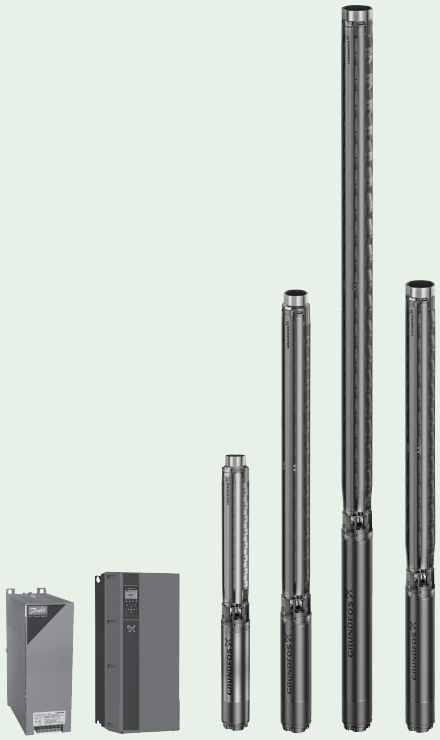
Data booklet

SPE

Regulated submersible pumps with PM motors

NAMREG

3600 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- as well as corrosive water.

The pump system consists of reliable hydraulics and an energy efficient Interior Permanent Magnet (IPM) 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.

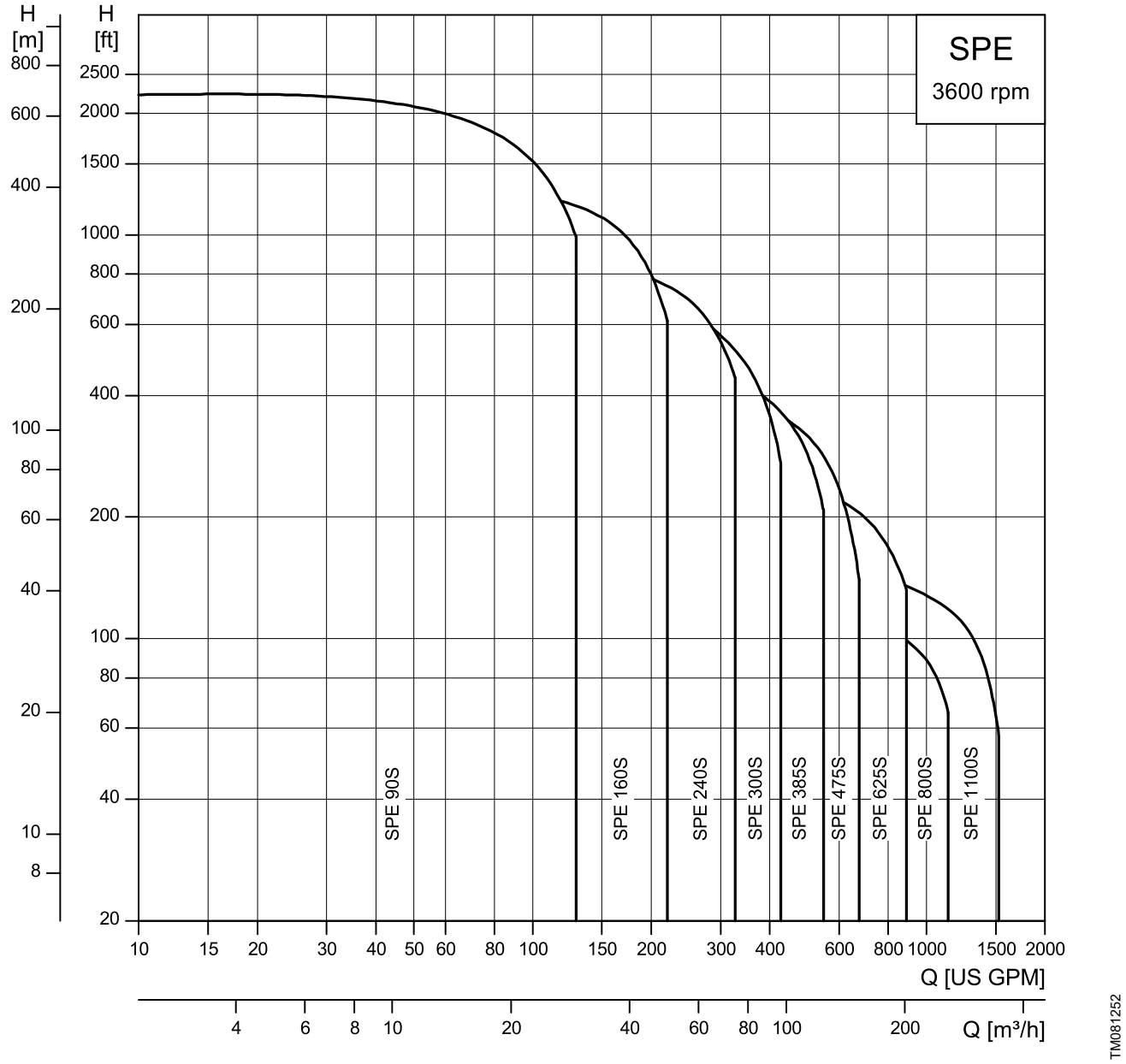
The motor is running synchronous and needs a Variable Frequency Drive (VFD), such as the Grundfos CUE, to control the speed according to the requirements. The CUE includes a wizard to make the setup easy. The CUE has the following predefined control modes:

- constant pressure
- constant flow
- constant level.

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

General description

Performance range



Pump Energy Index

Pump Energy Index (PEI) was established by the U.S. Department of Energy (DOE) and adopted by Canada as the standard metric used to evaluate pump efficiency. The value is the ratio of the pump efficiency rating (PER) divided by the calculated minimally compliant PER (PER_{STD}) for the pump type. This provides a representation of the actual pump performance compared to the minimal standard performance required by regulation. The lower the PEI value, the more efficient a pump is at the tested operating points.

PER is determined by defined testing parameters required by the DOE. This includes testing a particular pump model at its best efficiency point (BEP).

For PEI values, there are two different versions:

- PEI_{CL} (constant load): applies to a bare-shaft pump, and a pump sold with a motor
- PEI_{VL} (variable load): applies to pumps sold with a motor and controller (such as VFD, VSD).

The DOE has set the maximum PEI value as 1.00. Any pump, pump and motor, or pump, motor and controller that exceeds a PEI value of 1.00 can no longer be manufactured after January 26, 2020.

PEI is a generalized efficiency value. PEI cannot be used to determine the efficiency of a pump in a specific application.

PEI index

Pump type	Pole	Motor size [hp]	PEI_{CL} bare-shaft pump	PEI_{CL} pump with motor	PEI_{VL} pump with motor plus controller [1]	Impeller diameter [in]
90S	4	10	0.82	0.85	0.33	3.49
		25			0.32	
160S		10	0.91	0.91	0.35	3.52
		25			0.35	
240S		10	0.92	0.92	0.37	3.87
		25			0.36	
		40			0.36	
300S		10	0.92	0.92	0.37	3.90
		25			0.36	
		40			0.37	

[1] Grundfos continuous controls.

Type key

Example	SPE	475	S	500	5	PD
Pos.	1	2	3	4	5	6

Pos.	Description		
1	Pump type		
	- or SP	=	Standard design
	SPE	=	ECM-design (MS6000P)
2	Rated flow rate in gpm		
3	Material version Stainless steel parts of material		
	S	=	AISI 304 (EN 1.4301) SS
	N	=	AISI 316 (EN 1.4401) SS
	R	=	AISI 904L (EN 1.4539) SS
4	Hp of motor		
5	Number of impellers		
6	BP	=	Bare Pump
	-	=	Pump and motor (Standard or ECM motor)
	CUE	-	Standard motor and VFD
	PD	-	ECM motor and VFD (SPE only)

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 AISI 304	Steel (N) AISI 316	Steel (R) AISI 904L	Connection NPT
SPE 90S	•	•	•	3"
SPE 160S	•	•	•	3"
SPE 240S	•	•	•	4"
SPE 300S	•	•	•	4"
SPE 385S	•	•	•	4"
SPE 475S	•	•	•	6"
SPE 625S	•	•	•	6"
SPE 800S	•	•	•	6"
SPE 1100S	•	•	•	6"

Related information

Features and benefits

Motor range

MS6000P covers several standard motor outputs.

Motor execution [hp]		10			25			40	50
Motor output [hp]	5.0	7.5	10	15	20	25	30	40	50

2. Submersible pumps

Features and benefits

A wide pump range

Grundfos offers energy-efficient, submersible SPE pumps ranging from 45 to 1585 GPM. The pump range consists of various pump sizes from SPE 90S to SPE 1100S. Each pump size is available with an optional number of stages to match a given duty point.

High pump efficiency

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

Example

If pumping 300 GPM at 330 ft 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 results in a reduction of 274,200 kWh, corresponding to more than $ 27,420 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:** AISI 304
- **SPE N:** AISI 316
- **SPE R:** AISI 904L.

See specified material variants in Pump range.

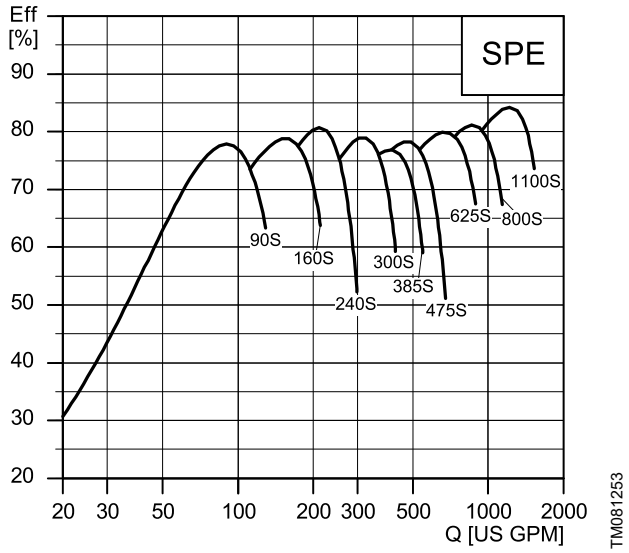
For further protection in corrosive environments, a complete range of zinc anodes for cathodic protection is available. See Zinc anodes.

Rubber components

For pumping liquids with a risk of chemical residue or above 140 °F (60 °C), all pumps can be supplied with rubber components made of FKM elastomer.

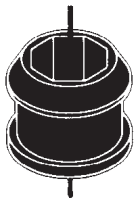
Low installation costs

Stainless steel sheet metal ensures 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

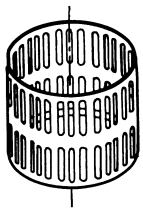


Bearing

TM007301

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, allowing a high limit for particles in the pumped liquid. LSR is used as standard in pumps ranging up to SPE 300S. On SPE 385S and larger pumps, the bearing material is NBR.

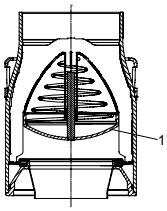


Inlet strainer

TM007302

Inlet strainer

The inlet strainer prevents particles over a certain size from entering the pump. The hole size is 0.16 × 0.79 in.



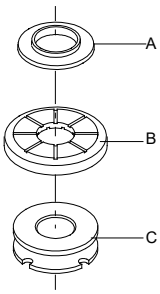
Non-return valve

Pos. 1 - Valve flap

TM0124991

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 minimize the pressure loss across the valve and to contribute to high efficiency.



Stop ring (rotating and stationary parts).

TM013327

Stop ring

The stop ring prevents damage to the pump during transportation and in case of upthrust during pump startup. The stop ring, which is designed as a thrust bearing, limits the 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).

