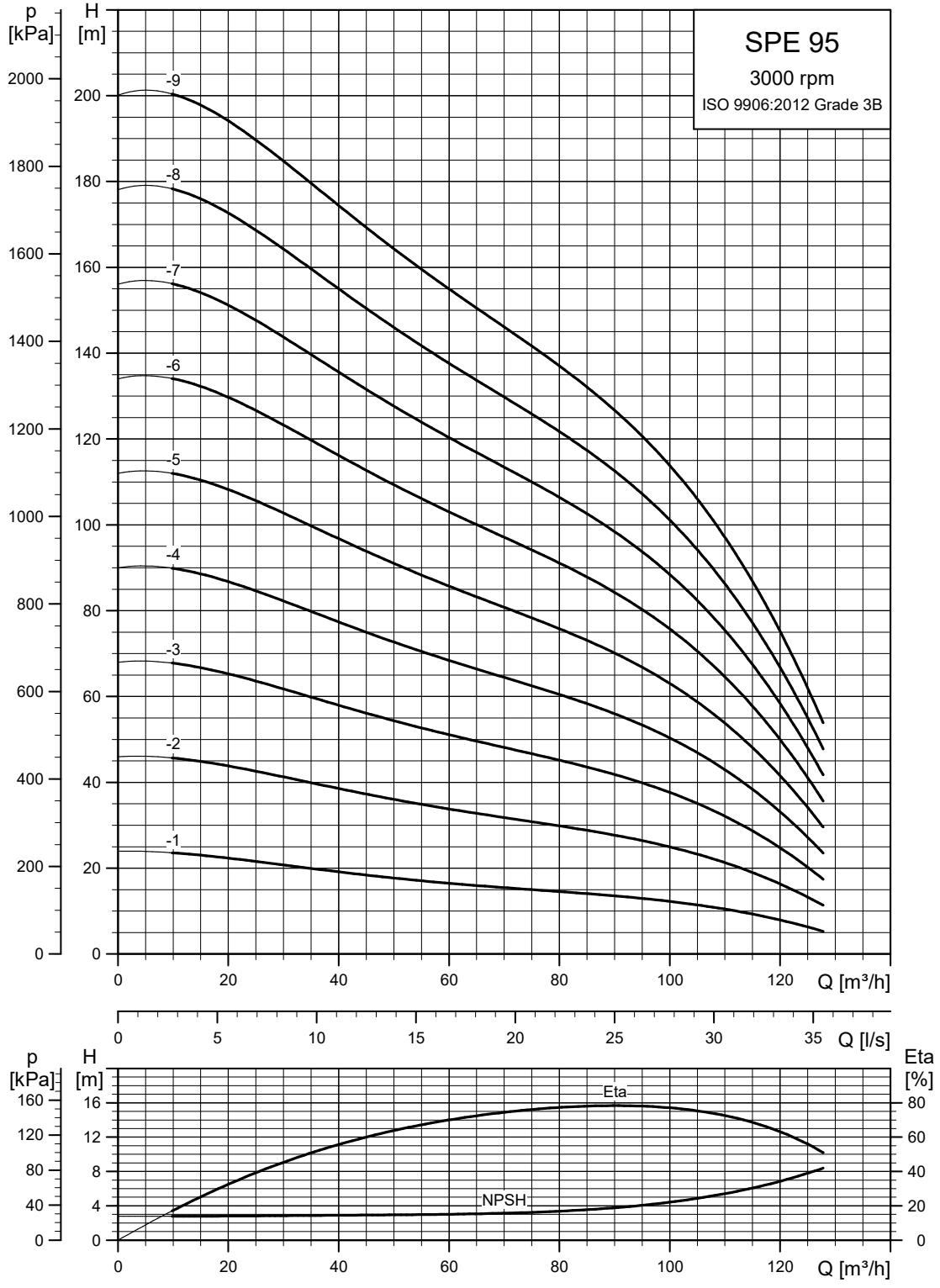
TM076264

Power curves



SPE 95

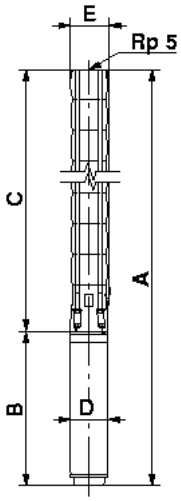
Performance curves



Related information

How to read the curve charts

Dimensions and weights



TM007872

Pump type	Motor Power [kW]	Dimensions					Net weight [kg]
		C	B	A	D	E	
SPE 95-1	5.5	619	547	1166	139.5	178	56.2
SPE 95-2	11	747	667	1414	139.5	178	73.4
SPE 95-3	15	875	667	1542	139.5	178	77.6
SPE 95-4	22	1003	817	1820	139.5	178	96.8
SPE 95-5	26	1131	817	1948	139.5	178	101.0
SPE 95-6	30	1259	817	2076	139.5	178	105.2
SPE 95-7	37	1387	947	2334	139.5	186 [13)]	124.4
SPE 95-8	37	1515	947	2462	139.5	186 [13)]	128.6
SPE 95-9	45	1643	947	2590	139.5	186 [13)]	132.8
The pump types above are also available in N- and R-versions. See Material specification (SPE 77 - SPE 215).							
Other types of connection are possible by means of connecting pieces. See Mechanical accessories.							

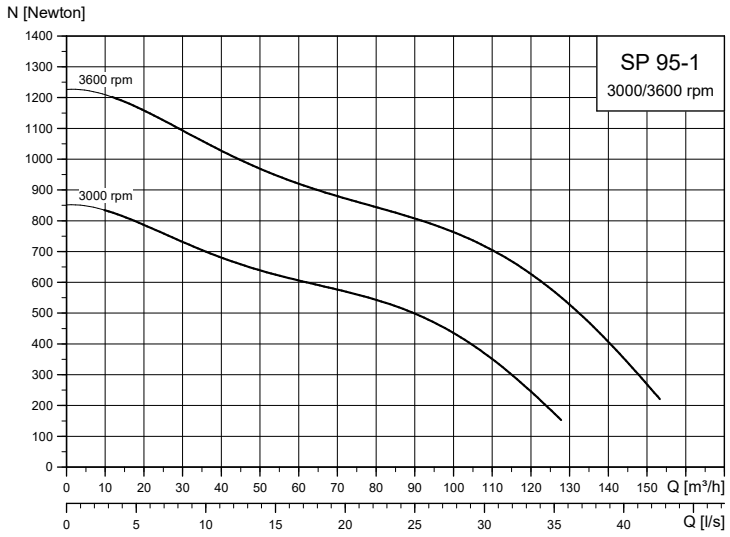
13) Maximum diameter of pump with two motor cables.

Related information

Material specification (SPE 77 - SPE 215)

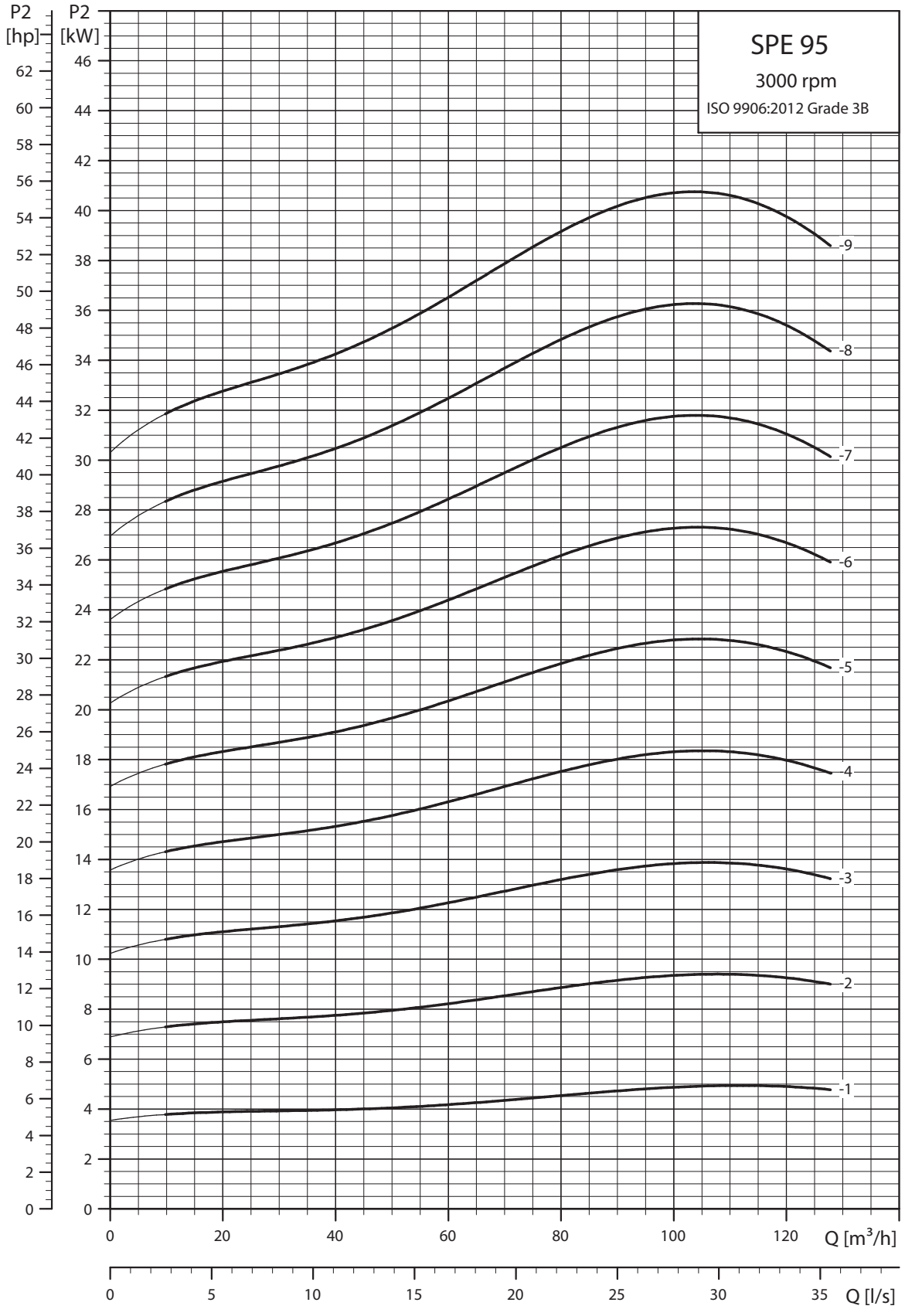
Connecting pieces / Adaptors

Single-stage curves, axial thrust



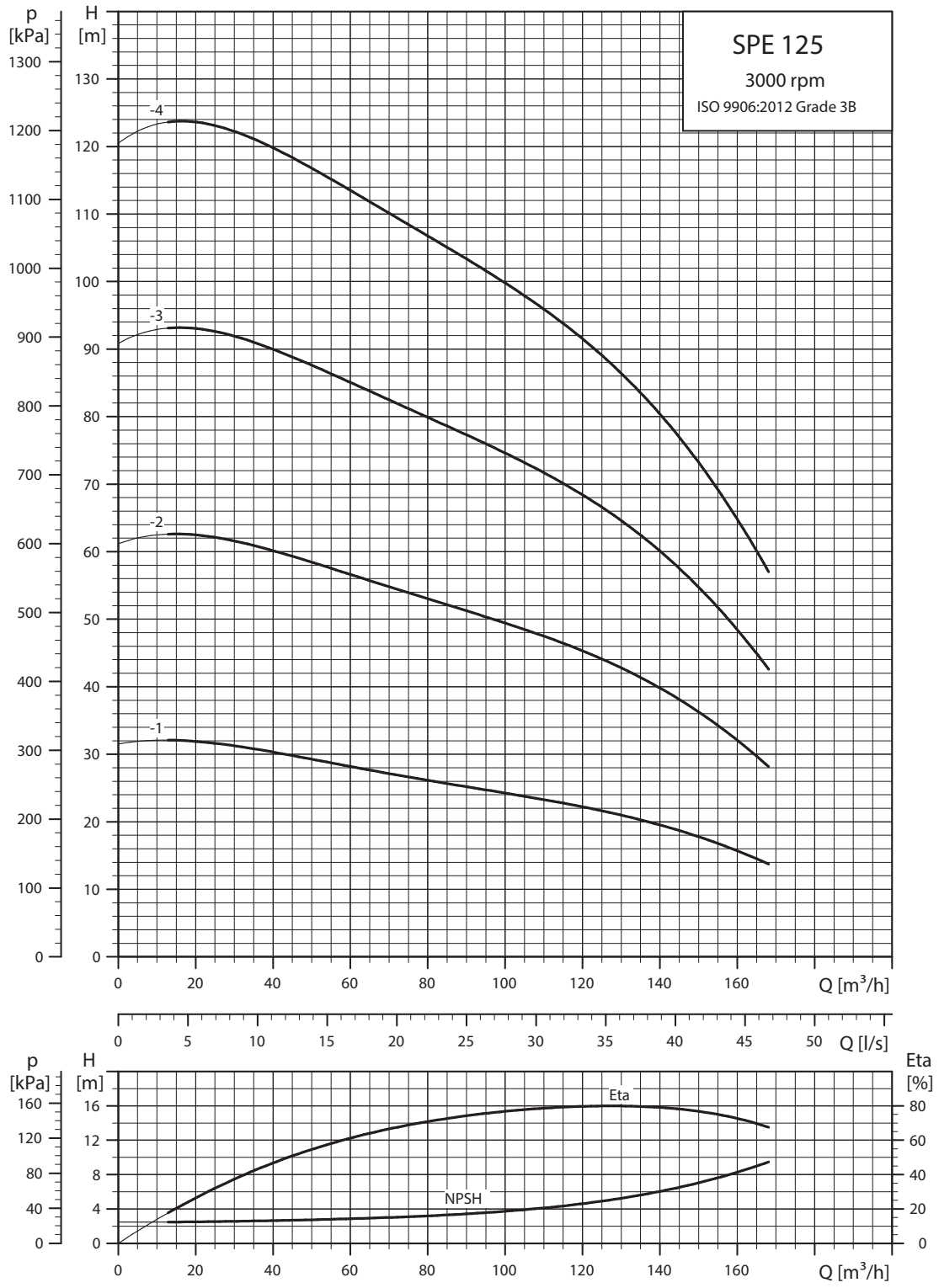
TM076265

Power curves



SPE 125

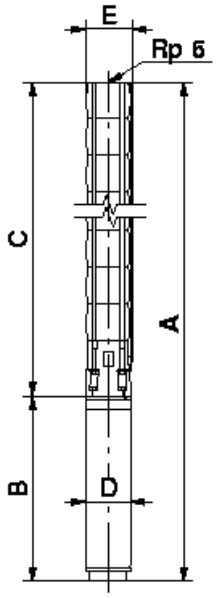
Performance curves



Related information

How to read the curve charts

Dimensions and weights



TM008760

Pump type	Motor Power [kW]	Dimensions					Net weight [kg]
		C	B	A	D	E	
SPE 125-1	13	652	667	1319	139.5	211	79.2
SPE 125-2	22	807	817	1624	139.5	211	100.2
SPE 125-3	37	963	947	1910	139.5	215 [14)]	121.2
SPE 125-4	45	1118	947	2065	139.5	215 [14)]	127.2
The pump types above are also available in N- and R-versions. See Material specification (SPE 77 - SPE 215).							
Other types of connection are possible by means of connecting pieces. See Mechanical accessories.							

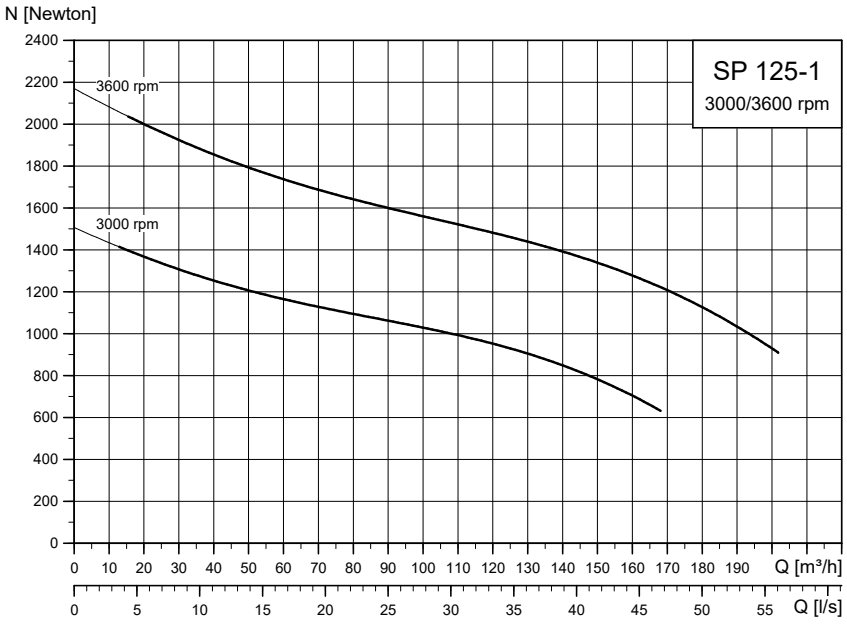
14) Maximum diameter of pump with two motor cables.

Related information

Material specification (SPE 77 - SPE 215)

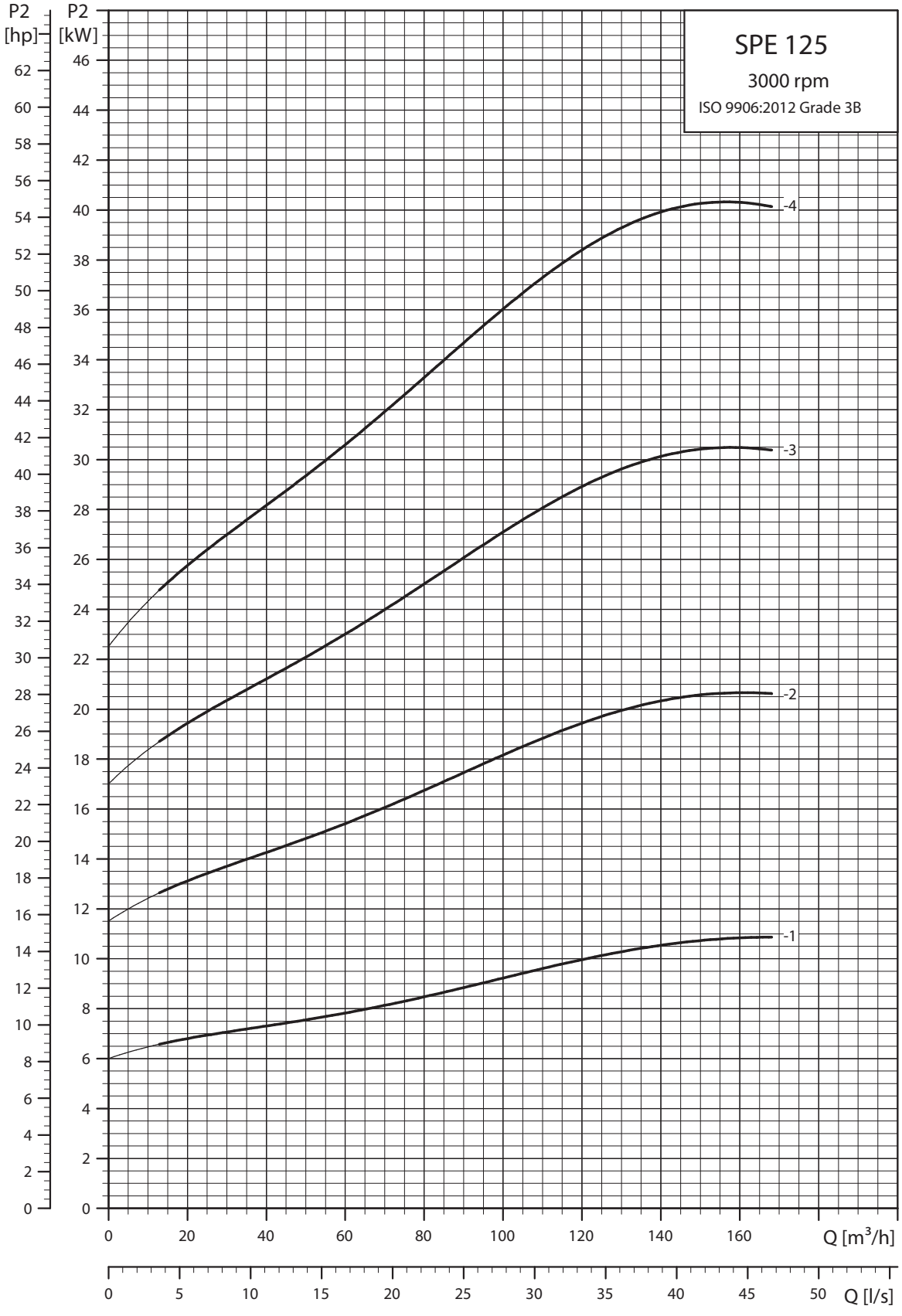
Connecting pieces / Adaptors

Single-stage curves, axial thrust



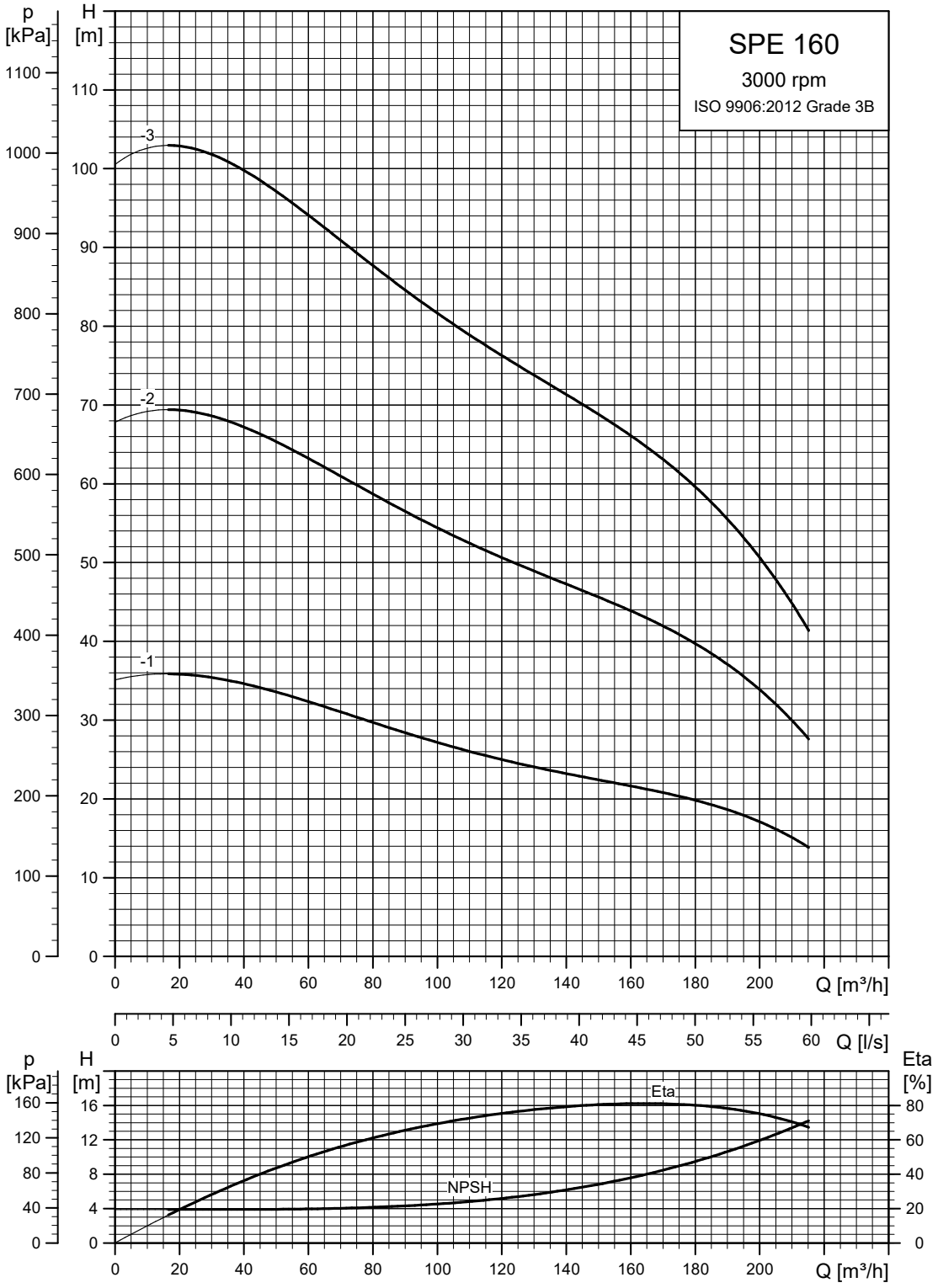
TM076266

Power curves



SPE 160

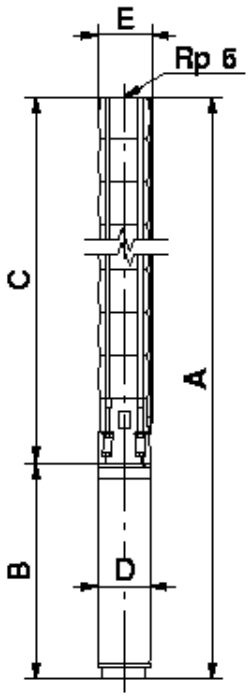
Performance curves



Related information

How to read the curve charts

Dimensions and weights



TM008760

Pump type	Motor Power [kW]	Dimensions					Net weight [kg]
		C	B	A	D	E	
SPE 160-1	15	652	667	1319	139.5	211	79.2
SPE 160-2	30	807	817	1624	139.5	211	100.2
SPE 160-3	45	963	947	1910	139.5	215 [15)]	121.2
The pump types above are also available in N- and R-versions. See Material specification (SPE 77 - SPE 215).							
Other types of connection are possible by means of connecting pieces. See Mechanical accessories.							