Pump functioning as a turbine

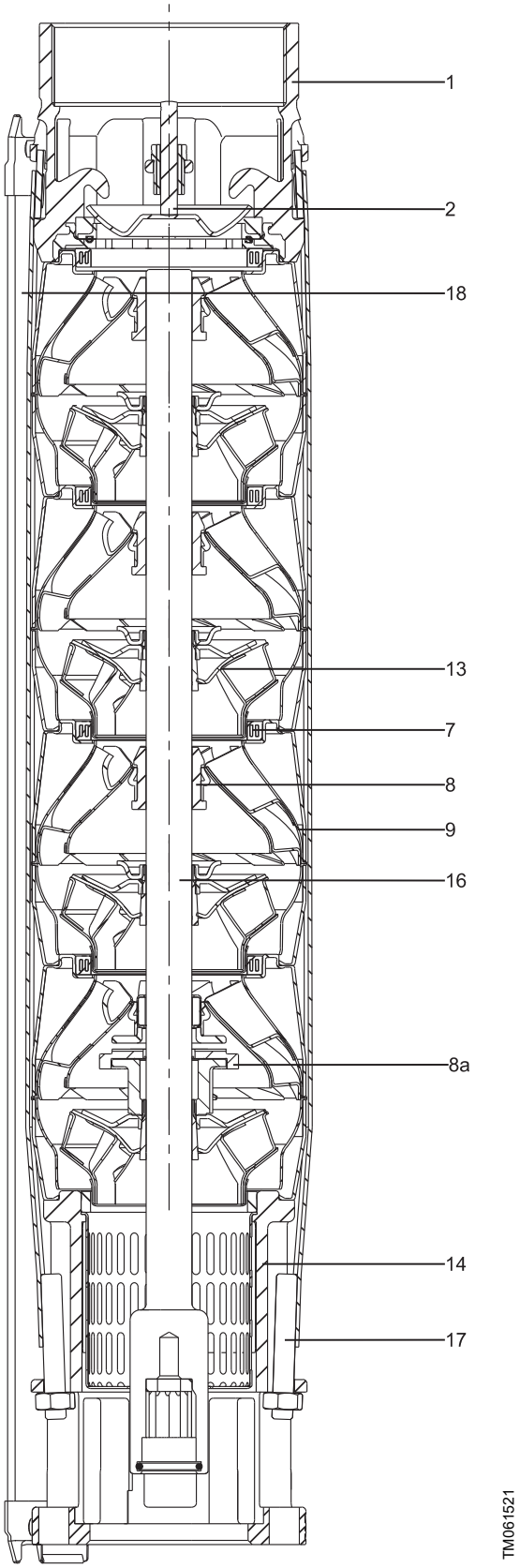
In case of unintended flow of water through a non-energized pump, there is a risk that the moving parts of the pump and the motor start rotating, thereby generating voltage over the terminals. The size of the voltage depends on the rotation speed. So the motor terminals must be considered as live until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

Related information

Pump range

Material specification (SPE 90S-SPE 300S)

Pos.	Component	Material	Standard	N-version	R-version
			AISI		
1	Valve casing	Stainless steel	304	316	904L
2	Valve cup	Stainless steel	316	316	904L
	Valve seat	NBR-FKM	NBR-FKM	NBR-FKM	NBR-FKM
7	Neck ring	NBR-FKM	NBR-FKM	NBR-FKM	NBR-FKM
8	Bearing	FKM-LSR	FKM-LSR	FKM-LSR	FKM-LSR
8a	Washer for stop ring	Carbon/graphite HY22 in PTFE mass			
9	Chamber	Stainless steel	304	316	904L
13	Impeller	Stainless steel	304	316	904L
14	Suction interconnector	Cast stainless steel	304	316	904L
	Strainer	Stainless steel	304	316	904L
16	Shaft complete	Stainless steel	431	329	904L
17	Strap	Stainless steel	304	316	904L
18	Cable guard	Stainless steel	304	316	904L



Example SPE 230S

Material specification (SPE 385S-SPE 1100S)

Pos.	Component	Material	Standard	N-version	R-version
			AISI		
1	Valve casing	Stainless steel	304	316	904L
2	Valve cup	Stainless steel	304	316	904L
	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	304	316	904L
13	Impeller	Stainless steel	304	316	904L
14	Suction interconnector	Cast stainless steel	304	316	904L
	Strainer	Stainless steel	304	316	904L
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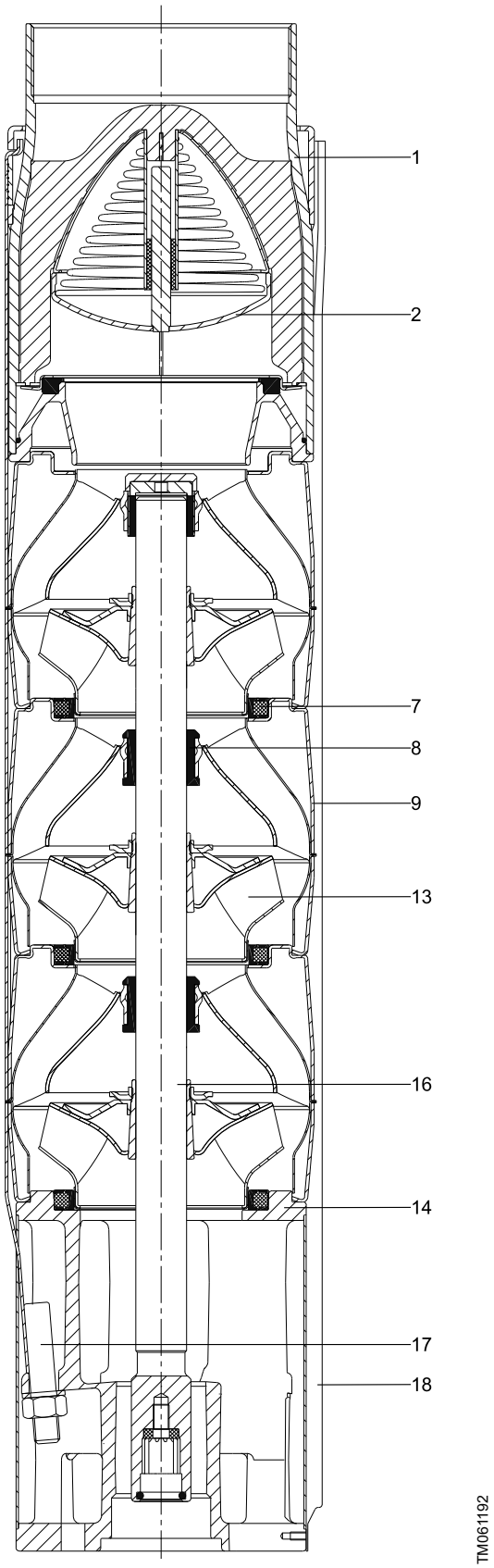


Example SPE 385S

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 Interior Permanent Magnet (IPM), 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. It requires 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, 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.

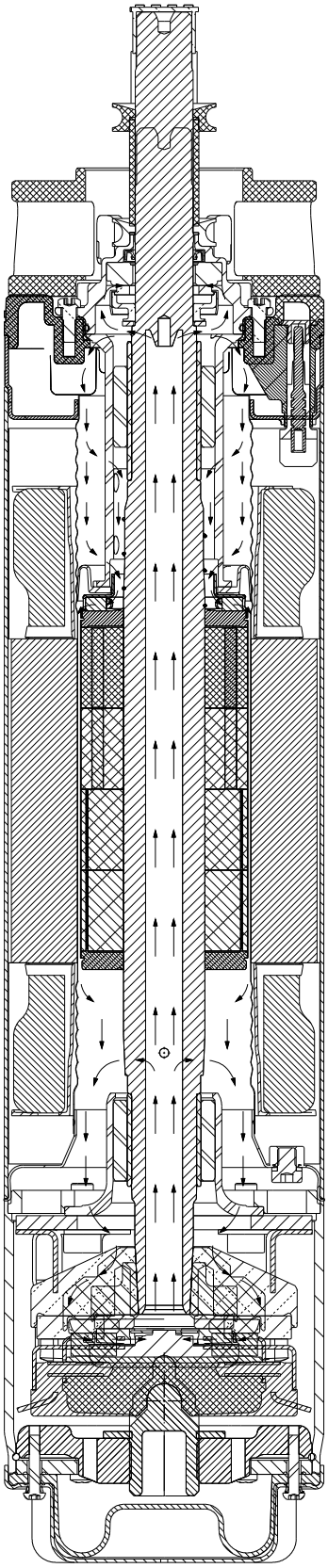
The MS6000P is available in T60 version only. This means that the motor is able to operate in applications up to 140 °F as long as a standard cooling flow of 0.5 feet/s is ensured. In most applications, the media temperature is less than 140 °F and the surplus temperature capacity ensures an even more robust motor.

For particularly demanding applications in corrosive media, MS6000P is available in stainless steel quality AISI 904L, R version. Typical applications are the following:

- mining dewatering
- fish farming
- offshore industrial applications.

TM081248

MS6000P motors



TM082006

MS6000P lubrication flow

Stator

Grundfos MS6000P consists of a hermetically sealed stator withstanding external pressure up to 870 psi. It is a 4-pole construction with insulation class F winding material. All surfaces in contact with the pump media are made of stainless steel. The following material grades are available:

- AISI 304 for non-demanding installations (approved for drinking water).
- AISI 904L for installations with high chloride content. The stator is filled with an epoxy filler and wound for high robustness using grade two, overcoated enamel winding wire.

Shaft and rotor

The NEMA splined shaft extension is friction welded to a stainless steel shaft. The stainless steel radial bearing bushes on the shaft form the rotating part of the radial bearings. The 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 to ensure lubrication of the mechanical shaft seal and the radial bearings. Due to the use of permanent magnets, heat is not generated in the rotor pack and subsequently the temperature rise in the motor liquid decreases drastically. This benefits the life time of the construction and ensures more a robust lubrication film in the radial and thrust bearing.

Thrust bearing

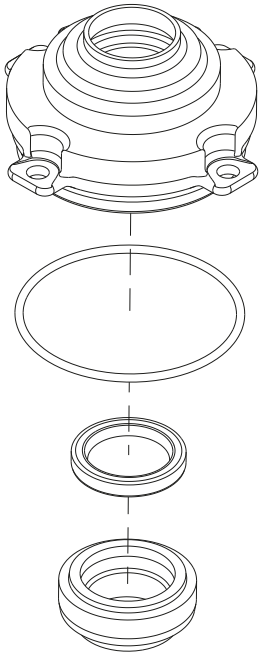
Grundfos MS6000P uses identical thrust bearing to the MS6000 series consisting of a ceramic rotating disc running against tilting pads and carbon or graphite shoes on the stationary part.

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.

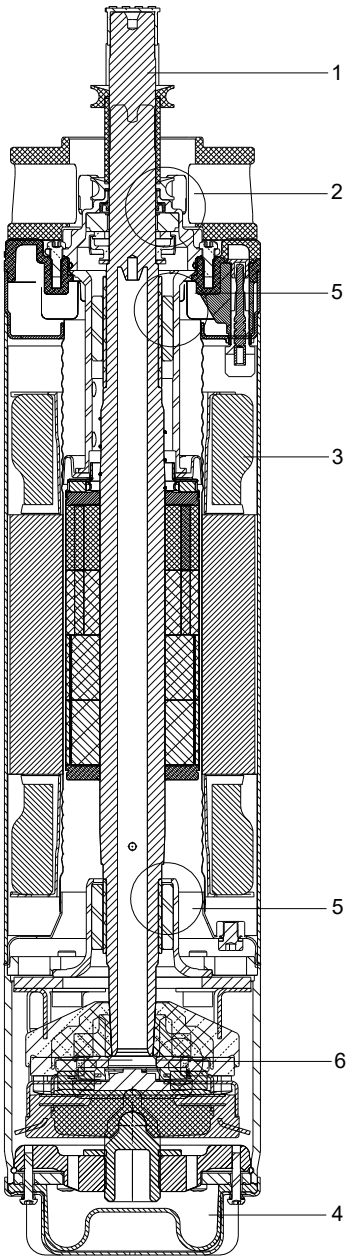
Material specification MS6000P

Standard version motor

Pos.	Component	Material
1	Shaft	AISI 431
2	Shaft seal	SiC/SiC
	Rubber type	NBR
3	Motor sleeve	AISI 304
4	Motor end shield	AISI 304
	Diaphragm	NBR
5	Radial bearing	Carbon/stainless steel
6	Axial bearing	Ceramic/carbon

R-version motor

Pos.	Component	Material
1	Shaft	AISI 904L
2	Shaft seal	SiC/SiC
	Rubber type	FKM
3	Motor sleeve	AISI 904L
4	Motor end shield	AISI 904L
	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 [hp]				
	5	10	15	60	100
3 × 380-500	•	•	•	•	•
3 × 525-600	•	•			
3 × 525-690			•	•	•

CUE is available in the following enclosure classes:

- NEMA 1
- NEMA 12.

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 [hp]	RFI filter type	Application
3 × 380-500	5-120	C1	Domestic
3 × 525-600	5-10	C3	Industry
3 × 525-690	15-35	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.

Sine-wave filter

The use of IPM-ready sine-wave filters is required on 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 120 Hz (3600 RPM).

Part number	Enclosure degree	Switching frequencies to be set manually in CUE	Filter current rating at 200-500 V and 120 Hz
		[kHz]	[A]
92617568	UL type 1/3R	4-6	9
92617569	UL type 1/3R	4-6	12
92617580	UL type 1/3R	4-6	16
92617581	UL type 1/3R	4-6	23
92617582	UL type 1/3R	4-6	30
92617583	UL type 1/3R	4-6	35
92617587	UL type 1/3R	4-6	45
92617588	UL type 1/3R	4-6	55
92617589	UL type 1/3R	4-6	65
92617590	UL type 1/3R	4-6	80
92617591	UL type 1/3R	4-6	110

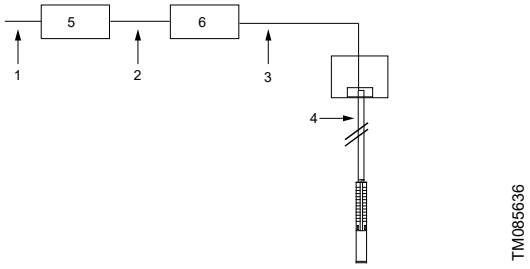
Cables in CUE installations

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

- installation in EMC-insensitive sites. See fig. below.
- installation in EMC-sensitive sites. See fig. below.

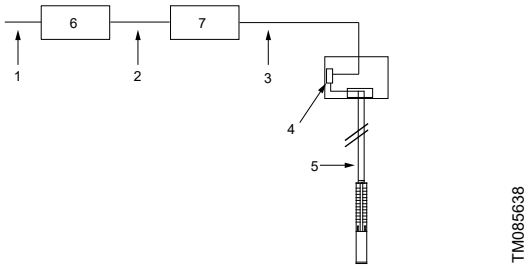
The two types of installation are different when it comes to the use of screened cable.

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 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

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 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. 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 poor lubrication of journal bearings.
Size CUE compared to 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 ft/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 120 Hz / 3 × 410 V motor voltage

	Power range [hp]			
	10	**25**	**40**	**50**
PM back EMF at 120 Hz [V]	320	312	324	295
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]	120			
Number of poles	4			

Grundfos offerings, easy selection

MS6000P single packed with cable			CUE (120 Hz)			Sine wave filter (120 Hz)	
Motor voltage 3 × 410 V (3600 RPM)			3 × 380-500V Nema 4X outdoor	3 × 380-500V Nema 1 indoor		TCI indoor/outdoor 3R	
Part number	Output [hp]	SF Current [A]	Part number	Part number	Current [A]	Part number	Current [A]
9984343	5.0	8.8	99619042	99616714	11	92617568	9
						92617569	12
	7.5	12.4	99619043	99616715	14.5	92617580	16
	10	16.2	99619044	99616716	21	92617581	23
99843439	15	24.5	99619045	99616717	27	92617582	30
	20	32.2	99619046	99616718	34	92617583	35
	25	39.0	99619047	99616719	40	92617587	45
99843440	30	44.8	99619048	99616720	52	92617588	55
	40	60.0	99619049	99616721	65	92617589	65
99843441	50	82.6	99619051	99616723	105	92617591	110

5. Selection and sizing

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

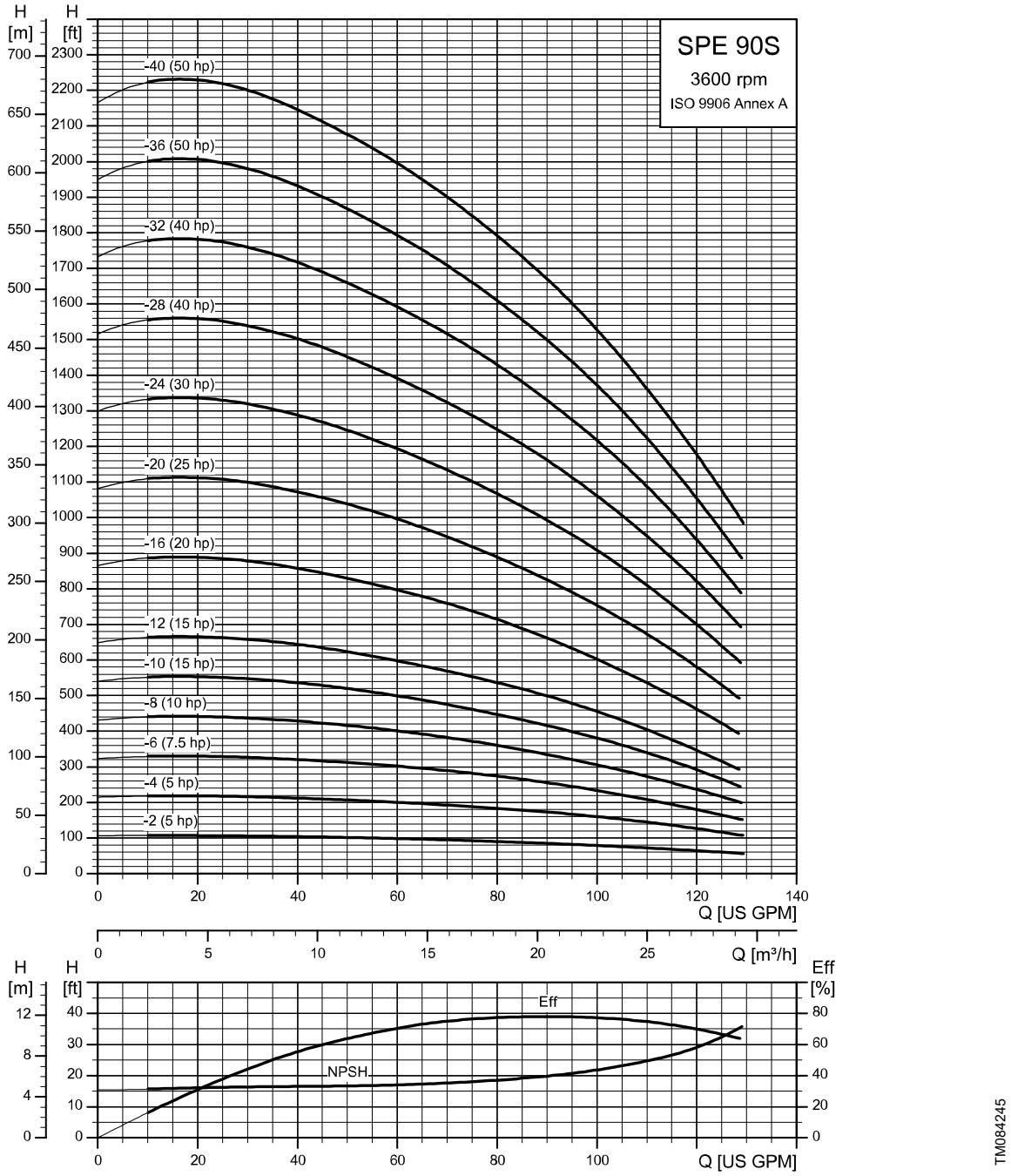
For further information, see Grundfos Product Center at https://product-selection.grundfos.com.

Select the pump based on the following parameters:

- duty point (see below)
- friction loss in the pipes, pump efficiency (see below)
- materials (see SPE 85S - SPE 300S)
- connections (see SPE 385S- SPE 1100S).

Duty point of the pump

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



Example of a curve chart

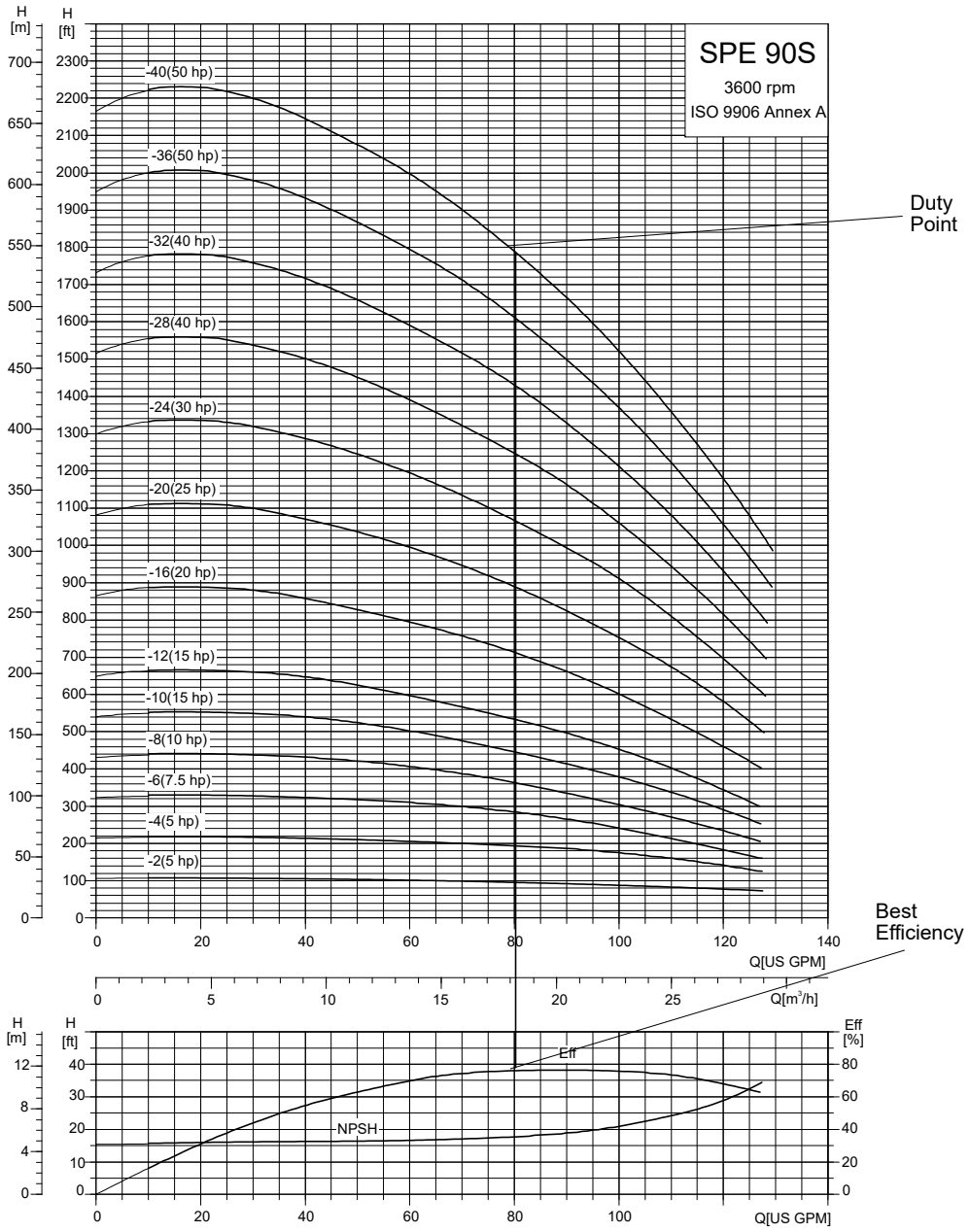
Dimensional data

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.

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.



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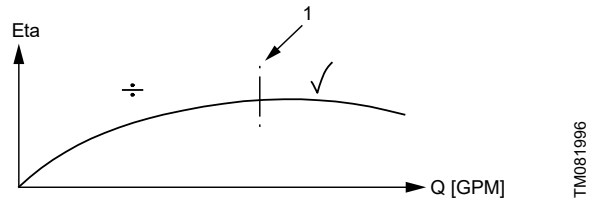
As the pump is sized based on the highest possible flow, it is important to have the duty point to the right on the efficiency curve (Eta) in order to keep the efficiency high when the flow drops.



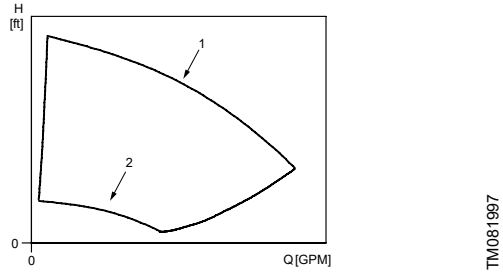
Best efficiency

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

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.



Min. and max. performance curves

Pos.	Description
1	Max. curve
2	Min. curve

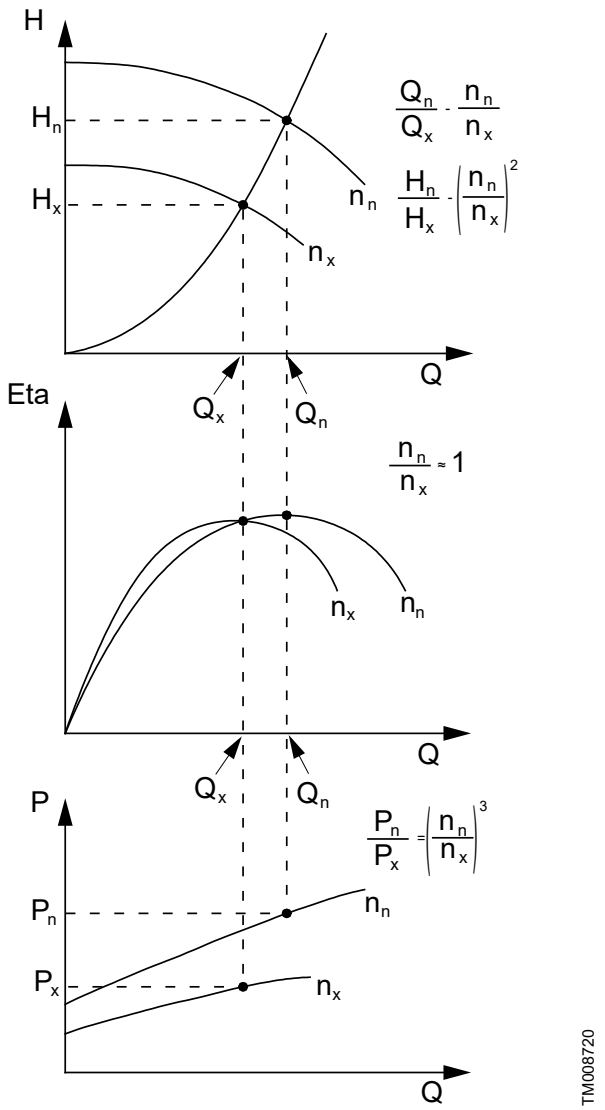
In situations where it is not possible to select a duty point close to the Max. curve, the below affinity equations can be used. The following are the appropriate variables for the motor speed (n):

- 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.



$$\frac{Q_n}{Q_x} = \frac{n_n}{n_x}$$

$$\frac{H_n}{H_x} = \left(\frac{n_n}{n_x}\right)^2$$

$$\frac{n_n}{n_x} \approx 1$$

$$\frac{P_n}{P_x} = \left(\frac{n_n}{n_x}\right)^3$$

Affinity equations

H_n	Rated head [ft]
H_x	Actual head [ft]
Q_n	Rated flow rate [GPM]
Q_x	Actual flow rate [GPM]
P_n	Rated input power [hp]
P_x	Actual input power [hp]
n_n	Rated motor speed [min^{-1}] (n_n = 3600 min^{-1})
n_x	Actual motor speed [min^{-1}]
η_n	Rated efficiency [%]
η_x	Actual efficiency [%]

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

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 1.5 ft 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 90S - SPE 300S	100
SPE 385S - SPE 1100S	50

Special liquids

A larger sand content reduces the lifespan of the pump.

The following versions are available for applications involving aggressive liquids:

- SPE-N made of stainless steel AISI 316
- SPE-R made of stainless steel AISI 904L.

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

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

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

In case of concerns, contact Grundfos.

Liquid temperature

For protection of pump and motor rubber parts, the liquid temperature must not exceed 140 °F.