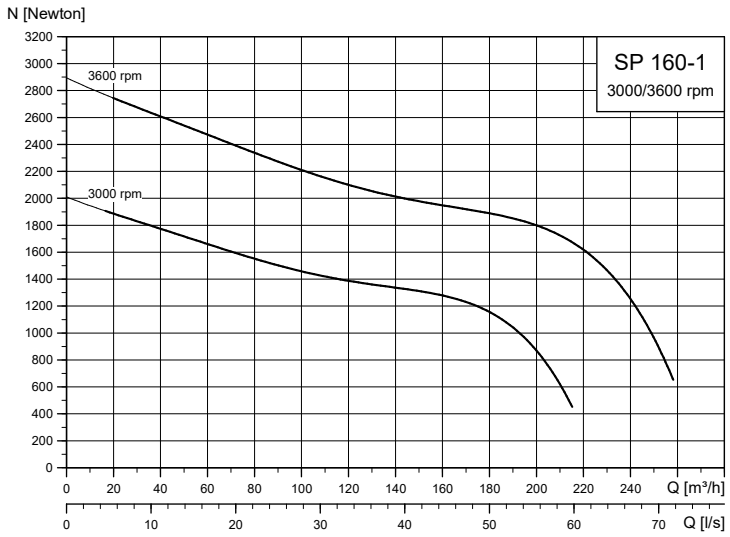
[15)] Maximum diameter of pump with two motor cables.

Related information

Material specification (SPE 77 - SPE 215)

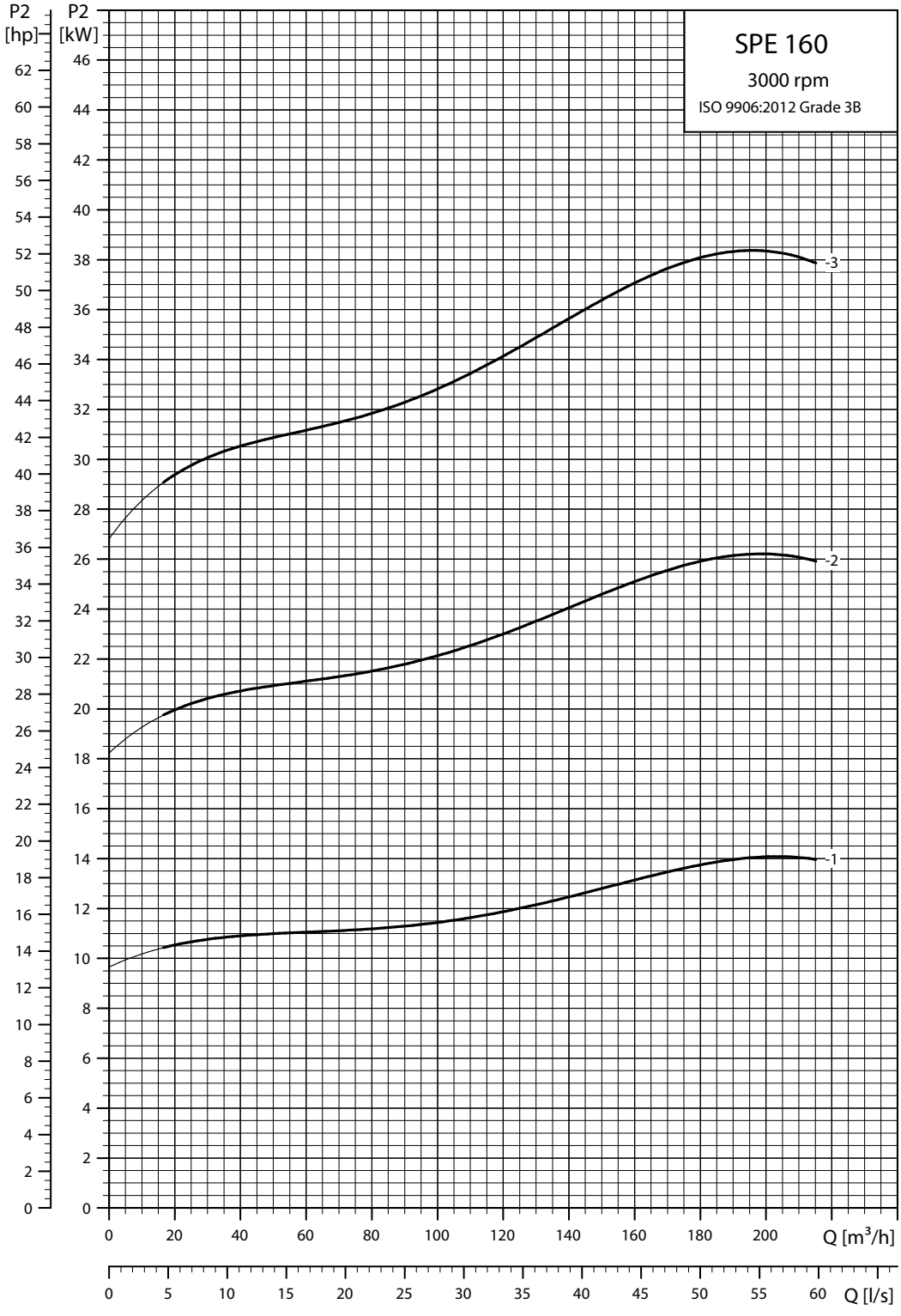
Connecting pieces / Adaptors

Single-stage curves, axial thrust



TM076267

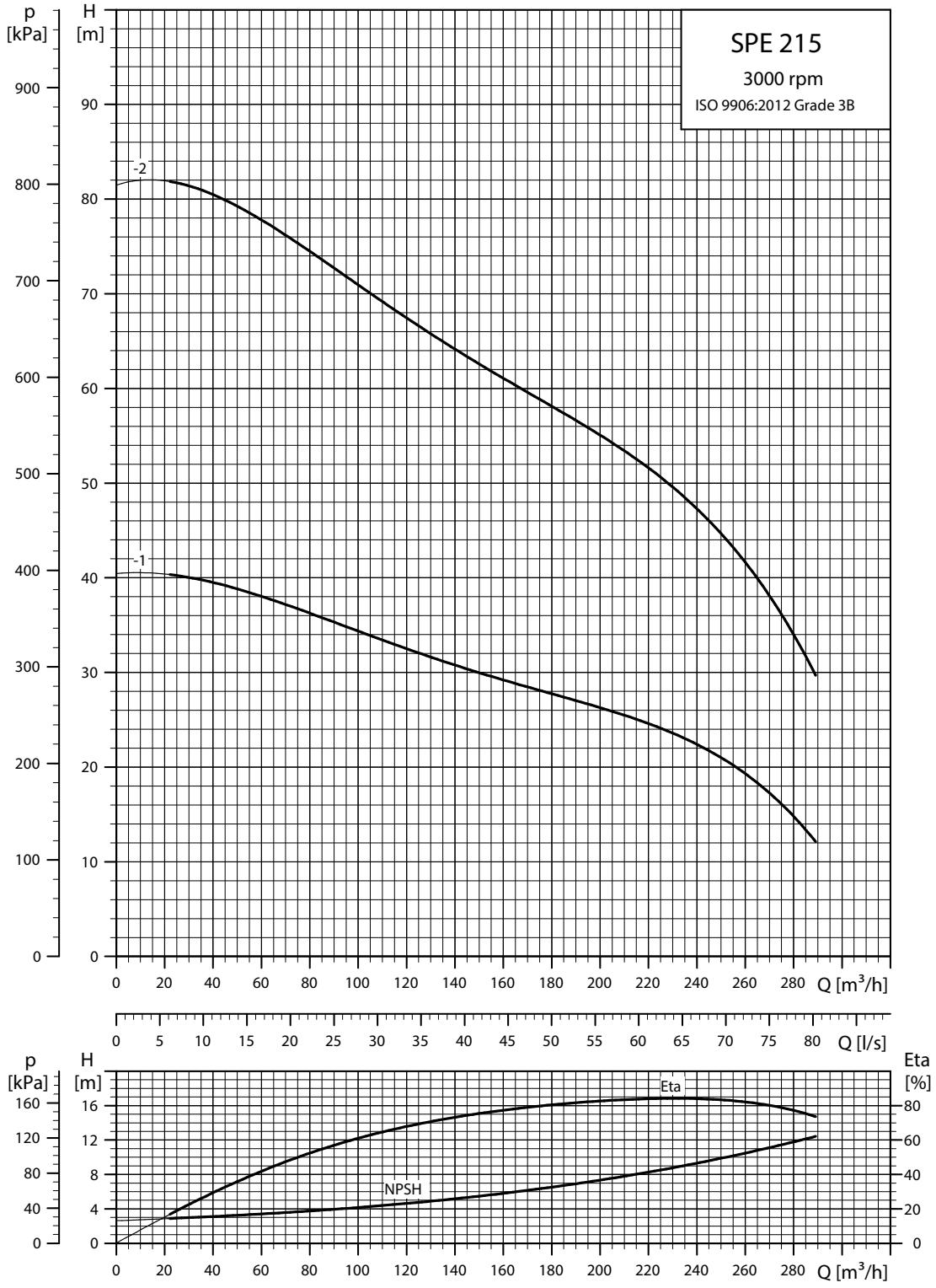
Power curves



TM076194

SPE 215

Performance curves

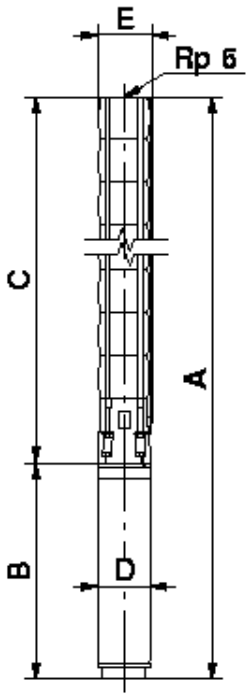


TM076195

Related information

How to read the curve charts

Dimensions and weights



TM008760

Pump type	Motor Power [kW]	Dimensions					Net weight [kg]
		C	B	A	D	E	
SPE 215-1	22	790	817	1607	139.5	236	100.0
SPE 215-2	45	966	947	1913	139.5	239 16)	125.0
The pump types above are also available in N- and R-versions. See Material specification (SPE 77 - SPE 215).							
Other types of connection are possible by means of connecting pieces. See Mechanical accessories.							

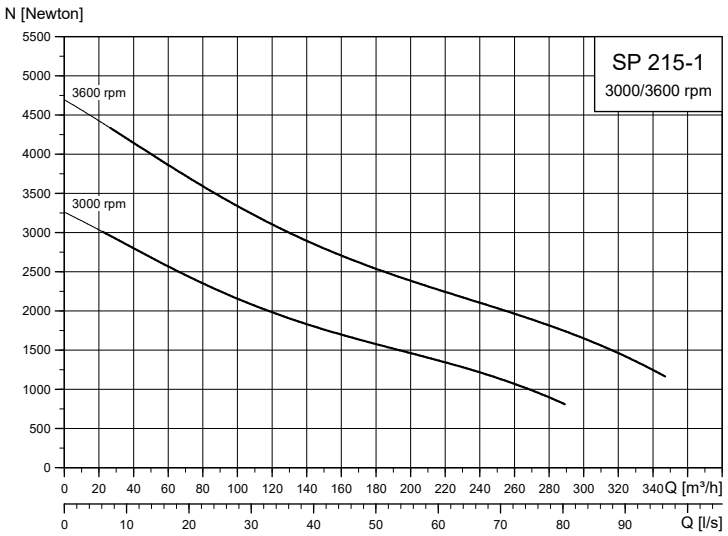
16) Maximum diameter of pump with two motor cables.