Max. liquid temperature

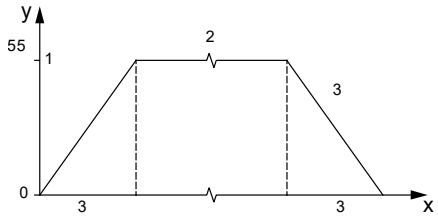
The maximum liquid temperature of 140 °F requires a flow velocity of the liquid past the motor of 0.5 ft/s.

Max. operating pressure

Maximum operating pressure is 870 psi.

Ramp times

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



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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 is measured in accordance with the rules of the 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)]
SPE 90S	< 70
SPE 160S	< 70
SPE 240S	< 70
SPE 300S	< 70
SPE 385S	< 70
SPE 475S	< 70
SPE 625S	79
SPE 800S	79
SPE 1100S	82

Sound pressure level of motors

The sound pressure level is lower than 70 dB(A).

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 [lb ft^2]
SPE 90S	$(100 + n \times 50) \times 10^{-4}$
SPE 160S	$(100 + n \times 125) \times 10^{-4}$
SPE 240S	$(100 + n \times 90) \times 10^{-4}$
SPE 300S	$(100 + n \times 100) \times 10^{-4}$
SPE 385S	$(140 + n \times 475) \times 10^{-4}$
SPE 475S	$(140 + n \times 550) \times 10^{-4}$
SPE 625S	$(140 + n \times 825) \times 10^{-4}$
SPE 800S	$(140 + n \times 825) \times 10^{-4}$
SPE 1100S	$(625 + n \times 2500) \times 10^{-4}$

n = number of stages.

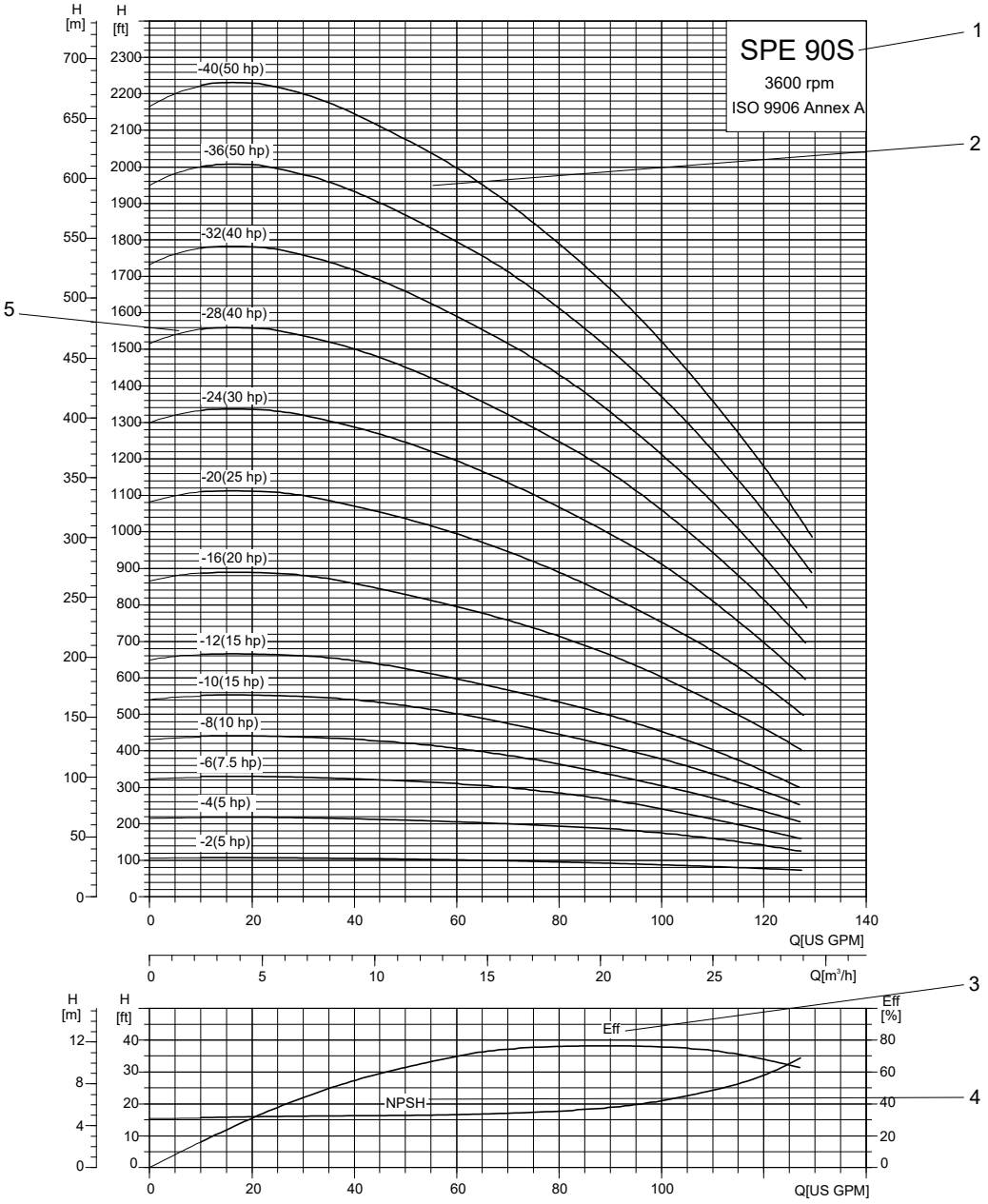
Recommended minimum borehole diameter

If using 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	Minimum borehole diameter [inches]		
	NPT 3"	NPT 4"	NPT 6"
SPE 90S	6.1	-	-
SPE 160S	6.1	-	-
SPE 240S / 300S	-	6.3	-
SPE 385S	-	7.7	-
SPE 475S	-	-	7.7
SPE 625S / SPE 800S	-	-	8.9
SPE 1100S	-	-	9.8

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. Pumps with fewer stages 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 1.5 ft.
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 = 3600 min^{-1}.
- The measurements are made with airless water at a temperature of 68 °F. The curves apply to a kinematic viscosity of 1 cSt. When pumping liquids with a density higher than 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.

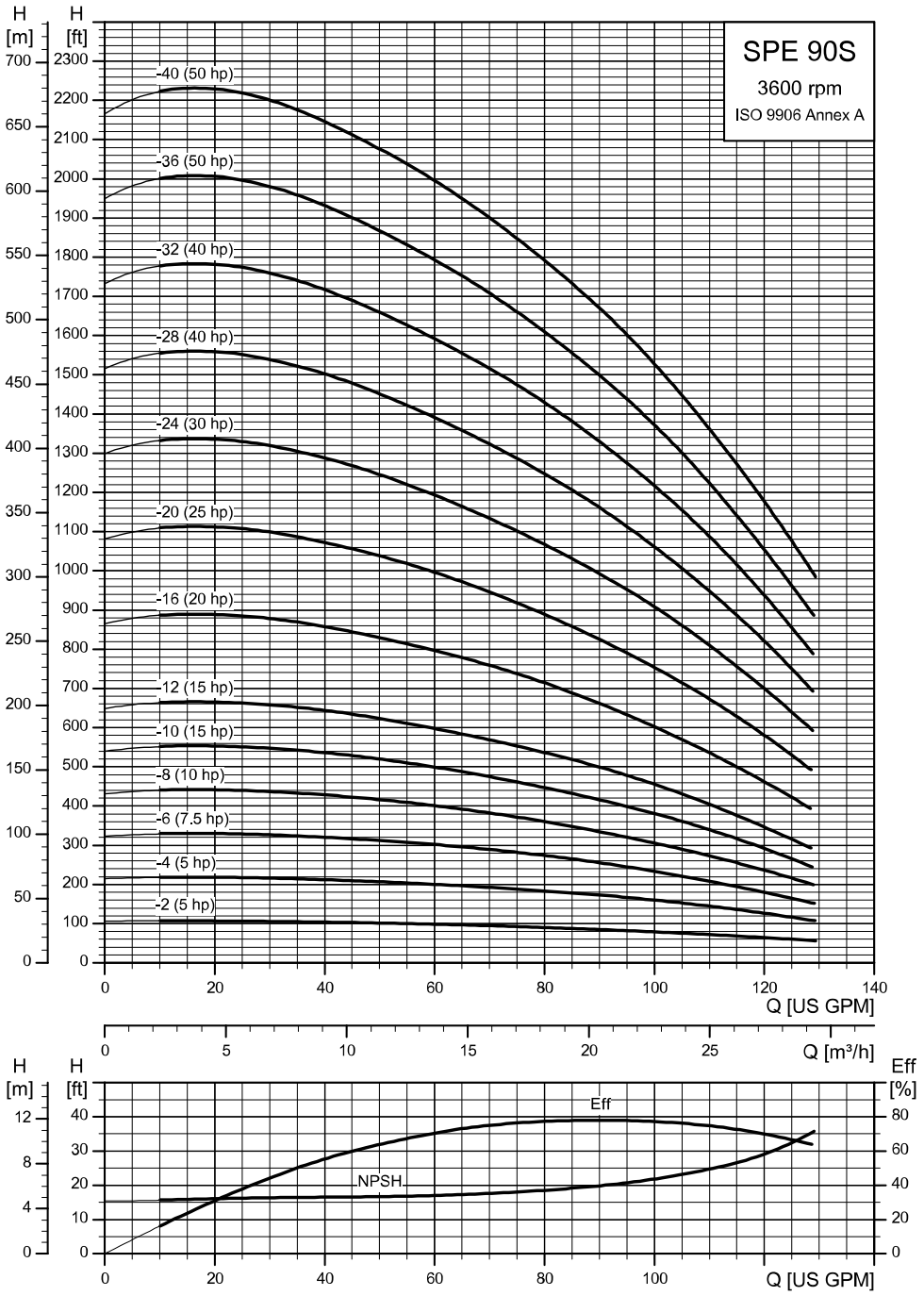
Curves

- **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 1.6 to 3.3 ft.
- **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, contact Grundfos or visit Grundfos Product Center https://product-selection.grundfos.com.

7. Performance curves and technical data

SPE 90S

Performance curves

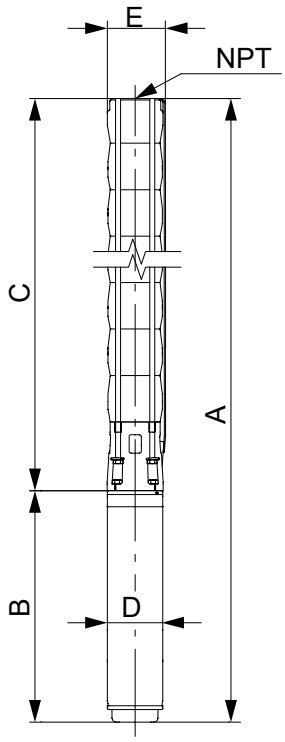


Related information

How to read the curve charts

Dimensions and weights

SPE 90S (90 gpm) pump



TM081341

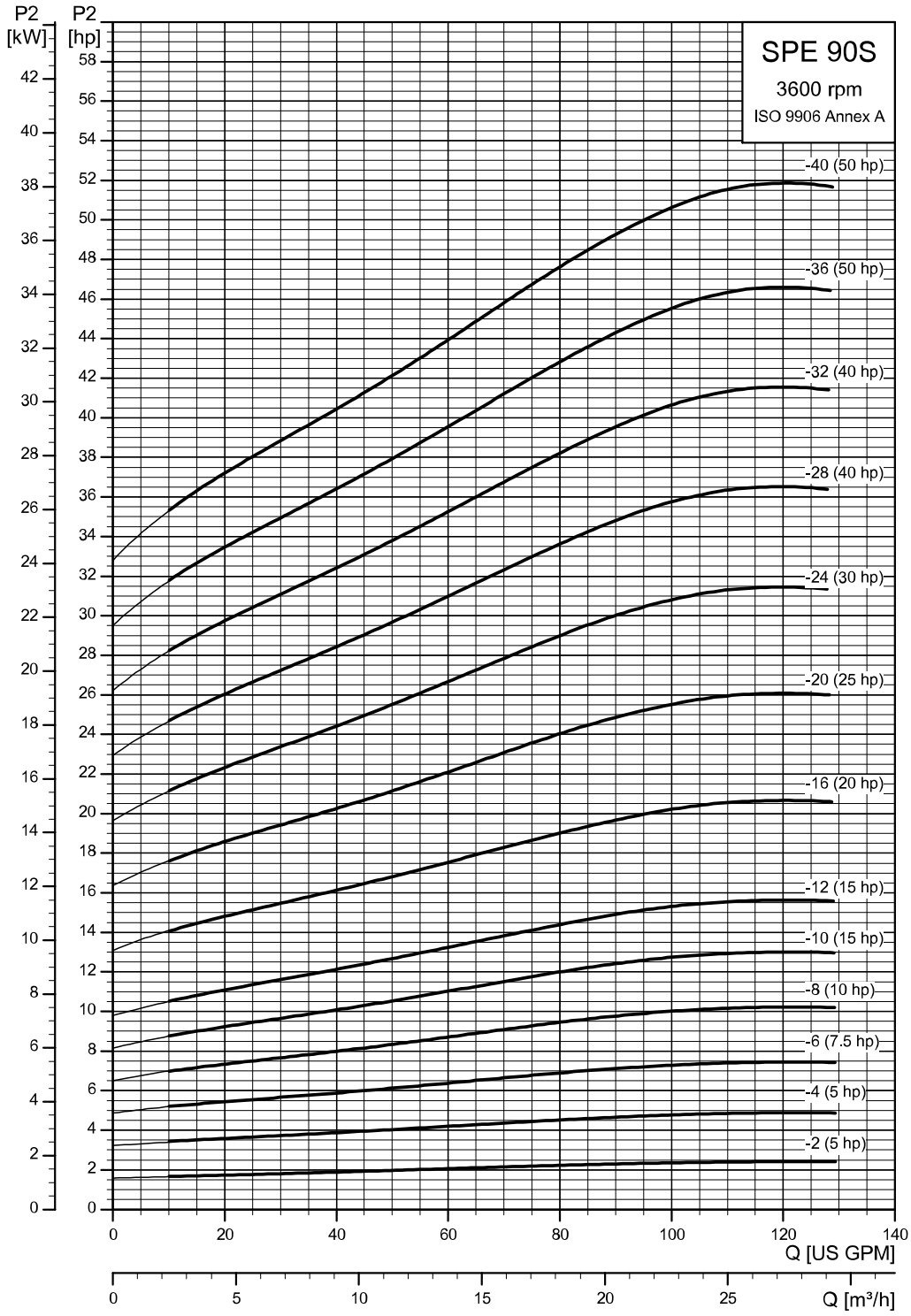
Pump model	Nom. head [ft]	Motor	Dimensions [in]					Net weight (complete) [lb]
		[Hp]	A	B	C	D	E	
90S, 60 Hz - rated flow rate 90 gpm (3" NPT)								
SPE 90S-2	89	5	39.33	23.50	15.83	6	5.49	119.0
SPE 90S-4	179	5	44.09	23.50	20.59	6	5.49	125.1
SPE 90S-6	271	7.5	48.86	23.50	25.35	6	5.49	131.1
SPE 90S-8	359	7.5	53.62	23.50	30.12	6	5.49	137.1
SPE 90S-10	450	10	58.39	23.50	34.88	6	5.49	143.2
SPE 90S-12	542	15	67.87	28.23	39.65	6	5.49	176.8
SPE 90S-16	724	15	77.40	28.23	49.17	6	5.49	188.9
SPE 90S-20	906	20	86.93	28.23	58.70	6	5.49	201.0
SPE 90S-24	1089	25	96.46	28.23	68.23	6	5.49	213.0
SPE 90S-28	1271	25	105.98	28.23	77.76	6	5.49	225.1
SPE 90S-32	1453	30	136.02	34.13	101.89	6	6.89	274.9
SPE 90S-36	1635	40	145.55	34.13	111.42	6	6.89	351.9
SPE 90S-40	1818	40	155.08	34.13	120.94	6	6.89	366.6