Related information

Material specification (SPE 77 - SPE 215)

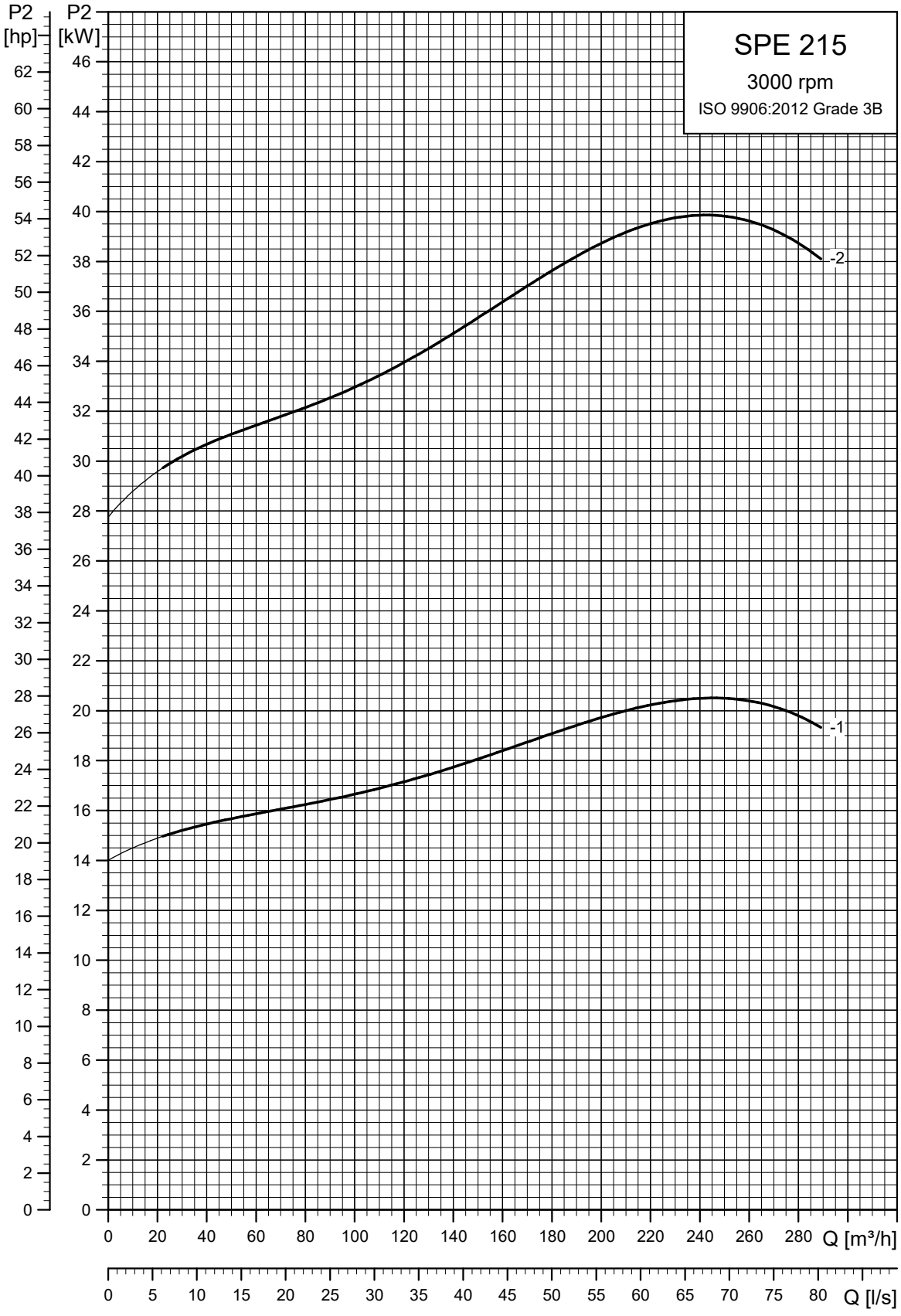
Connecting pieces / Adaptors

Single-stage curves, axial thrust



TM076268

Power curves



TM076196

8. Electrical data

3 × 350 V 3000 rpm, MS6000P submersible motors T60

Electrical data									Dimensions	
Power [kW]	Full-load current I_n [A]	Motor efficiency [%]			Power factor			$\frac{I_{st}}{I_n}$ [%]	Build in length [mm]	Weight [kg]
		η50 %	η75 %	η100 %	Cos φ 50 %	Cos φ 75 %	Cos φ 100 %			
4.0	9.6	83.6	87.4	89.2	0.98	0.96	0.95	100	547	32.9
5.5	12.6	86.8	89.3	90.3	0.97	0.94	0.92			
7.5	16.6	88.9	90.3	90.5	0.95	0.92	0.88			
9.2	21.4	88.2	90.8	91.8	0.98	0.96	0.94		667	46.3
11	25.0	89.6	91.6	92.2	0.97	0.95	0.93			
13	29.2	90.6	92.0	92.4	0.96	0.94	0.92			
15	33.4	91.2	92.2	92.4	0.94	0.91	0.88			
18.5	40.6	91.8	92.4	92.0	0.94	0.91	0.88			
22	46.2	91.6	92.7	92.8	0.96	0.93	0.91		817	61.3
26	54.0	92.2	92.8	92.6	0.95	0.92	0.90			
30	61.8	92.5	92.8	92.4	0.94	0.91	0.90			
37	85.6	91.5	92.3	92.2	0.92	0.89	0.86		947	76.2
45	103.0	92.0	92.3	91.9	0.90	0.87	0.85			

9. Electrical accessories

Accessories for CUE

MCB 114 sensor input module

MCB 114 offers the following additional analog inputs for CUE:

- 1 analog input, 0/4-20 mA
- 2 inputs for Pt100 and Pt1000 temperature sensors.

CIU communication interface units

TM078946

Grundfos CIU communication interface unit

The Communication Interface Unit (CIU) enables data communication through open and interoperable networks, such as:

- Profibus DP
- Profinet
- Modbus RTU
- Modbus TPC
- LonWorks
- BACnet MS/TP
- BACnet/IP
- EtherNet/IP
- Cellular connection
- GiC/GRM

Applications

The range of Grundfos communication interface offers easy installation and commissioning, as well as user-friendliness. All units are based on standard functional profiles for an easy integration into the network.

The CIM/CIU units enable communication of operating data, such as measured values and setpoints, between pumps and PLCs, SCADA system and building management system.

Benefits

CIM/CIU offers the following benefits:

- open communication standards
- complete process control
- one concept for Grundfos products
- 24-240 VAC/DC power supply in CIM/CIU modules
- simple configuration and easy to install
- prepared for DIN rail or wall mounting.

For data communication between an SP pump and a main network, a CIM/CIU has to be used with a Cue frequency converter, an MP 24 motor protector or an LC 232 and LC 242 level control unit.

TM080034

MP 204 motor protector, CUE frequency converter and LC 232/242 level control unit

Fieldbus support for products

Fieldbus protocol	CUE	MP 204	LC232	LC242	CIU 900/901	CIM module
GENI	Built in	Built in	CIM	CIM	-	CIM 050 - 96824631
LonWorks	CIM + CIU	-	-	-	CIU 900 - 99448387	CIM 100 - 96824797
PROFIBUS D	CIM + CIU	CIM + CIU	CIM	CIM	CIU 900 - 99448387	CIM 150 - 96824793
Modbus RTU	CIM + CIU	CIM + CIU	CIM	CIM	CIU 900 - 99448387	CIM 200 - 96824796
Cellular connection EU	CIM + CIU	CIM + CIU	CIM	CIM	CIU 900 - 99448387	CIM 260 - 99439302
Cellular connection US	CIM + CIU	CIM + CIU	CIM	CIM	CIU 900 - 99448387	CIM 260 - 99439306
GiC/GRM [17] EU	CIM + CIU	CIM + CIU	CIM	CIM	CIU 900 - 99448387	CIM 280 - 99439724
GiC/GRM [17] US	CIM + CIU	CIM + CIU	CIM	CIM	CIU 900 - 99448387	CIM 280 - 99439725
GiC/GRM [17] + extra I/O EU	CIM + CIU	CIM + CIU	-	-	CIU 901 - 99448389	CIM 280 - 99439724
GiC/GRM [17] + extra I/O US	CIM + CIU	CIM + CIU	-	-	CIU 901 - 99448389	CIM 280 - 99439725
BACnet MS/T	CIM + CIU	-	CIM	CIM	CIU 900 - 99448387	CIM 300 - 96893770
Profinet IO	CIM + CIU	CIM + CIU	CIM	CIM	CIU 900 - 99448387	CIM 500 - 98301408
Modbus TCP	CIM + CIU	CIM + CIU	CIM	CIM	CIU 900 - 99448387	CIM 500 - 98301408
BACnet TCP	CIM + CIU	-	CIM	CIM	CIU 900 - 99448387	CIM 500 - 98301408
EtherNet/IP	CIM + CIU	CIM + CIU	CIM	CIM	CIU 900 - 99448387	CIM 500 - 98301408
GiC/GRM [17]	CIM + CIU	CIM + CIU	CIM	CIM	CIU 900 - 99448387	CIM 500 - 98301408

[17] Grundfos iSOLUTIONS Cloud (GiC) and Grundfos Remote Management (GRM) are easy-to-install, low-cost solutions for wireless monitoring and management of Grundfos products.

If CIM and CIU are used together, then mount the CIM module inside CIU upon installation. For products with integrated CIM support, mount the CIM directly into the product during installation.

Antennas for CIU 260 and 280

Accessories	Product number	Description
Antenna for CIM 260/280 EU	99518079	puc antenna, 1.5 m cable
Optional battery for CIM 260/280 EU/US	99499908	to get alarm in case of power break

For further information about data communication through CIU and fieldbus protocols, see the CIU documentation available at *Grundfos Product Center*.

MS motor cables

See the following tables for information about additional motor cables.

Drinking water approval

TML-B cables are drinking water compatible with ACS and UBA approvals.

For more information on sizing cables, see Cable sizing.

The maximum permissible voltage drop in the motor cable is 3 %.

Always dimension motor cables that are not submerged in the pumped liquid as submersible drop cables.

Related information

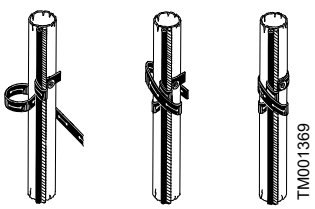
Cables

Submersible drop cable

TML-B motor cables EPR outer sheath (ethylene propylene rubber)			
Length [m]	Cross-section [mm²]	Product numbers	
		Plug steel grade	Plug steel grade R
10	4G 10.0	96164215	96300124
20		96164216	96300126
30		96164217	96300128
40		99522680	96300129
50		96164218	96300130

Product	Description	Number of leads and nominal cross-section [mm²]	Outer cable diameter min. / max. [mm]	Weight [kg/m]	Product number
 TM007882	Suitable for the following applications: continuous application in groundwater and water (approved for drinking water applications) connection of electrical equipment, such as submersible motors installation depths up to 600 metres and average loads. Insulation and sheath of special EPR-based elastomer materials adapted to applications in water. Maximum permissible water temperature: 70 °C. Maximum permissible lead service temperature: 90 °C. Further cable sizes are available on request.	1 × 25	12.5 / 16.5	0.410	00ID4072
		1 × 35	14.0 / 18.5	0.560	00ID4073
		1 × 50	16.5 / 21.0	0.740	00ID4074
		1 × 70	18.5 / 23.5	1.000	00ID4075
		1 × 95	21.0 / 26.5	1.300	00ID4076
		1 × 120	23.5 / 28.5	1.650	00ID4077
		1 × 150	26.0 / 31.5	2.000	00ID4078
		1 × 185	27.5 / 34.5	2.500	00ID4079
		4G1.5	10.5 / 13.5	0.190	00ID4063
		4G2.5	12.5 / 15.5	0.280	00ID4064
		4G4.0	14.5 / 18.0	0.390	00ID4065
		4G6.0	16.5 / 22.0	0.520	00ID4066
		4G10	22.5 / 24.5	0.950	00ID4067
		4G16	26.5 / 28.5	1.400	00ID4068
		4G25	32.0 / 34.0	1.950	00ID4069
		4G35	33.0 / 42.5	2.700	96432949
		4G50	38.0 / 48.5	3.600	96432950
		4G70	43.0 / 54.5	4.900	96432951

Cable clips

Product	Description	Product number
 TM001369	For fastening of the cable and straining wire to the riser pipe. The clips must be fitted every 3 metres. One set for approximately 45 m riser pipe. • 16 cable buttons. • 7.5 m rubber band.	00115016

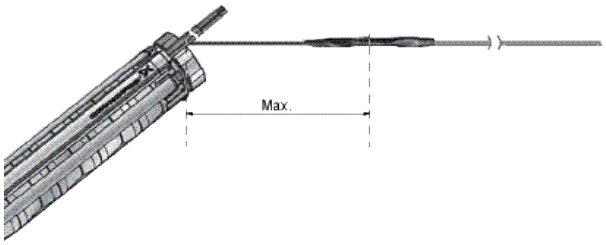
Cable termination kit, type KM

For instruction on how to make the cable termination between motor cable and drop cable, see the KM quick guide available in Grundfos Product Center at http://net.grundfos.com/qr/i/V7065924.

Grundfos recommendation

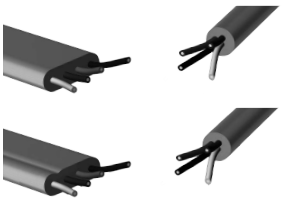
First termination of motor cable and drop cable should be placed maximum 1/2 meters above the pump end.

Do not attempt to join two cables that have a larger cross-section span than stated in the following table.

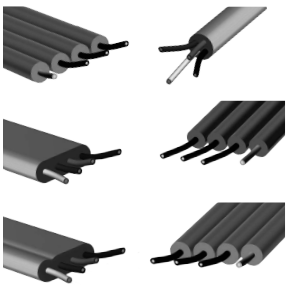


TM069876

Motor cable [mm²]	Drop cable, maximum increase per step. [mm²]			
6.0	16.0	35.0	70.0	150.0
10.0	25.0	50.0	120.0	240.0
16.0	50.0	120.0	240.0	-
25.0	70.0	150.0	240.0	-
35.0	70.0	150.0	240.0	-
50.0	120.0	240.0	-	-
70.0	150.0	240.0	-	-

Possible cable termination	Content of kit	Motor cable [mm²]	Drop cable [mm²]	Number of leads	Product number
		KM kits with pressed connections:			
		6-16	6-16	4	00116252
		10-25	10-25	4	00116255
		KM kits with screw connectors:			
		6-35	6-35	4	96636867
		25-70	25-70	4	96636868

TM059986

		KM kits with pressed connections:			
		6-16	6-16	4	00116258
		10-50	10-50	4	96637330
		16-70	16-70	4	96637332
		1.5 - 6	1.5 - 6	3	00116253
		10-25	10-25	3	00116254
		10-50	10-50	3	96637318
		16-70	16-70	3	96637331

TM059985

		KM kits with pressed connections:			
		10-70	10-70	1	96828296
		32-120	32-120	1	00116256
		KM kits with screw connectors:			
		90-240	90-240	1	96637279

TM059987

Note: KM termination kit for single conductors only consist of material for one connection. When ordering, keep in mind how many kits are needed for a complete cable termination.

Product	Description	Version		
		Cross-section of leads [mm²]	Number of connectors	Product number
	Screw connector kit.	6-25	4	96626021
		16-95		96626022
		35-185		96626023
		70-240		96626028

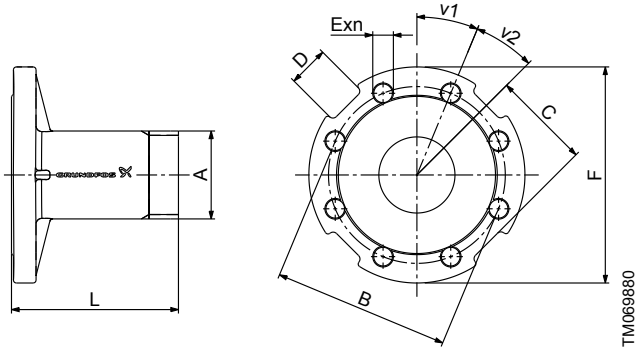
GRA8251

10. Mechanical accessories

Connecting pieces / Adaptors

The tables below show the range of connecting pieces for connection of thread-to-flange and thread-to-thread.

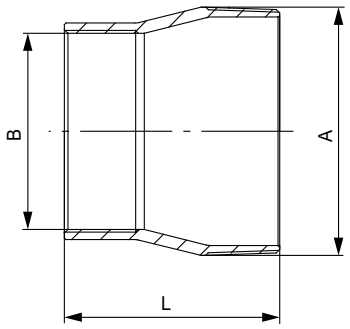
Thread-to-flange (standard flange to EN 1092-1)



Dimensional sketch and photo of the connecting piece thread-to-flange

Type	Pump outlet	Connecting piece	Thread-to-flange										Product number	
			A	Dimensions [mm]						v1	v2	n		
				B	C	D	E	F	L				EN 1.4308	EN 1.4517
SP 18	Rp 2 1/2	R 2 1/2 → DN 50 PN 16/40	R 2 1/2	125	65	40	Ø19	Ø165	170	30	30	4	00120125	00120911
		R 2 1/2 → DN 65 PN 16/40	R 2 1/2	145	71	30	Ø19	Ø185	170	22.5	22.5	8	00120126	00120910
		R 2 1/2 → DN 80 PN 16/40	R 2 1/2	160	82.5	40	Ø19	Ø200	170	22.5	22.5	8	00120127	00120909
SP 30 SP 46 SP 60	Rp 3	R 3 → DN 65 PN 16/40	R 3	145	71	30	Ø19	Ø185	170	22.5	22.5	8	00130187	00130920
		R 3 → DN 80 PN 16/40	R 3	160	82.5	40	Ø19	Ø200	170	22.5	22.5	8	00130188	00130921
		R 3 → DN 100 PN 40	R 3	190	100	40	Ø23	Ø235	170	22.5	22.5	8	00130189	00130922
		R 3 → DN 100 PN 16	R 3	180	100	40	Ø19	Ø220	170	22.5	22.5	8	00130210	00130867
SP 46 SP 60	Rp 4	R 4 → DN 100 PN 16	R 4	180	100	40	Ø19	Ø235	180	22.5	22.5	8	00140077	00140737
		R 4 → DN 100 PN 40	R4	190	100	40	Ø23	Ø235	180	22.5	22.5	8	00140071	00140577
SP 77 SP 95	Rp 5	R 5 → DN 100 PN 16	R 5	180	82	35	Ø19	Ø220	195	22.5	22.5	8	00160159	00160657
		R 5 → DN 100 PN 40	R 5	190	82	35	Ø23	Ø235	195	22.5	22.5	8	00160148	00160646
		R 5 → DN 125 PN 16	R 5	210	99	37	Ø19	Ø250	195	22.5	22.5	8	00160157	00160655
		R 5 → DN 125 PN 40	R 5	220	99	37	Ø28	Ø270	195	22.5	22.5	8	00160149	00160647
		R 5 → DN 150 PN 16	R 5	240	115	36	Ø23	Ø285	195	22.5	22.5	8	00160161	00160659
		R 5 → DN 150 PN 40	R 5	250	115	36	Ø28	Ø300	195	22.5	22.5	8	00160150	00160648
SP 125 SP 160 SP 215	Rp 6	R 6 → DN 125 PN 16	R 6	210	99	36	Ø19	Ø250	195	22.5	22.5	8	00170170	00170694
		R 6 → DN 125 PN 40	R 6	220	99	36	Ø28	Ø270	195	22.5	22.5	8	00170159	00170596
		R 6 → DN 150 PN 16	R 6	240	114	36	Ø23	Ø285	195	22.5	22.5	8	98518437	98518487
		R 6 → DN 150 PN 40	R 6	250	114	36	Ø28	Ø300	195	22.5	22.5	8	00170160	00170597
		R 6 → DN 200 PN 16	R 6	295	134	36	Ø23	Ø340	195	15	15	12	00170161	00170598
		R 6 → DN 200 PN 40	R 6	320	151	36	Ø31	Ø375	200	15	15	12	00170162	00170599

Thread-to-thread



TM012397

TM069783

Dimensional sketch and photo of a connecting piece thread-to-thread

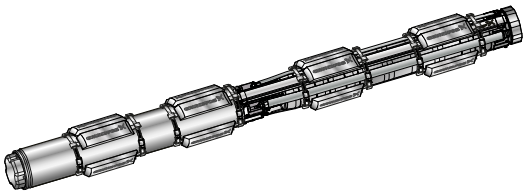
Type	Pump outlet	Connecting piece	Dimensions			Product number		
			Thread-to-thread		L [mm]			
			A	B		EN 1.4301	EN 1.4401	EN 1.4539
SP 77 SP 95	Rp 5	R 5 → Rp 4	R 5	Rp 4	121	00190063	00190585	96917293
		R 5 → Rp 6	R 5	Rp 6	150	00190069	00190591	96917296
	5" NPT	5" NPT → 4" NPT	5" NPT	4" NPT	121	00190064	00190586	00190964
		5" NPT → 6" NPT	5" NPT	6" NPT	150	00190070	00190592	00190965
SP 125 SP 160 SP 215	Rp 6	R 6 → Rp 5	R 6	Rp 5	150	00200130	00200640	00200971
	6" NPT	6" NPT → 5" NPT	6" NPT	5" NPT	150	00200135	00200645	00200970

Zinc anodes

Application

Cathodic protection by means of zinc can be used for corrosion protection of SP pumps in chloride-containing liquids, such as brackish water and seawater.

Sacrificial anodes are placed on the outside of the pump and motor as protection against corrosion. See the figure below



TM078808

Submersible motor fitted with anode strings

The number of anodes required depends on the pump and motor in question.

Please contact Grundfos for further details.

Flow sleeves

Grundfos offers a complete range of stainless-steel flow sleeves for both vertical and horizontal operation. We recommend flow sleeves for all applications in which motor cooling is insufficient. The result is a general extension of motor life. Flow sleeves are to be fitted in these cases:

- If the submersible pump is exposed to a high thermal load such as current unbalance, dry running, overload, high ambient temperature, and bad cooling conditions.
- If aggressive liquids are pumped, since corrosion is doubled for every 10 °C the temperature rises.
- If sedimentation or deposits occur around and/or on the motor.

See example

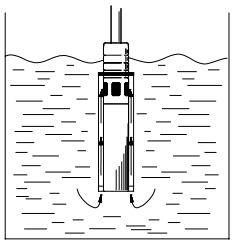
More information about flow sleeves and product numbers are available in SP accessories data booklet.

TM080215

Flow sleeves

Example of calculated flow sleeve

The flow sleeve is fitted to the submersible motor so that the liquid passes close by the motor on its way towards the pump suction interconnector, thus ensuring optimum cooling of the motor. See fig. Flow sleeve function.



TM010509

Flow sleeve function

The flow sleeve is designed so that the flow velocity past the motor is minimum 0.5 m/s and maximum 3 m/s to ensure optimum pump operating conditions.

Use this formula to calculate the flow velocity:

$$V = \frac{Q \times 353}{D^2 - d^2} \quad [m/s]$$

Q	m^3/h	Flow rate
D	mm	Sleeve diameter
d	mm	Pump diameter

11. Certificates

Grundfos SPE offers a number of certificates and reports.

In case a certificate or a report is needed, the request must be stated on the order.

The certificate or the report is then put into the bill of materials and included in the product documentation.

Certificates or reports have to be confirmed for each order.

SPE certificates

Part number	Description
96507896	Test certificate non- specified. Inspection + test
96507897	Inspection certificate internal
96699829	Inspection certificate 3rd party
96507928	Material specification report
96507934	Cleaned and dried pump report
96507895	Certificate of compliance with the order
96507930	Report Pump curve test - Grade 3B

ISO 9906: 2012 test report

Test reports and certifications for Grundfos pumps are from state-of-the-art test facilities.

Grundfos supplies different acceptance grades evaluated case-by-case by the SSE team and the result is communicated to sales.

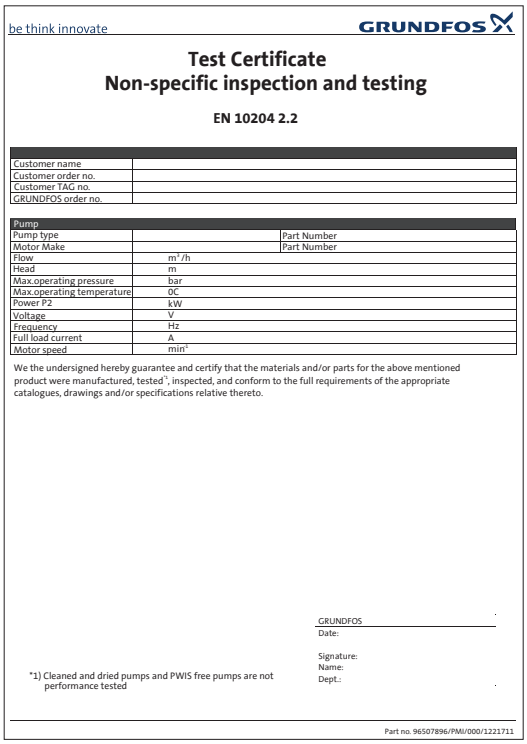
Part number	Test report
98578602 96539699	Witness test + Duty point verification report - Grade 3B, Q&H
96539699	Duty point verification report - Grade 3B, Q&H
99542665	Duty point verification report - Grade 3B, Q&H+eta total
99542666	Duty point verification report - Grade 3B, Q&H+P1
98578602 98777781	Witness test + Duty point verification report - Grade 2B, Q&H
98777781	Duty point verification report - Grade 2B, Q&H
99542667	Duty point verification report - Grade 2B, Q&H+eta total
99542668	Duty point verification report - Grade 2B, Q&H+P1
98578602 99542669	Witness test + Duty point verification report - Grade 2U, Q&H
99542669	Duty point verification report - Grade 2U, Q&H
99542670	Duty point verification report - Grade 2U, Q&H+eta total
99542671	Duty point verification report - Grade 2U, Q&H+P1
98578602 99542672	Witness test + Duty point verification report - Grade 1B, Q&H
99542672	Duty point verification report - Grade 1B, Q&H
99542673	Duty point verification report - Grade 1B, Q&H+eta total
99542675	Duty point verification report - Grade 1B, Q&H+P1
98578602 99542676	Witness test + Duty point verification report - Grade 1E, Q&H
99542676	Duty point verification report - Grade 1E, Q&H
99542677	Duty point verification report - Grade 1E, Q&H+eta total
99542678	Duty point verification report - Grade 1E, Q&H+P1
98578602 99542680	Witness test + Duty point verification report - Grade 1U, Q&H
99542680	Duty point verification report - Grade 1U, Q&H
99542682	Duty point verification report - Grade 1U, Q&H+eta total
99542693	Duty point verification report - Grade 1U, Q&H+P1

ISO 9906: 2012 tolerance factors

	Grade 1			Grade 2		Grade 3	
	1U	1E	1B	2B	2U	3B	
Flow rate [τ_Q]	+10 %	± 5 %	± 5 %	± 8 %	± 16 %	± 9 %	Mandatory
Head [τ_H]	+6 %	± 3 %	± 3 %	± 5 %	± 10 %	± 7 %	
Efficiency [τ_η]	≥ 0 %	≥ 0 %	-3 %	-5 %	-5 %	-7 %	Optional

Example of certificate

Test certificate non- specified. Inspec+test



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GRUNDFOS

Test Certificate
Non-specific inspection and testing

EN 10204 2.2

Customer name	
Customer order no.	
Customer TAG no.	
GRUNDFOS order no.	