Note:
Performance conforms to ISO 9906:2012, Grade 3B.
Minimum submergence is 5 ft.

Related information

Material specification (SPE 90S-SPE 300S)
Connecting pieces / Adaptors

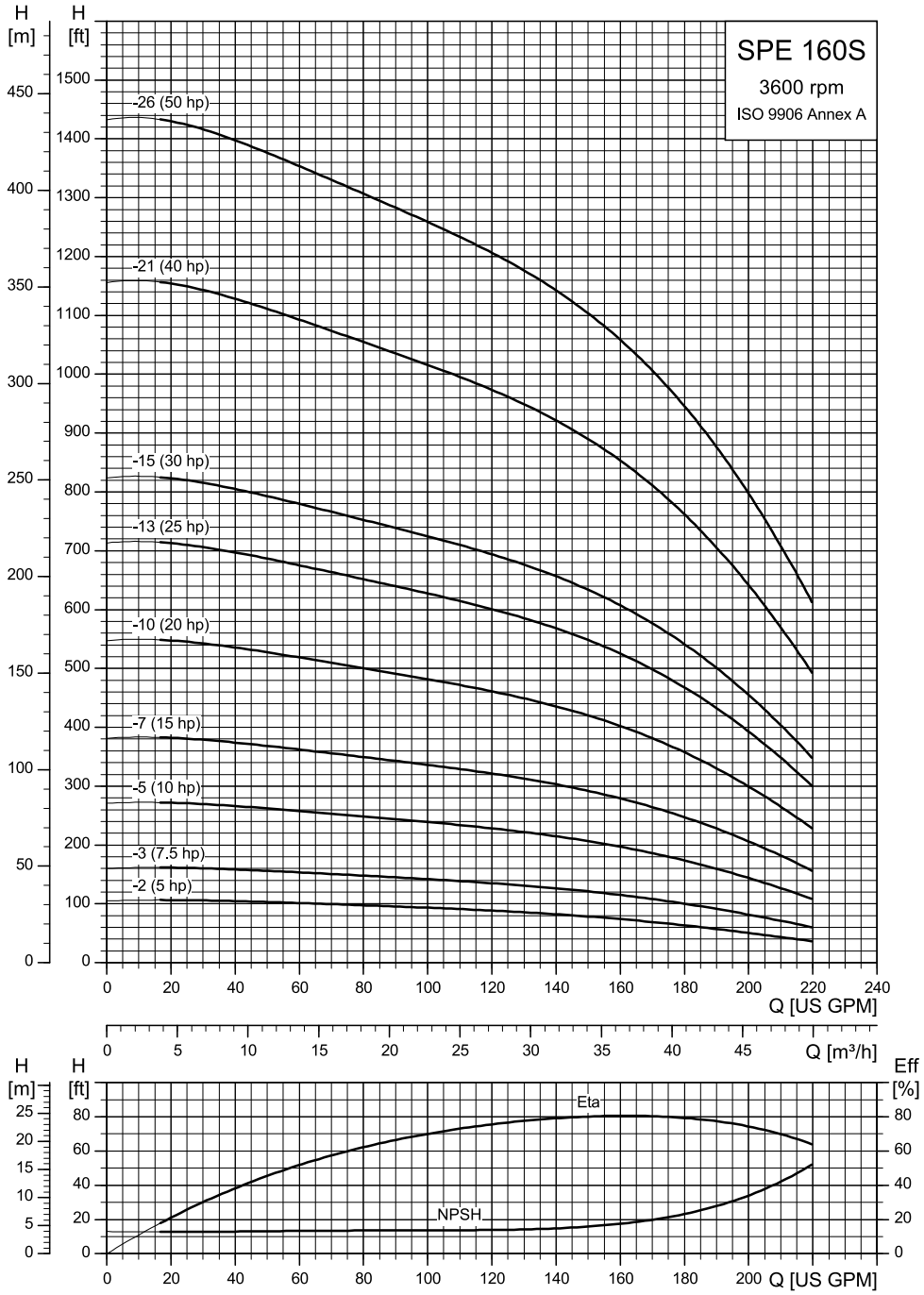
Power curves



TM084246

SPE 160S

Performance curves



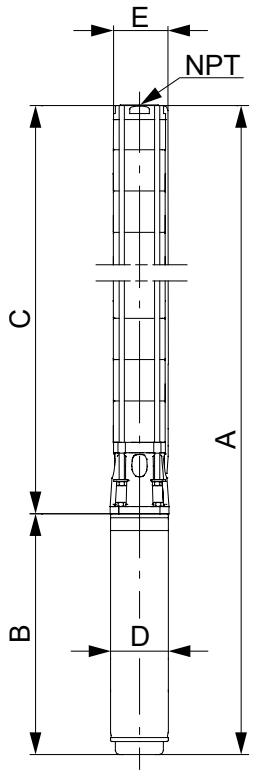
TM087029

Related information

How to read the curve charts

Dimensions and weights

SPE 160S (160 gpm) pump



TM081342

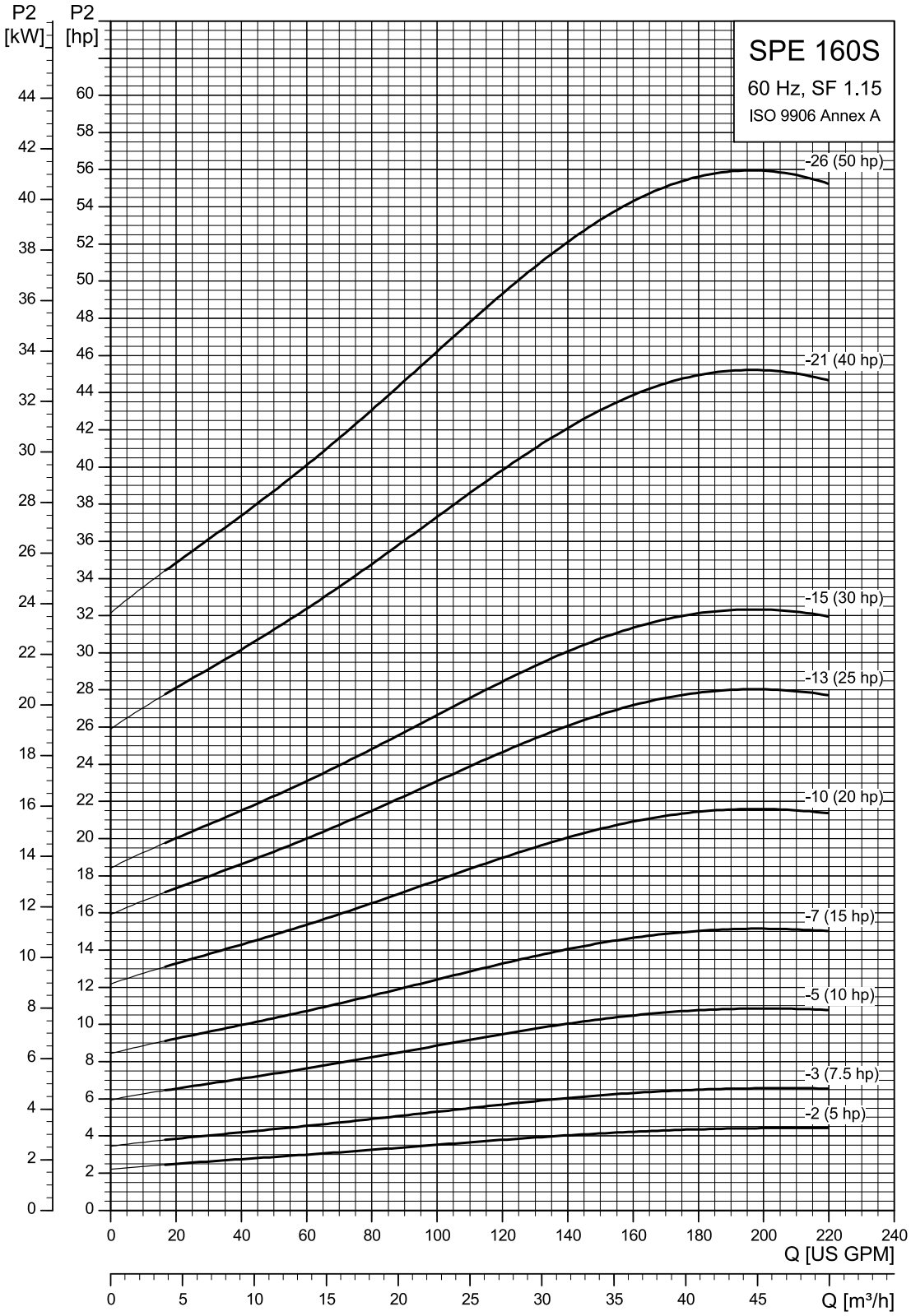
Pump model	Nom. head [ft]	Motor	Dimensions [in]					Net weight (complete) [lb]
		[Hp]	A	B	C	D	E	
160S, 60 Hz - rated flow rate 160 gpm (3" NPT)								
SPE 160S-2	83	5	42.13	23.50	18.62	6	5.59	121.0
SPE 160S-3	125	7.5	45.91	23.50	22.40	6	5.59	125.3
SPE 160S-5	209	10	53.46	23.50	29.96	6	5.59	133.8
SPE 160S-7	292	15	65.75	28.23	37.52	6	5.59	169.9
SPE 160S-10	419	20	77.09	28.23	48.86	6	5.59	182.8
SPE 160S-13	545	25	88.43	28.23	60.20	6	5.59	195.6
SPE 160S-15	624	30	101.89	34.13	67.76	6	5.59	241.8
SPE 160S-18	749	40	113.23	34.13	79.09	6	5.59	254.7
SPE 160S-21	876	40	124.57	34.13	90.43	6	5.59	267.5
SPE 160S-24	1001	50	141.02	39.25	101.77	6	5.59	309.0
SPE 160S-26	1086	50	144.58	39.25	109.33	6	5.59	317.6

Note:
Performance conforms to ISO 9906:2012, Grade 3B.
Minimum submergence is 5 ft.

Related information

Material specification (SPE 90S-SPE 300S)
Connecting pieces / Adaptors

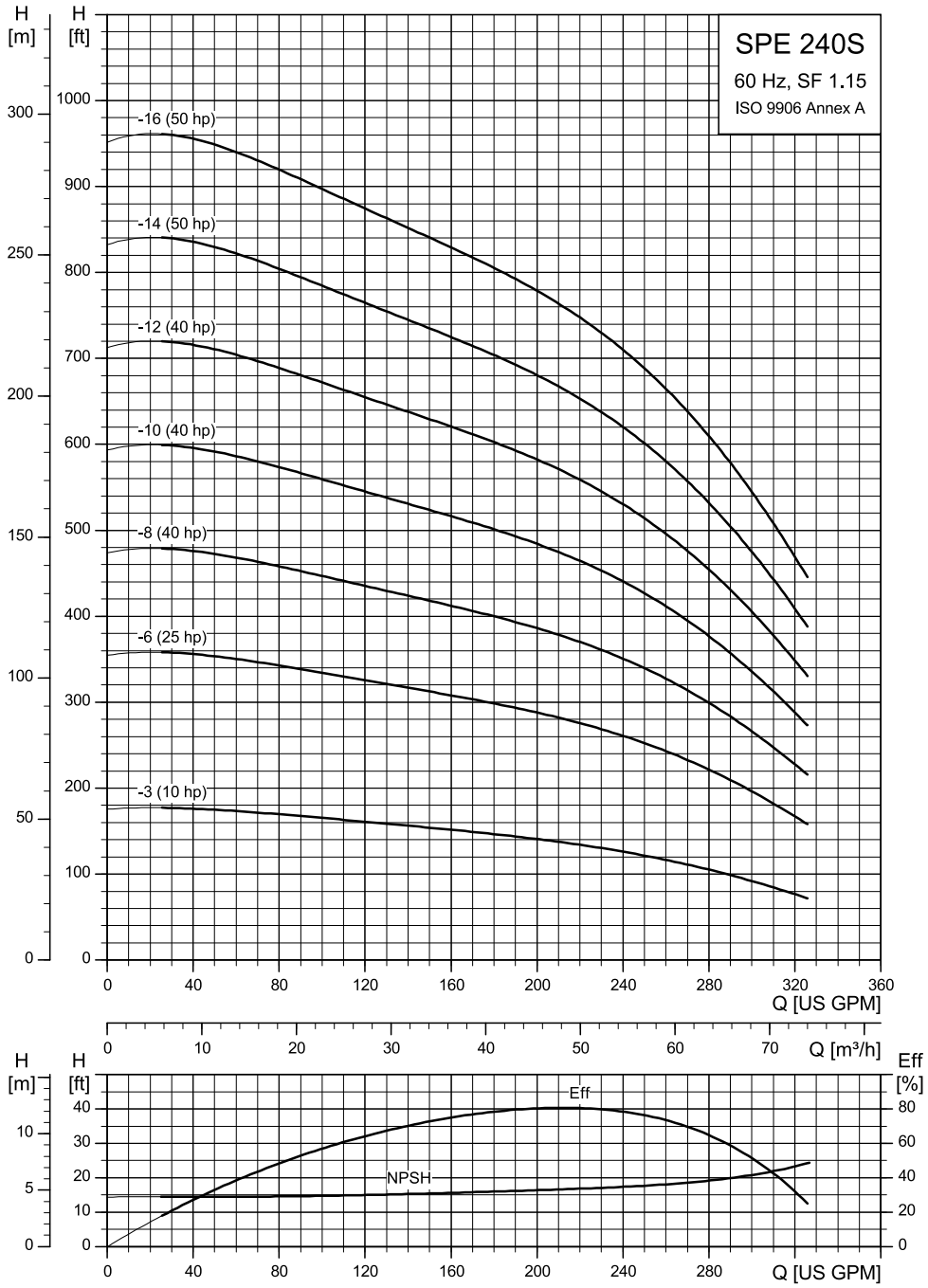
Power curves



TM087030

SPE 240S

Performance curves



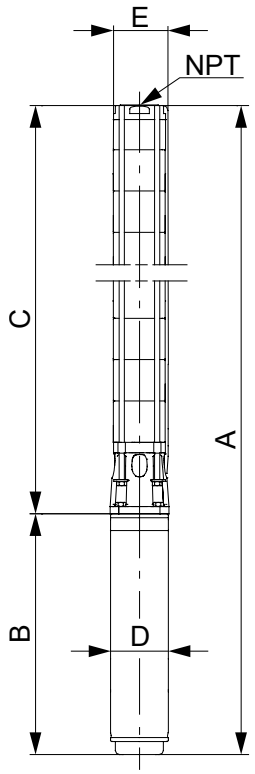
TM092474

Related information

How to read the curve charts

Dimensions and weights

SPE 240S (240 gpm) pump



TM081342

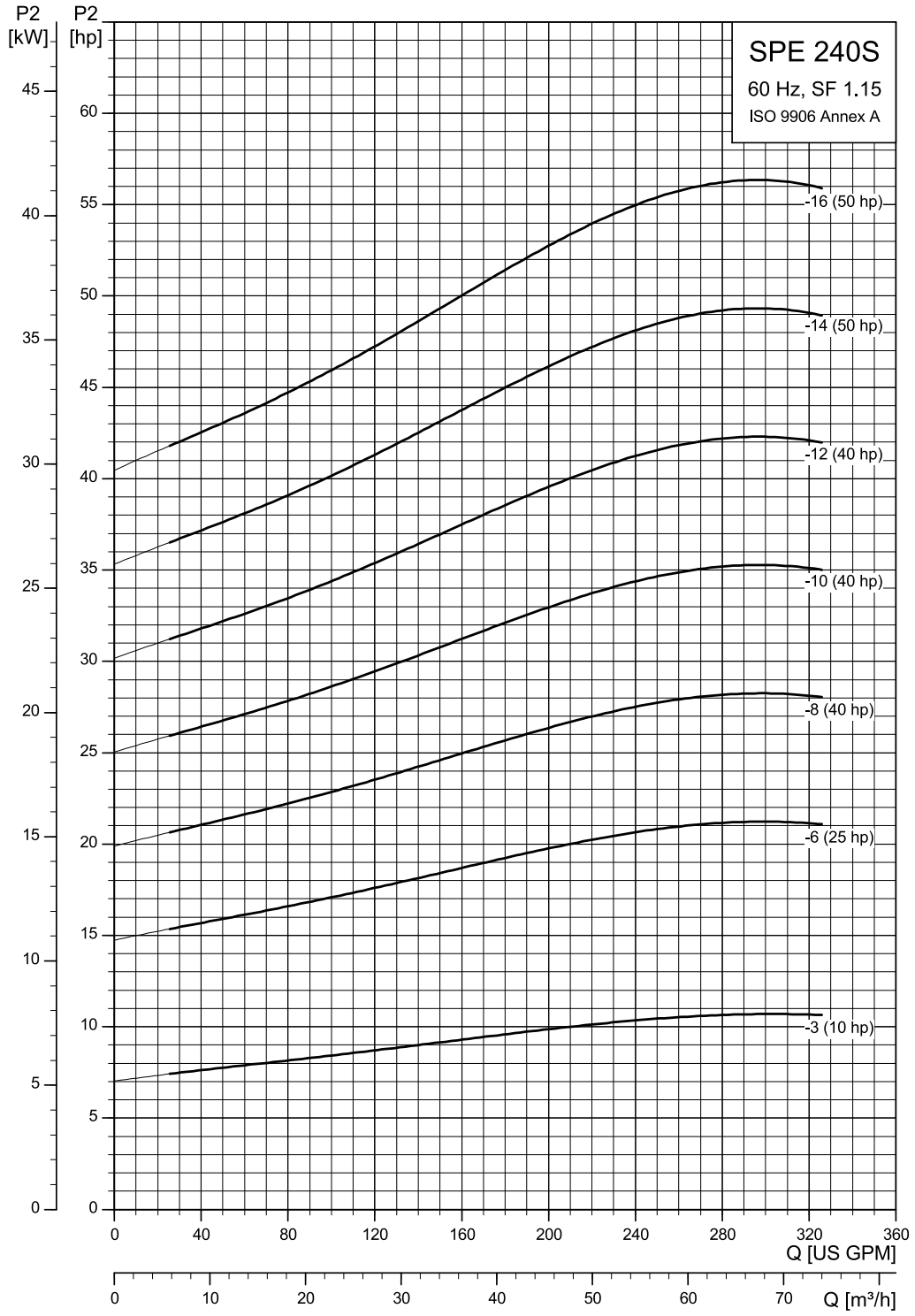
Pump model	Nom. head [ft]	Motor type	Motor [Hp]	Dimensions [in] A	B	C	D	E	Net weight (complete) [lb]
240S, 60 Hz - rated flow rate 240 gpm (4" NPT)									
SPE 240S-3	132	MS6000P	10	47.91	23.50	24.41	6	5.83	130.7
SPE 240S-6	265	MS6000P	25	65.98	28.23	37.76	6	5.83	174.2
SPE 240S-8	353	MS6000P	40	80.68	34.13	46.55	6	5.83	217.7
SPE 240S-10	441	MS6000P	40	89.69	34.13	55,55	6	5.83	233.0
SPE 240S-12	530	MS6000P	40	98.58	34.13	64,45	6	5.83	243.6
SPE 240S-14	620	MS6000P	50	112.60	39.25	73,35	6	5.83	282.9
SPE 240S-16	710	MS6000P	50	121.50	39.25	82,24	6	5.83	293.4

Note:
Performance conforms to ISO 9906:2012, Grade 3B.
Minimum submergence is 8 ft.

Related information

Material specification (SPE 90S-SPE 300S)
Connecting pieces / Adaptors

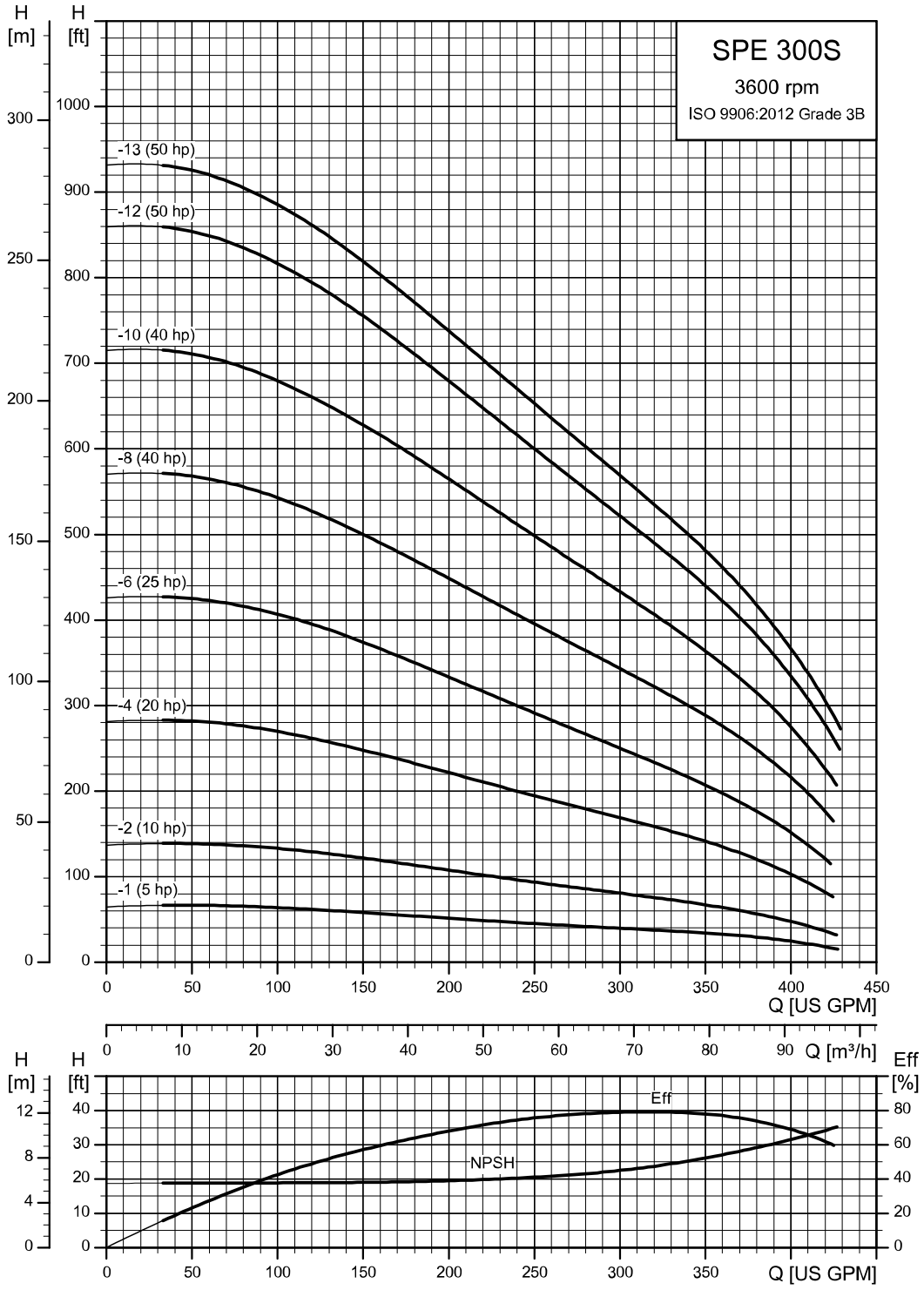
Power curves



TM092475

SPE 300S

Performance curves



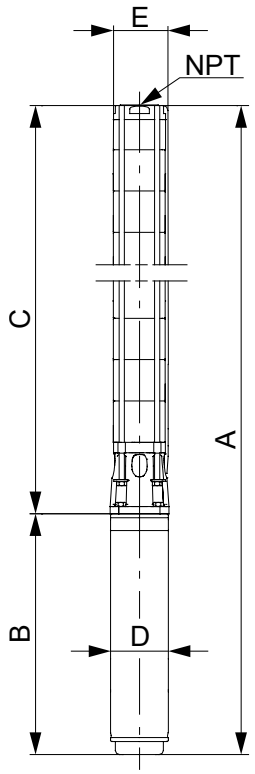
TM081079

Related information

How to read the curve charts

Dimensions and weights

SPE 300S (300 gpm) pump



TM081342

Pump model	Nom. head [ft]	Motor	Dimensions [in]					Net weight (complete) [lb]
		[Hp]	A	B	C	D	E	
300S, 60 Hz - rated flow rate 300 gpm (3" 4" NPT)								
SPE 300S-1 [2]	44	5	39.02	23.50	15.51	6	5.83	120.2
SPE 300S-2 [2]	85	10	43.46	23.50	19.96	6	5.83	125.4
SPE 300S-4 [2]	169	15	57.09	28.23	28.86	6	5.83	163.6
SPE 300S-6 [2]	254	25	65.98	28.23	37.76	6	5.83	174.2
SPE 300S-8 [3]	338	40	80.79	34.13	46.65	6	5.83	222.4
SPE 300S-10 [3]	419	40	89.69	34.13	55.55	6	5.83	233.0
SPE 300S-12 [3]	505	50	103.70	39.25	64.45	6	5.83	272.3
SPE 300S-13 [3]	547	50	108.15	39.25	68.90	6	5.83	277.6