Pump		
Pump type		Part Number
Motor Make		Part Number
Flow	m^3/h	
Head	m	
Max.operating pressure	bar	
Max.operating temperature	0C	
Power P2	kW	
Voltage	V	
Frequency	Hz	
Full load current	A	
Motor speed	min^{1}	

We the undersigned hereby guarantee and certify that the materials and/or parts for the above mentioned product were manufactured, tested*), inspected, and conform to the full requirements of the appropriate catalogues, drawings and/or specifications relative thereto.

GRUNDFOS
Date:

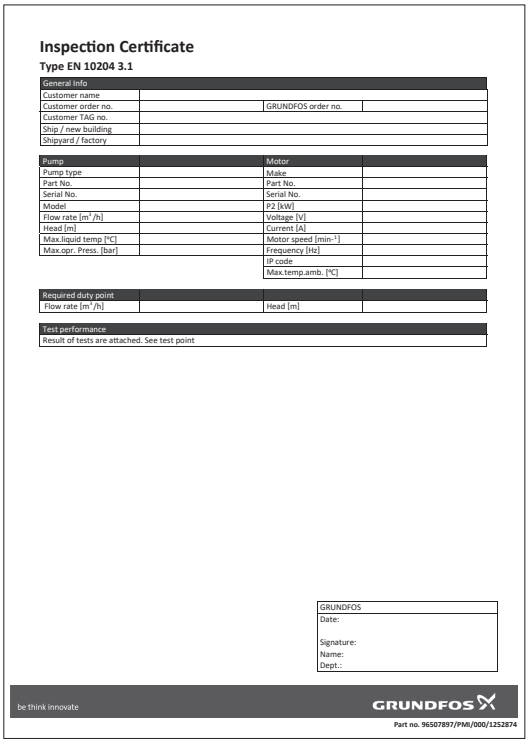
Signature:
Name:
Dept.:

*1) Cleaned and dried pumps and PWIS free pumps are not performance tested

Part no. 96507896/PMI/000/1221711

TM034163

Inspection certificate internal



Inspection Certificate

Type EN 10204 3.1

General Info			
Customer name			
Customer order no.		GRUNDFOS order no.	
Customer TAG no.			
Ship / new building			
Shipyard / factory			

Pump		Motor	
Pump type		Make	
Part No.		Part No.	
Serial No.		Serial No.	
Model		P2 [kW]	
Flow rate [m^3/h]		Voltage [V]	
Head [m]		Current [A]	
Max.liquid temp [°C]		Motor speed [min^{-1}]	
Max.opr. Press. [bar]		Frequency [Hz]	
		IP code	
		Max.temp.amb. [°C]	

Required duty point			
Flow rate [m^3/h]		Head [m]	

Test performance
Result of tests are attached. See test point

GRUNDFOS
Date:
Signature:
Name:
Dept.:

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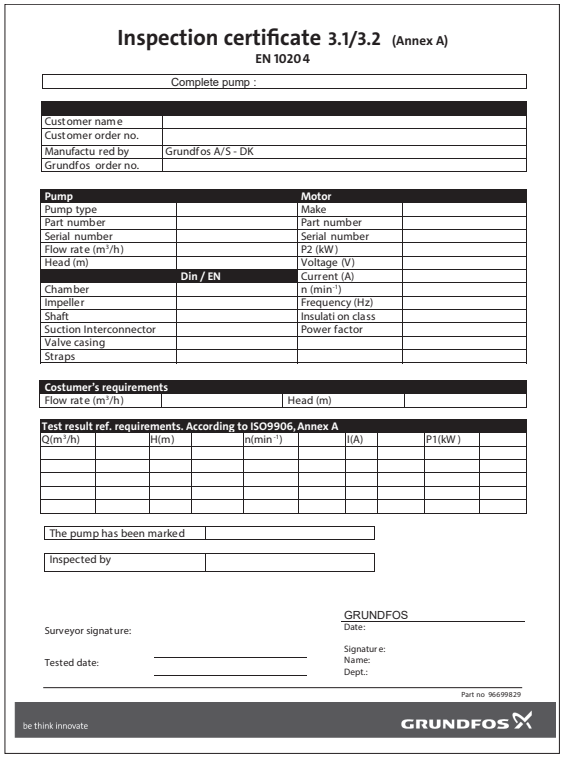
GRUNDFOS

Part no. 96507897/PMI/000/1252874

TM060200

Inspection certificate 3rd party



Inspection certificate 3.1/3.2 (Annex A)
EN 10204

Complete pump :

Customer name	
Customer order no.	
Manufactu red by	Grundfos A/S - DK
Grundfos order no.	

Pump		Motor	
Pump type		Make	
Part number		Part number	
Serial number		Serial number	
Flow rate (m^3/h)		P2 (kW)	
Head (m)		Voltage (V)	
	Din / EN	Current (A)	
Chamber		n (min^{-1})	
Impeller		Frequency (Hz)	
Shaft		Insulati on class	
Suction Interconnector		Power factor	
Valve casing			
Straps			

Costumer's requirements			
Flow rate (m^3/h)		Head (m)	

Test result ref. requirements. According to ISO9906, Annex A									
Q(m^3/h)		H(m)		n(min^{-1})		I(A)		P1(kW)	

The pump has been marked	

Inspected by	

Surveyor signature:

Tested date:

GRUNDFOS
Date:

Signature:
Name:
Dept.:

Part no 96699829

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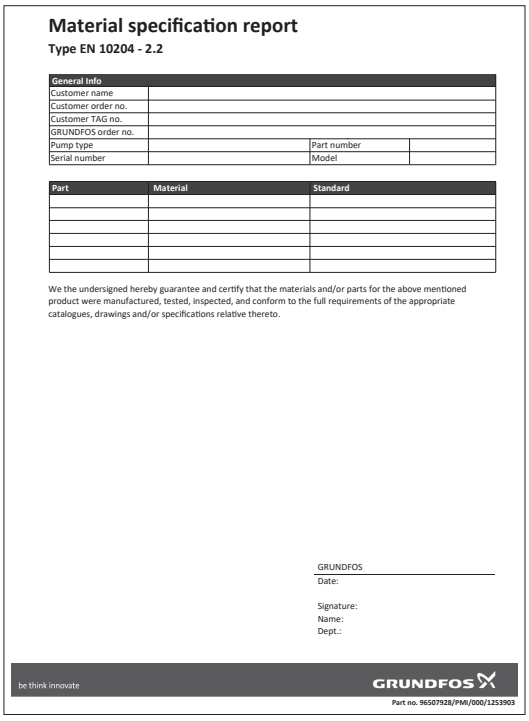
GRUNDFOS

TM073153

Material specification report



Material specification report

Type EN 10204 - 2.2

General Info			
Customer name			
Customer order no.			
Customer TAG no.			
GRUNDFOS order no.			
Pump type		Part number	
Serial number		Model	

Part	Material	Standard

We the undersigned hereby guarantee and certify that the materials and/or parts for the above mentioned product were manufactured, tested, inspected, and conform to the full requirements of the appropriate catalogues, drawings and/or specifications relative thereto.

GRUNDFOS
Date:

Signature:
Name:
Dept.:

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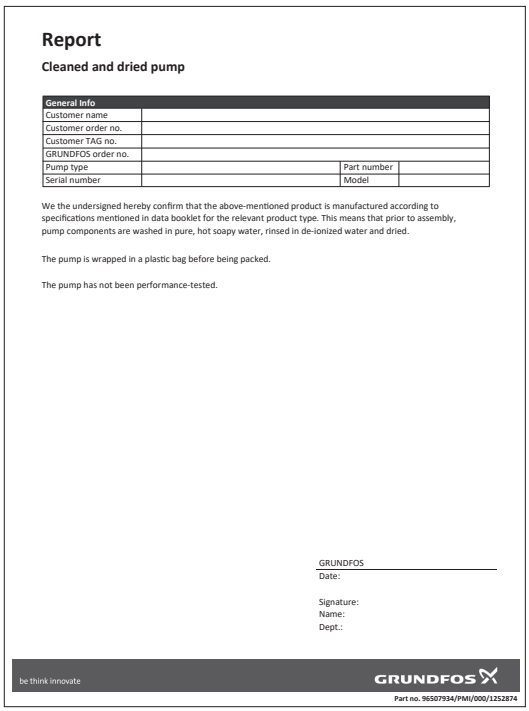
GRUNDFOS

Part no. 96507928/PMI/000/1253903

TM034150

Cleaned and dried pump report

Certificate of compliance with the order



Report

Cleaned and dried pump

General Info			
Customer name			
Customer order no.			
Customer TAG no.			
GRUNDFOS order no.			
Pump type		Part number	
Serial number		Model	

We the undersigned hereby confirm that the above-mentioned product is manufactured according to specifications mentioned in data booklet for the relevant product type. This means that prior to assembly, pump components are washed in pure, hot soapy water, rinsed in de-ionized water and dried.

The pump is wrapped in a plastic bag before being packed.

The pump has not been performance-tested.

GRUNDFOS
Date:

Signature:
Name:
Dept.:

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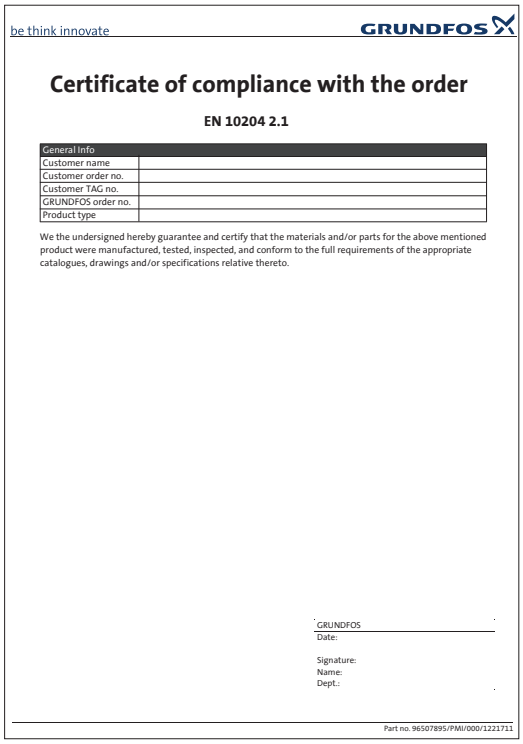
Part no. 96507934/PMI/000/1252874

TM034145



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Certificate of compliance with the order

EN 10204 2.1

General Info	
Customer name	
Customer order no.	
Customer TAG no.	
GRUNDFOS order no.	
Product type	

We the undersigned hereby guarantee and certify that the materials and/or parts for the above mentioned product were manufactured, tested, inspected, and conform to the full requirements of the appropriate catalogues, drawings and/or specifications relative thereto.