[2] 3" NPT

[3] 4" NPT

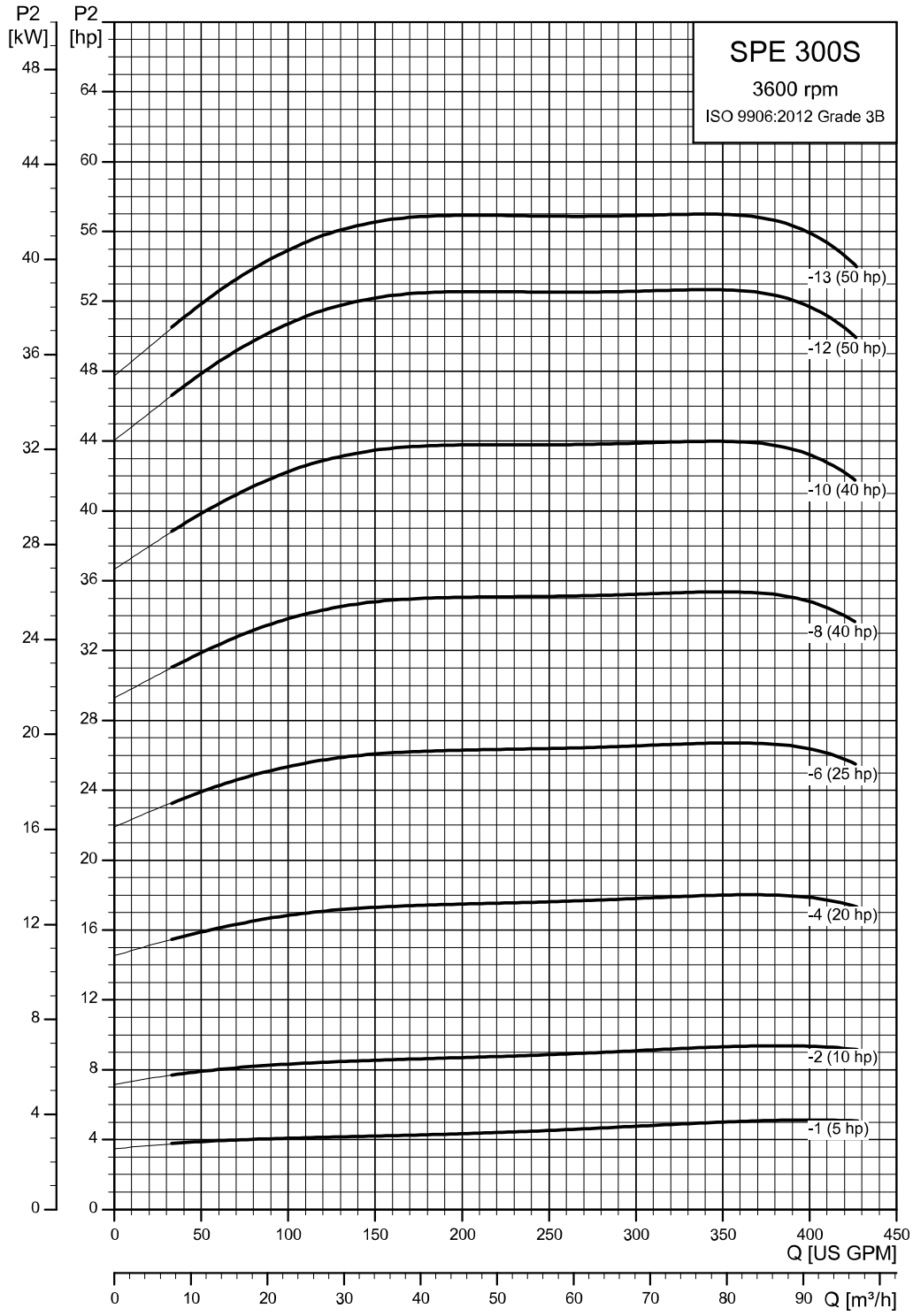
Note:
Performance conforms to ISO 9906:2012, Grade 3B.
Minimum submergence is 8 ft.

Related information

Material specification (SPE 90S-SPE 300S)

Connecting pieces / Adaptors

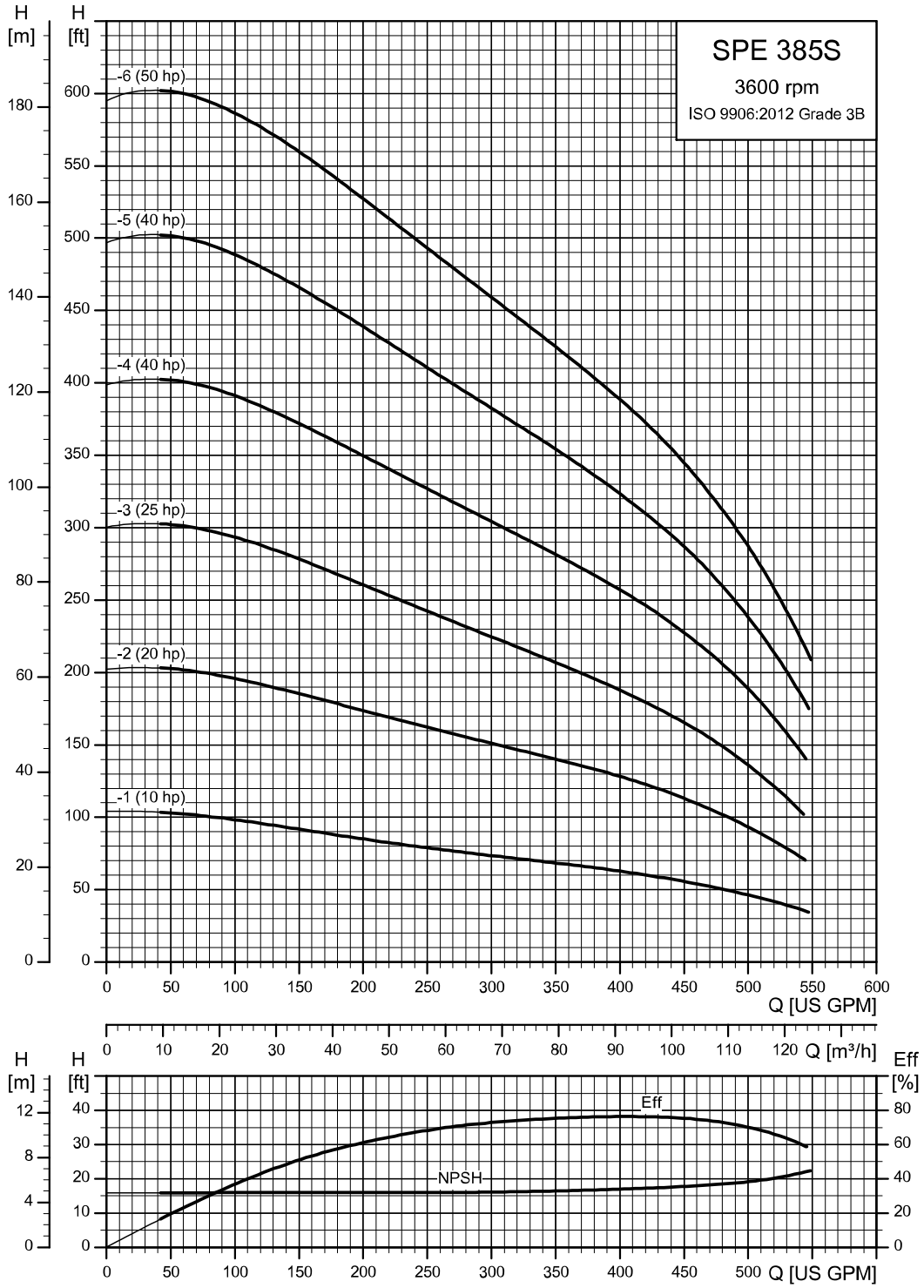
Power curves



TM081080

SPE 385S

Performance curves



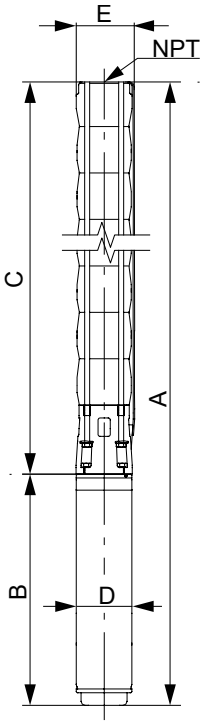
TM081081

Related information

How to read the curve charts

Dimensions and weights

SPE 385S (385 gpm) pump



TM081343

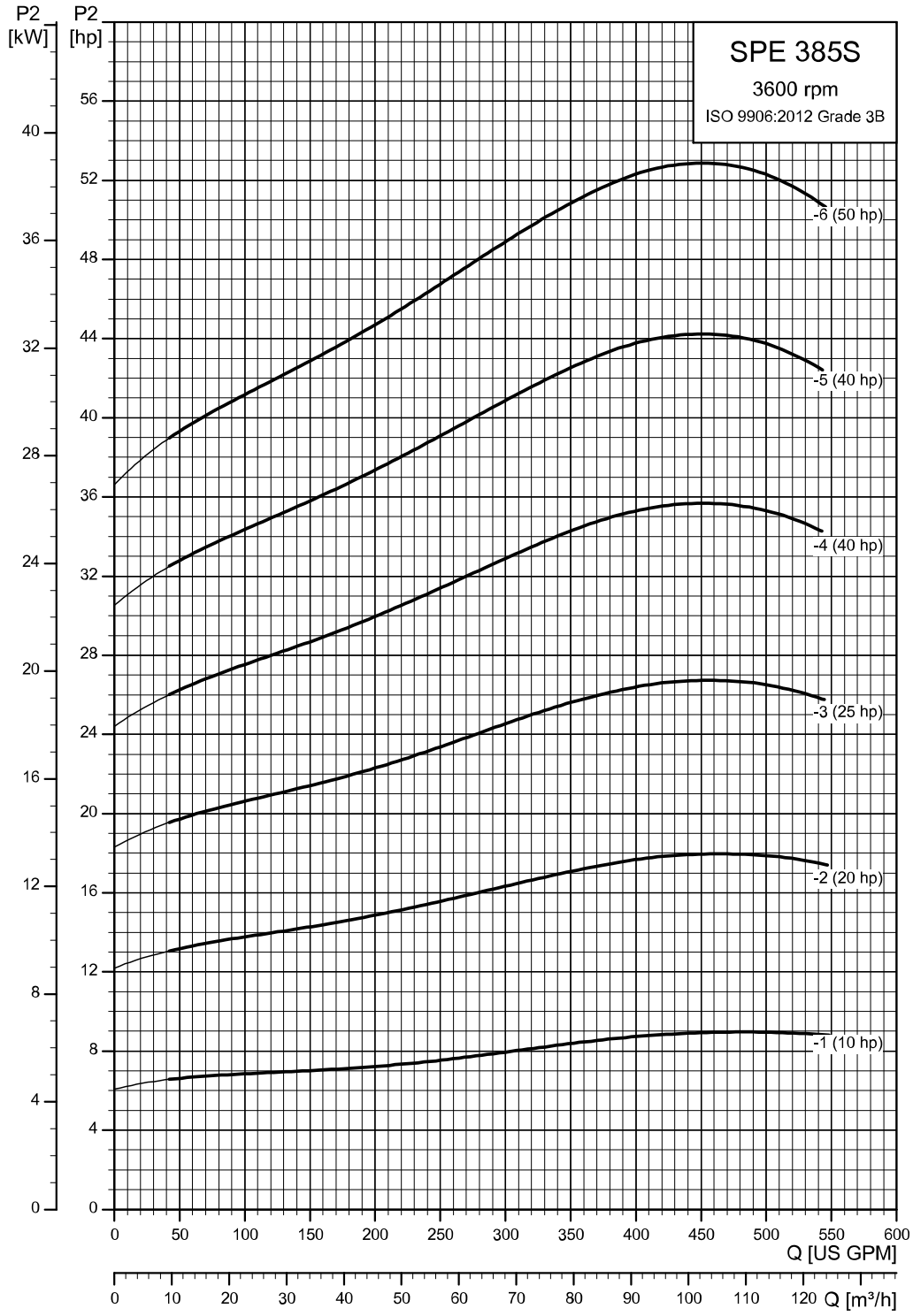
Pump model	Nom. head [ft]	Motor	Dimensions [in]					Net weight (complete) [lb]
		[Hp]	A	B	C	D	E	
385S, 60 Hz - rated flow rate 385 gpm (4" NPT)								
SPE 385S-1	64	10	47.83	23.50	24.33	6	7.05	159.0
SPE 385S-2	129	20	57.60	28.23	29.37	6	7.05	195.8
SPE 385S-3	193	25	62.64	28.23	34.41	6	7.05	205.0
SPE 385S-4	256	40	73.58	34.13	39.45	6	7.05	252.0
SPE 385S-5	321	40	78.62	34.13	44.49	6	7.05	261.2
SPE 385S-6	385	50	88.78	39.25	49.53	6	7.05	299.2

Note:
Performance conforms to ISO 9906:2012, Grade 3B.
Minimum submergence is 8 ft.