GRUNDFOS
Date:

Signature:
Name:
Dept.:

Part no. 96507895/PMI/000/1221711

TM034165

Example of test report

ISO 9906:2012 test report - F. SP pump Grade 3B

Test Report for SP Pump

ISO 9906: 2012 Grade 3B

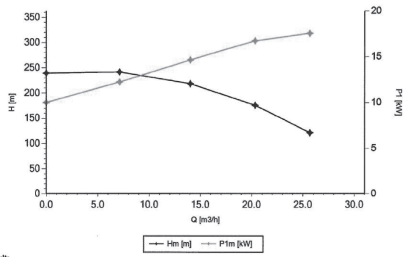
Customer:
Order Number:
Operator:
Certificate Part Number: 96643427

Serial number: 98357225p312410001
Date: 18/10/2012 13:38
Testbed: 508276

Pump type: SP1715 RP 2 1/2
Product Number: 98357225

Motor manufacturer MS6000

Measured values for tested pump



Result:

	Qm [m3/h]	Hm [m]	n [1/min]	η_total [%]	EsQ [kW/m3/h]	EsQH [kW/m3/h/m]
Point 1	25.67	121.05	3457	48	0.68	0.0057
Point 2	20.32	176.02	3463	58	0.82	0.0047
Point 3	14.02	218.39	3479	57	1.05	0.0048
Point 4	7.13	241.53	3500	38	1.72	0.0071
Point 5	0.00	239.45	3519	0	0.00	0

	U1 [V]	U2 [V]	U3 [V]	f [Hz]	I_Avg [A]	I1 [A]	I2 [A]	I3 [A]	Cos(ϕ)	P1m [kW]
Point 1	441.0	439.0	439.0	60	26.78	27.04	26.94	26.35	0.86	17.56
Point 2	441.0	439.0	440.0	60	25.64	25.82	25.81	25.30	0.86	16.75
Point 3	440.0	439.0	439.0	60	22.81	22.99	22.92	22.51	0.84	14.65
Point 4	441.0	439.0	440.0	60	19.67	19.90	19.61	19.49	0.81	12.23
Point 5	440.0	439.0	440.0	60	16.92	17.03	16.86	16.88	0.78	10.01

GRUNDFOS

TM072188

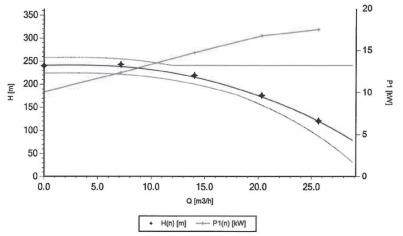
Test Report for SP Pump

ISO 9906: 2012 Grade 3B

Customer:
Order Number:
Operator:
Certificate Part Number: 96643427

Serial number: 98357225p312410001
Date: 18/10/2012 13:38
Testbed: 508276

Measured values calculated to nominal speed n_nom



Result:

	Q(n) [m3/h]	H(n) [m]	P1(n) [kW]	n_nom [1/min]
Point 1	25.63	120.75	17.59	3462.83
Point 2	20.32	176.00	16.75	3462.9
Point 3	14.04	219.12	14.73	3484.89
Point 4	7.15	242.99	12.35	3510.61
Point 5	0.00	240.16	10.06	3524.24

GRUNDFOS

TM072189

Test Report for SP Pump

ISO 9906: 2012 Grade 3B

Customer:
Order Number:
Operator:
Certificate Part Number: 96643427

Serial number: 98357225p312410001
Date: 18/10/2012 13:38
Testbed: 508276

Measured values

U	=	Voltage	Cos(ϕ)	=	Power factor
f	=	Frequency	n	=	Speed
I_Avg	=	Average current			
Qm	=	Measured flow			
Hm	=	Measured Total Head			
P1m	=	Measured Motor Power Input			

Calculated values

Q(n)	=	Flow at nominal speed	η_total	=	Total Efficiency
H(n)	=	Total Head at nominal speed	η_pump	=	Pump efficiency
P1(n)	=	Motor Power Input at norminal speed	EsQ	=	Specific energy consumption
			EsQH	=	Specific energy consumption

Formulas

Q(n)	=	Qm x (n_nom/n)	H	=	Head_Sta + Head_Dyn + Head_Geo + Head_J
H(n)	=	Hm x (n_nom/n)²	Head_Static	=	Static Pressure head
P1(n)	=	P1m x (n_nom/n)³	Head_Dyn	=	Dynamic head
η_total	=	(ρ x Qm x Hm x g) / P1m	Head_Geo	=	Geometric elevation head
η_pump	=	η_total / η_motor	Head_J	=	Friction head
EsQ	=	P1m / Qm	EsQH	=	P1m / Qm / Hm

Legend and test conditions:

- Measurements were made with airless water at approximately 20 °C and a kinematic viscosity of 1mm²/s (= 1 cSt)
- The test bed is calibrated according to ISO 9001

Calibration Date:

Test Facility:

Grundfos Danmark
GL. Viborgvej 79
Aalestrup
9620
Danmark
Phone:
Fax:

Tested Date

Signed by

24/01/2013 13:02:04
www.grundfos.com

GRUNDFOS

TM072190

12. Cable sizing

Cables

Grundfos offers 4-core cable and single conductors as submersible drop cables for all applications. The submersible drop cable is chosen according to application and type of installation. See Submersible drop cable.

Tables indicating cable dimension in borehole

The tables indicate the maximum length of drop cables in metres from motor starter to pump at direct-on-line starting at different cable dimensions.

If, for example, the operating current is 10 % lower than the full-load current, the cable can be 10 % longer than indicated in the tables.

The calculation of the cable length is based on a maximum voltage drop of 1 % to 3 % of the rated voltage and a water temperature of maximum 30 °C.

In order to minimise operating losses, the cable cross-section may be increased compared to what is indicated in the tables. This is only economical if the following apply:

- Borehole provides the necessary space.
- Operational time of the pump is long.
- Operating voltage is below the rated voltage.

A cable sizing tool is available on Grundfos insite at https://www.grundfos.com/sp-system/download-sp-app.html.

TM076259

Cable sizing tool

The values of the cable sizing tool are calculated on the basis of the formula for maximum cable length for a three-phase submersible pump.

Formula:

$$L = \frac{U \times \Delta U}{I \times 1.73 \times 100 \times \left(\cos\varphi \times \frac{\rho}{q} + \sin\varphi \times X_L\right)} [m]$$

A prerequisite for using the formulas is that the current is sinusoidal, which requires the use of a working sine wave filter.

Related information

Submersible drop cable

Formula designations

U	=	Rated voltage [V]
ΔU	=	Voltage drop [%]
I	=	Rated current of the VFD [A]
cos φ	=	Power factor
ρ	=	Specific resistance: 0.025 [Ω mm^2]
q	=	Cross-section of submersible drop cable [mm^2]
sin φ	=	$\sqrt{1 - \cos^2\varphi}$
X_L	=	Inductive resistance: 0.078 × 10^{-3} [Ω/m].

Example

Motor size:	30 kW, MS6000P
Starting method:	Direct-on-line
Rated voltage (U):	3 × 380 V
Voltage drop (ΔU):	3 %
Rated current (I):	64.0 A
Power factor (cos φ):	0.90
Specific resistance (ρ):	0.025
Cross-section (q):	25 mm^2
sin φ:	0.54
Inductive resistance (X_L):	0.078 x 10^{-3} [Ω/m]

$$L = \frac{380 \times 3}{64.0 \times 1.73 \times 100 \times \left(0.909 \times \frac{0.025}{25} + 0.54 \times 0.078 \times 10^{-3}\right)}$$

L = 112 m.

Calculation of cable cross-section

Formula designations

U	=	Rated voltage [V]
ΔU	=	Voltage drop [%]
I	=	Rated current of the VFD [A]
cos φ	=	Power factor
ρ	=	$1/\chi$ Materials of cable: Copper: χ = 40 m/Ω x mm^2
q	=	Cross-section [mm^2]
sin φ	=	$\sqrt{1 - \cos^2\varphi}$
X_L	=	Inductive resistance 0.078 × 10^{-3} [Ω/m]
L	=	Length of cable [m]
Δp	=	Power loss [W].

For calculation of the cross-section of the submersible drop cable, use the following formulas:

Single plug motor

$$q = \frac{I \text{ x } 1.73 \text{ x } 100 \text{ x } L \text{ x } \rho \text{ x } \cos\varphi}{U \text{ x } \Delta U - (I \text{ x } 1.73 \text{ x } 100 \text{ x } L \text{ x } X_L \text{ x } \sin\varphi)}$$

Two-plug motor

$$q = \frac{I \text{ x } 100 \text{ x } L \text{ x } \rho \text{ x } \cos\varphi}{U \text{ x } \Delta U - (I \text{ x } 100 \text{ x } L \text{ x } X_L \text{ x } \sin\varphi)}$$

The values of the rated current (I) and the power factor (cos φ) are shown in the tables at Cable dimensions at 3 x 380 V, 100 Hz motor supply, valid for use of TML-B cables.

Related information

Cable lengths at 3 × 350 V, 100 Hz motor supply, valid for use of TML-B cables.

Calculation of the power loss

For calculation of the power loss in the submersible drop cable, use the following formula:

$$\Delta\rho = \frac{3 \text{ x } L \text{ x } \rho \text{ x } I^2}{q}$$

Example

Motor size:	30 kW MS6000P
Voltage:	3 × 380 V, 50 Hz
Starting method:	Direct-on-line
Rated current (I_n):	64.0 A
Required cable length (L):	112 m
Water temperature:	30 °C.

Cable selection

Choice A:	3 × 25 mm^2.
Choice B:	3 × 35 mm^2.

Calculation of power loss

Choice A

$$\Delta p_A = \frac{3 \text{ x } L \text{ x } \rho \text{ x } I^2}{q}$$

$$\Delta p_A = \frac{3 \text{ x } 112 \text{ x } 0.02 \text{ x } 64.0^2}{25}$$

$$\Delta p_A = 1101 \text{ W}$$

Choice B

$$\Delta p_B = \frac{3 \text{ x } 112 \text{ x } 0.02 \text{ x } 64.0^2}{35}$$

$$\Delta p_B = 786 \text{ W}$$

Savings

Operating hours/year: h = 4000.

Annual saving (A):

A = (Δp_A - Δp_B) × h = (1101 W - 786 W) × 4000 = 1260000 Wh = 1260 kWh.

By choosing the cable size 3 × 35 mm^2 instead of 3 × 25 mm^2, an annual saving of 1260 kWh can be achieved.

Operating time: 10 years.

Saving after 10 years (A_{10}):

A_{10} = A × 10 = 1260 × 10 = 12600 kWh.

The saved amount must be calculated in the local currency.

Cable lengths at 3 × 350 V, 100 Hz motor supply, valid for use of TML-B cables.

Voltage drop: 3 %.

Maximum cable length from sine wave filter to pump, expressed in metres:

kW	I_n [A]	Cos φ 100 %	Dimensions [mm²]														
			1.5	2.5	4	6	10	16	25	35	50	70	95	120	150	185	240	300
4.0	9.6	0.95	40	66	106	158	283	417	645									
5.5	12.6	0.92	31	52	83	125	207	328	507	700	982							
7.5	16.6	0.88	25	41	66	99	163	259	399	549	766							
9.2	21.4	0.94	18	30	48	72	119	190	293	406	571	783						
11	25.0	0.93		26	42	62	103	164	253	350	492	673	888					
13	29.2	0.92		23	36	54	89	142	219	302	424	579	762	935				
15	33.4	0.88			33	49	81	129	198	273	381	517	676	825	989			
18.5	40.6	0.88			27	40	67	106	163	225	313	425	557	678	814	958		
22	46.2	0.91				34	57	90	139	193	270	368	483	592	714	846		
26	54.0	0.90					49	78	120	166	232	316	415	507	611	722	880	
30	61.8	0.90					43	68	105	145	203	276	363	443	534	631	769	901
37 [18)]	85.6	0.86					65	102	158	217	302	409	533	648	774	909		
45 [18)]	103.0	0.85					54	86	132	182	253	342	445	540	645	756	909	
Max. current for cable [A] at 30 °C ambient temperature			23	30	41	53	74	99	131	162	202	250	301	352	404	461	547	633

[18)] For 37 and 45 kW, the calculated lengths are for parallel cabling

13. Table of head losses

Head losses in ordinary water pipes

Upper figures indicate the velocity of water in m/sec.

Lower figures indicate head loss in metres per 100 metres of straight pipes.

Quantity of water			Head losses in ordinary water pipes										
			Nominal pipe diameter in inches and internal diameter in [mm]										
m^3/h	Litres/min.	Litres/sec.	1/2"	3/4"	1"	1 1/4"	1 1/2"	2"	2 1/2"	3"	3 1/2"	4"	5"	6"
			15.75	21.25	27.00	35.75	41.25	52.50	68.00	80.25	92.50	105.0	130.0	155.5
0.6	10	0.16	0.855	0.470	0.292									
			9.910	2.407	0.784									
0.9	15	0.25	1.282	0.705	0.438	0.249								
			20.11	4.862	1.570	0.416								
1.2	20	0.33	1.710	0.940	0.584	0.331	0.249							
			33.53	8.035	2.588	0.677	0.346							
1.5	25	0.42	2.138	1.174	0.730	0.415	0.312							
			49.93	11.91	3.834	1.004	0.510							
1.8	30	0.50	2.565	1.409	0.876	0.498	0.374	0.231						
			69.34	16.50	5.277	1.379	0.700	0.223						
2.1	35	0.58	2.993	1.644	1.022	0.581	0.436	0.269						
			91.54	21.75	6.949	1.811	0.914	0.291						
2.4	40	0.67		1.879	1.168	0.664	0.499	0.308						
				27.66	8.820	2.290	1.160	0.368						
3.0	50	0.83		2.349	1.460	0.830	0.623	0.385	0.229					
				41.40	13.14	3.403	1.719	0.544	0.159					
3.6	60	1.00		2.819	1.751	0.996	0.748	0.462	0.275					
				57.74	18.28	4.718	2.375	0.751	0.218					
4.2	70	1.12		3.288	2.043	1.162	0.873	0.539	0.321	0.231				
				76.49	24.18	6.231	3.132	0.988	0.287	0.131				
4.8	80	1.33			2.335	1.328	0.997	0.616	0.367	0.263				
					30.87	7.940	3.988	1.254	0.363	6.164				
5.4	90	1.50			2.627	1.494	1.122	0.693	0.413	0.269				
					38.30	9.828	4.927	1.551	0.449	0.203				
6.0	100	1.67			2.919	1.660	1.247	0.770	0.459	0.329	0.248			
					46.49	11.90	5.972	1.875	0.542	0.244	0.124			
7.5	125	2.08			3.649	2.075	1.558	0.962	0.574	0.412	0.310	0.241		
					70.41	17.93	8.967	2.802	0.809	0.365	0.185	0.101		
9.0	150	2.50				2.490	1.870	1.154	0.668	0.494	0.372	0.289		
						25.11	12.53	3.903	1.124	0.506	0.256	0.140		
10.5	175	2.92				2.904	2.182	1.347	0.803	0.576	0.434	0.337		
						33.32	16.66	5.179	1.488	0.670	0.338	0.184		
12	200	3.33				3.319	2.493	1.539	0.918	0.659	0.496	0.385	0.251	
						42.75	21.36	6.624	1.901	0.855	0.431	0.234	0.084	
15	250	4.17				4.149	3.117	1.924	1.147	0.823	0.620	0.481	0.314	
						64.86	32.32	10.03	2.860	1.282	0.646	0.350	0.126	
18	300	5.00					3.740	2.309	1.377	0.988	0.744	0.577	0.377	0.263
							45.52	14.04	4.009	1.792	0.903	0.488	0.175	0.074
24	400	6.67					4.987	3.078	1.836	1.317	0.992	0.770	0.502	0.351
							78.17	24.04	6.828	3.053	1.530	0.829	0.294	0.124
30	500	8.33						3.848	2.295	1.647	1.240	0.962	0.628	0.439
								36.71	10.40	4.622	2.315	1.254	0.445	0.187
36	600	10.0						4.618	2.753	1.976	1.488	1.155	0.753	0.526
								51.84	14.62	6.505	3.261	1.757	0.623	0.260
42	700	11.7							3.212	2.306	1.736	1.347	0.879	0.614
									19.52	8.693	4.356	2.345	0.831	0.347
48	800	13.3							3.671	2.635	1.984	1.540	1.005	0.702
									25.20	11.18	5.582	3.009	1.066	0.445
54	900	15.0							4.130	2.964	2.232	1.732	1.130	0.790
									31.51	13.97	6.983	3.762	1.328	0.555
60	1000	16.7							4.589	3.294	2.480	1.925	1.256	0.877
									38.43	17.06	8.521	4.595	1.616	0.674
75	1250	20.8								4.117	3.100	2.406	1.570	1.097
										26.10	13.00	7.010	2.458	1.027

90	1500	25.0								4.941 36.97	3.720 18.42	2.887 9.892	1.883 3.468	1.316 1.444
105	1750	29.2									4.340 24.76	3.368 13.30	2.197 4.665	1.535 1.934
120	2000	33.3									4.960 31.94	3.850 17.16	2.511 5.995	1.754 2.496
150	2500	41.7										4.812 26.26	3.139 9.216	2.193 3.807
180	3000	50.0											3.767 13.05	2.632 5.417
240	4000	66.7											5.023 22.72	3.509 8.926
300	5000	83.3												4.386 14.42
90° bends, slide valves			1.0	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.6	1.7	2.0	2.5
T-pieces, non-return valves			4.0	4.0	4.0	5.0	5.0	5.0	6.0	6.0	6.0	7.0	8.0	9.0

The table is calculated in according to H. Lang's new formula a = 0.02 and for a water temperature of 10 °C.

The head loss in bends, slide valves, T-pieces and non-return valves is equivalent to the metres of straight pipes stated in the last two lines of the table. To find the head loss in foot valves, multiply the loss in T-pieces by two.

Head losses in plastic pipes

Upper figures indicate the velocity of water in m/sec.

Lower figures indicate head loss in metres per 100 metres of straight pipes.

Quantity of water			PELM/PEH PN 10											
m^3/h	Litres/min.	Litres/sec.	PELM						PEH					
			25	32	40	50	63	75	90	110	125	140	160	180
			20.4	26.2	32.6	40.8	51.4	61.4	73.6	90.0	102.2	114.6	130.8	147.2
0.6	10	0.16	0.49 1.8	0.30 0.66	0.19 0.27	0.12 0.085								
0.9	15	0.25	0.76 4.0	0.46 1.14	0.3 0.6	0.19 0.18	0.12 0.63							
1.2	20	0.33	1.0 6.4	0.61 2.2	0.39 0.9	0.25 0.28	0.16 0.11							
1.5	25	0.42	1.3 10.0	0.78 3.5	0.5 1.4	0.32 0.43	0.2 0.17	0.14 0.074						
1.8	30	0.50	1.53 13.0	0.93 4.6	0.6 1.9	0.38 0.57	0.24 0.22	0.17 0.092						
2.1	35	0.58	1.77 16.0	1.08 6.0	0.69 2.0	0.44 0.70	0.28 0.27	0.2 0.12						
2.4	40	0.67	2.05 22.0	1.24 7.5	0.80 3.3	0.51 0.93	0.32 0.35	0.23 0.16	0.16 0.063					
3.0	50	0.83	2.54 37.0	1.54 11.0	0.99 4.8	0.63 1.40	0.4 0.50	0.28 0.22	0.2 0.09					
3.6	60	1.00	3.06 43.0	1.85 15.0	1.2 6.5	0.76 1.90	0.48 0.70	0.34 0.32	0.24 0.13	0.16 0.050				
4.2	70	1.12	3.43 50.0	2.08 18.0	1.34 8.0	0.86 2.50	0.54 0.83	0.38 0.38	0.26 0.17	0.18 0.068				
4.8	80	1.33		2.47 25.0	1.59 10.5	1.02 3.00	0.64 1.20	0.45 0.50	0.31 0.22	0.2 0.084				
5.4	90	1.50		2.78 30.0	1.8 12.0	1.15 3.50	0.72 1.30	0.51 0.57	0.35 0.26	0.24 0.092	0.18 0.05			
6.0	100	1.67		3.1 39.0	2.0 16.0	1.28 4.6	0.8 1.80	0.56 0.73	0.39 0.30	0.26 0.12	0.2 0.07			
7.5	125	2.08		3.86 50.0	2.49 24.0	1.59 6.6	1.00 2.50	0.70 1.10	0.49 0.50	0.33 0.18	0.25 0.10	0.20 0.055		
9.0	150	2.50			3.00 33.0	1.91 8.6	1.20 3.5	0.84 1.40	0.59 0.63	0.39 0.24	0.30 0.13	0.24 0.075		
10.5	175	2.92			3.5 38.0	2.23 11.0	1.41 4.3	0.99 1.80	0.69 0.78	0.46 0.30	0.36 0.18	0.28 0.09		
12	200	3.33			3.99 50.0	2.55 14.0	1.60 5.5	1.12 2.40	0.78 1.0	0.52 0.40	0.41 0.22	0.32 0.12	0.25 0.065	
15	250	4.17				3.19 21.0	2.01 8.0	1.41 3.70	0.98 1.50	0.66 0.57	0.51 0.34	0.40 0.18	0.31 0.105	0.25 0.06
18	300	5.00				3.82 28.0	2.41 10.5	1.69 4.60	1.18 1.95	0.78 0.77	0.61 0.45	0.48 0.25	0.37 0.13	0.29 0.085
24	400	6.67					3.21 19.0	2.25 8.0	1.57 3.60	1.05 1.40	0.81 0.78	0.65 0.44	0.50 0.23	0.39 0.15
30	500	8.33					4.01 28.0	2.81 11.5	1.96 5.0	1.31 2.0	1.02 1.20	0.81 0.63	0.62 0.33	0.49 0.21
36	600	10.0					4.82 37.0	3.38 15.0	2.35 6.6	1.57 2.60	1.22 1.50	0.97 0.82	0.74 0.45	0.59 0.28
42	700	11.7					5.64 47.0	3.95 24.0	2.75 8.0	1.84 3.50	1.43 1.90	1.13 1.10	0.87 0.60	0.69 0.40
48	800	13.3						4.49 26.0	3.13 11.0	2.09 4.5	1.62 2.60	1.29 1.40	0.99 0.81	0.78 0.48
54	900	15.0						5.07 33.0	3.53 13.5	2.36 5.5	1.83 3.20	1.45 1.70	1.12 0.95	0.08 0.58
60	1000	16.7						5.64 40.0	3.93 16.0	2.63 6.7	2.04 3.90	1.62 2.2	1.24 1.2	0.96 0.75
75	1250	20.8							4.89 25.0	3.27 9.0	2.54 5.0	2.02 3.0	1.55 1.6	1.22 0.95
90	1500	25.0							5.88 33.0	3.93 13.0	3.05 8.0	2.42 4.1	1.86 2.3	1.47 1.40
105	1750	29.2							6.86 44.0	4.59 17.5	3.56 9.7	2.83 5.7	2.17 3.2	1.72 1.9
120	2000	33.3								5.23 23.0	4.06 13.0	3.23 7.0	2.48 4.0	1.96 2.4

Quantity of water			PELM/PEH PN 10					
m^3/h	Litres/min.	Litres/sec.	PELM	PEH				
150	2500	41.7		6.55 34.0	5.08 18.0	4.04 10.5	3.10 6.0	2.45 3.5
180	3000	50.0		7.86 45.0	6.1 27.0	4.85 14.0	3.72 7.6	2.94 4.4
240	4000	66.7			8.13 43.0	6.47 24.0	4.96 13.0	3.92 7.5
300	5000	83.3				8.08 33.0	6.2 18.0	4.89 11.0

The table is based on a nomogram.
Roughness: K = 0.01 mm.
Water temperature: t = 10 °C.

14. Grundfos Product Center

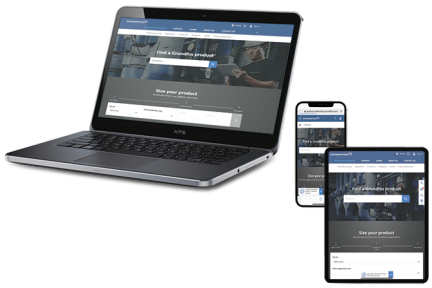
Online search and sizing tool to help you make the right choice.
From the international view, you can select your specific country to view the product range available to you.
International view: *http://product-selection.grundfos.com*

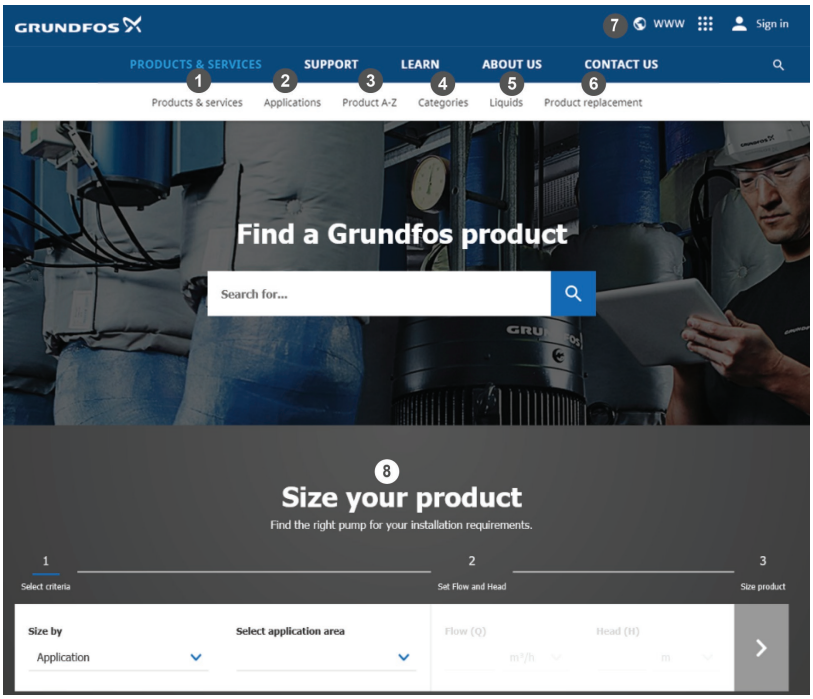
All the information you need in one place

Performance curves, technical specifications, pictures, dimensional drawings, motor curves, wiring diagrams, spare parts, service kits, 3D drawings, documents, system parts. The Product Center displays any recent and saved items - including complete projects - right on the main page.

Downloads

On the product pages, you can download installation and operating instructions, data booklets, service instructions, etc., in PDF format.





When you select your country, you will see the menus below. Note that some menus may not be available depending on the country.
Example: *https://product-selection.grundfos.com/uk*

Pos.	Description
1	**Products & services** enables you to find products and documents by typing a product number or name into the search field.
2	**Applications** enables you to choose an application to see how Grundfos can help you design and optimise your system.
3	**Products A-Z** enables you to look through a list of all the Grundfos products.
4	**Categories** enables you to look for a product category.
5	**Liquids** enables you to find pumps designed for aggressive, flammable or other special liquids.
6	**Product replacement** enables you to find a suitable replacement.
7	**WWW** enables you to select the country, which changes the language, the available product range and the structure of the website.
8	**Sizing** enables you to size a product based on your application and operating conditions.

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