Related information

Material specification (SPE 385S-SPE 1100S)
Connecting pieces / Adaptors

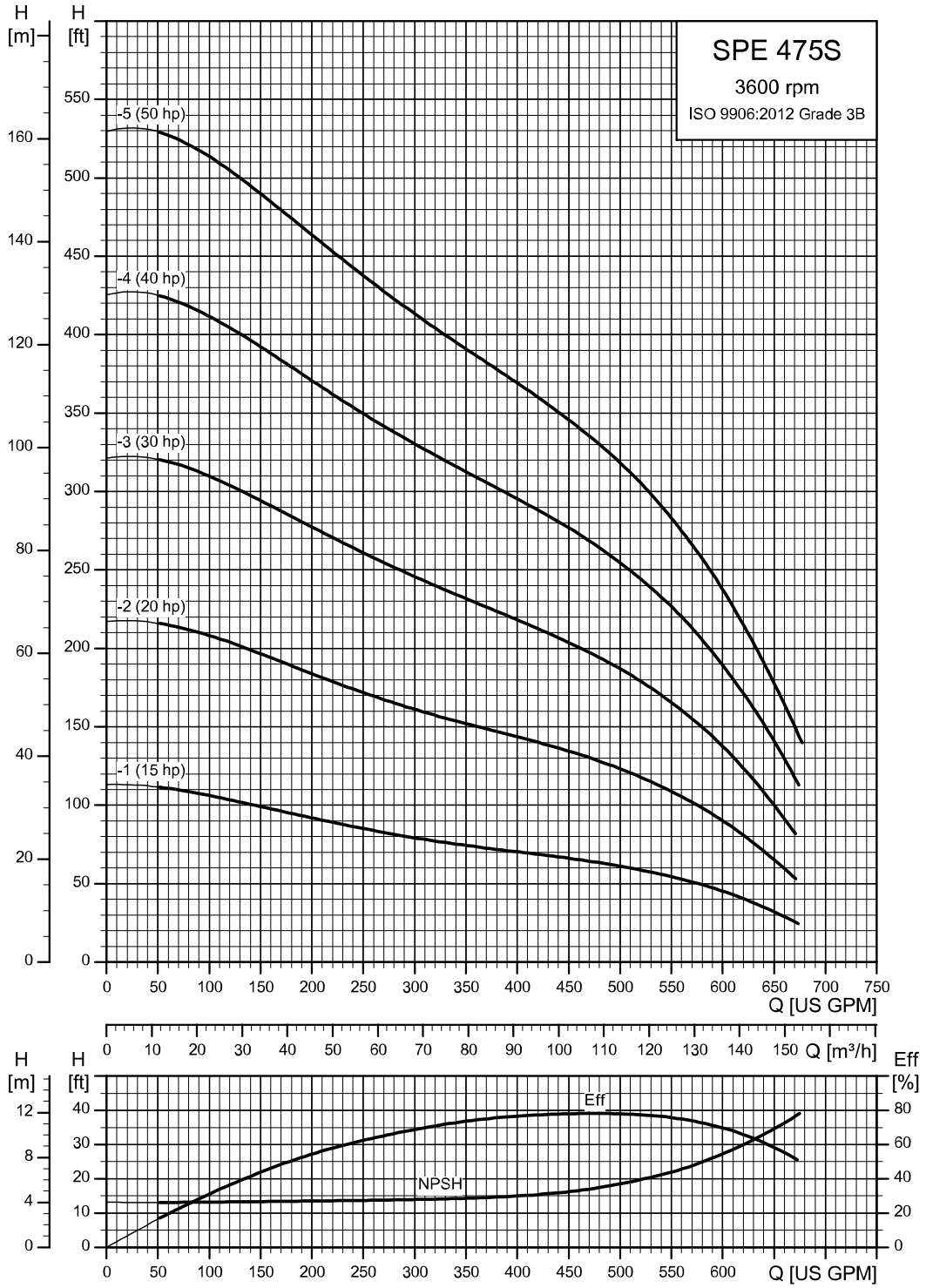
Power curves



TM081082

SPE 475S

Performance curves

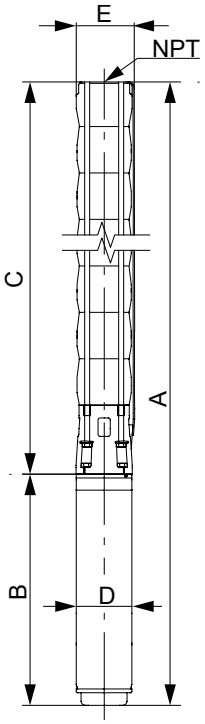


Related information

How to read the curve charts

Dimensions and weights

SPE 475S (475 gpm) pump



TM081343

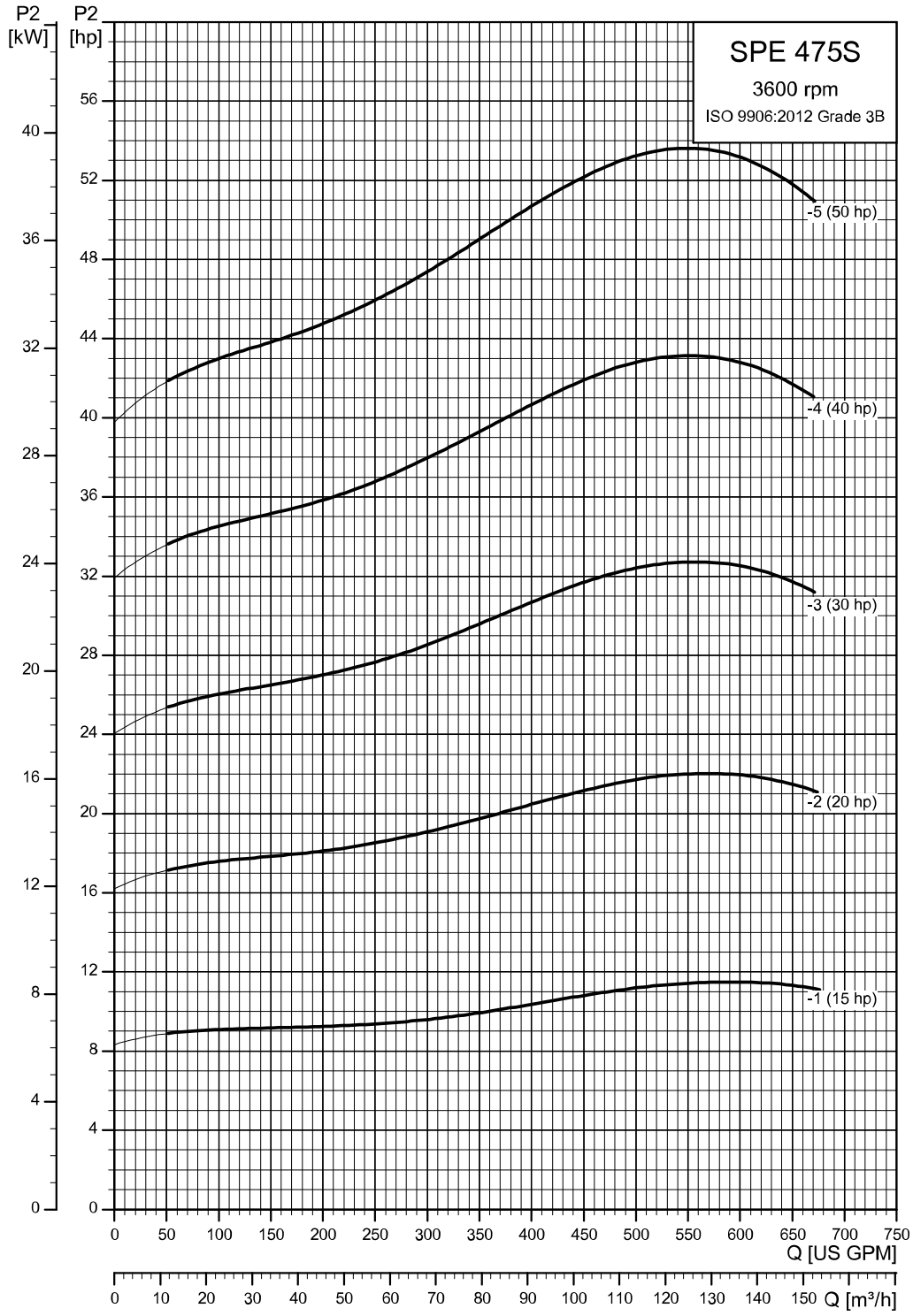
Pump model	Nom. head [ft]	Motor	Dimensions [in]					Net weight (complete) [lb]
		[Hp]	A	B	C	D	E	
475S, 60 Hz - rated flow rate 475 gpm (6" NPT)								
SPE 475S-1	65	15	52.56	28.23	24.33	6	7.05	188.1
SPE 475S-2	132	20	57.60	28.23	29.37	6	7.05	197.3
SPE 475S-3	197	30	68.54	34.13	34.41	6	7.05	244.3
SPE 475S-4	264	40	73.58	34.13	39.45	6	7.05	253.5
SPE 475S-5	331	50	83.74	39.25	44.49	6	7.05	291.5

Note:
Performance conforms to ISO 9906:2012, Grade 3B.
Minimum submergence is 8 ft.

Related information

Material specification (SPE 385S-SPE 1100S)
Connecting pieces / Adaptors

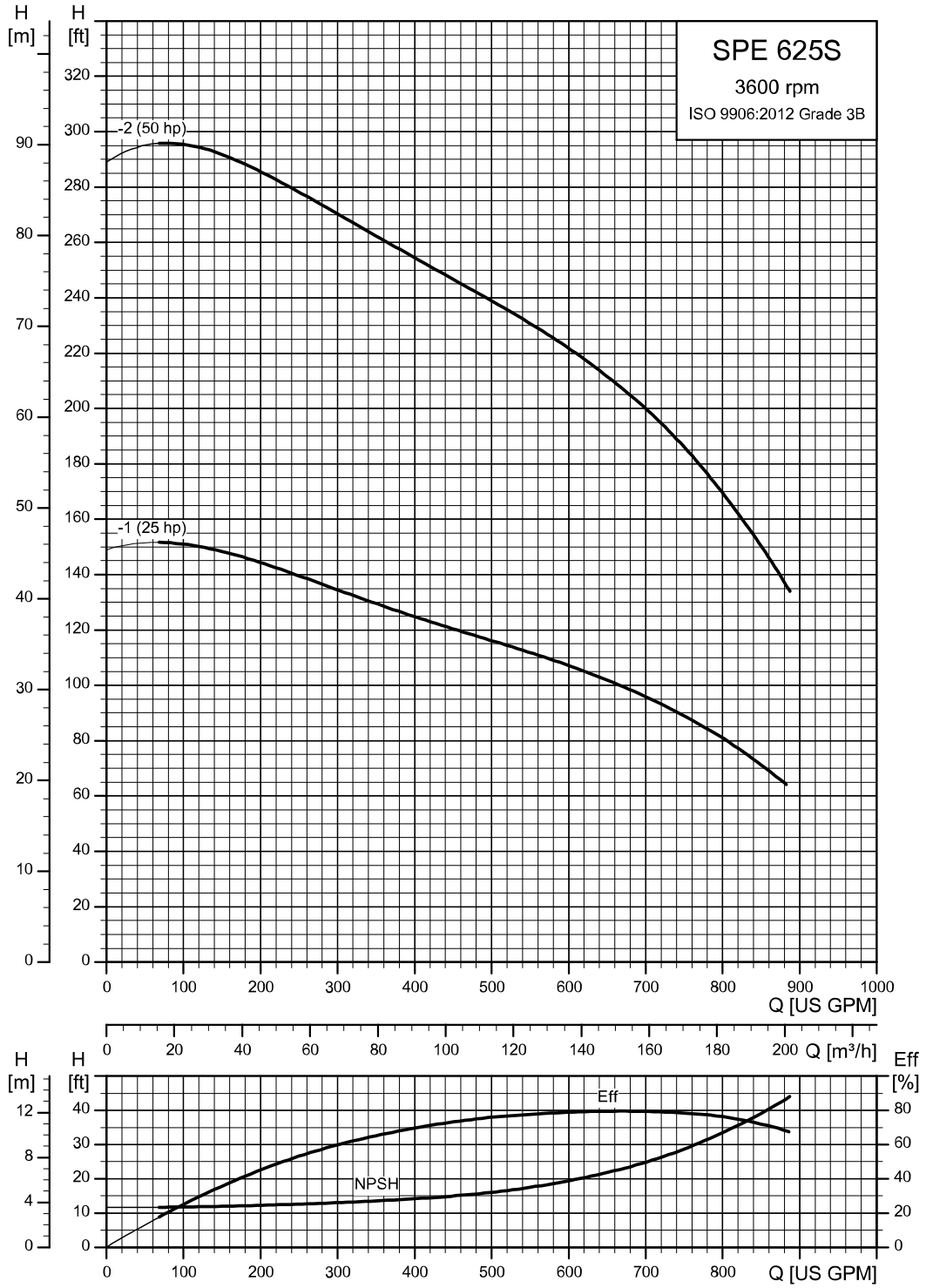
Power curves



TM081084

SPE 625S

Performance curves

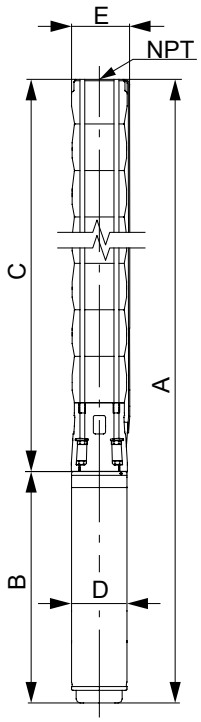


Related information

How to read the curve charts

Dimensions and weights

SPE 625S (625 gpm) pump



TM081344

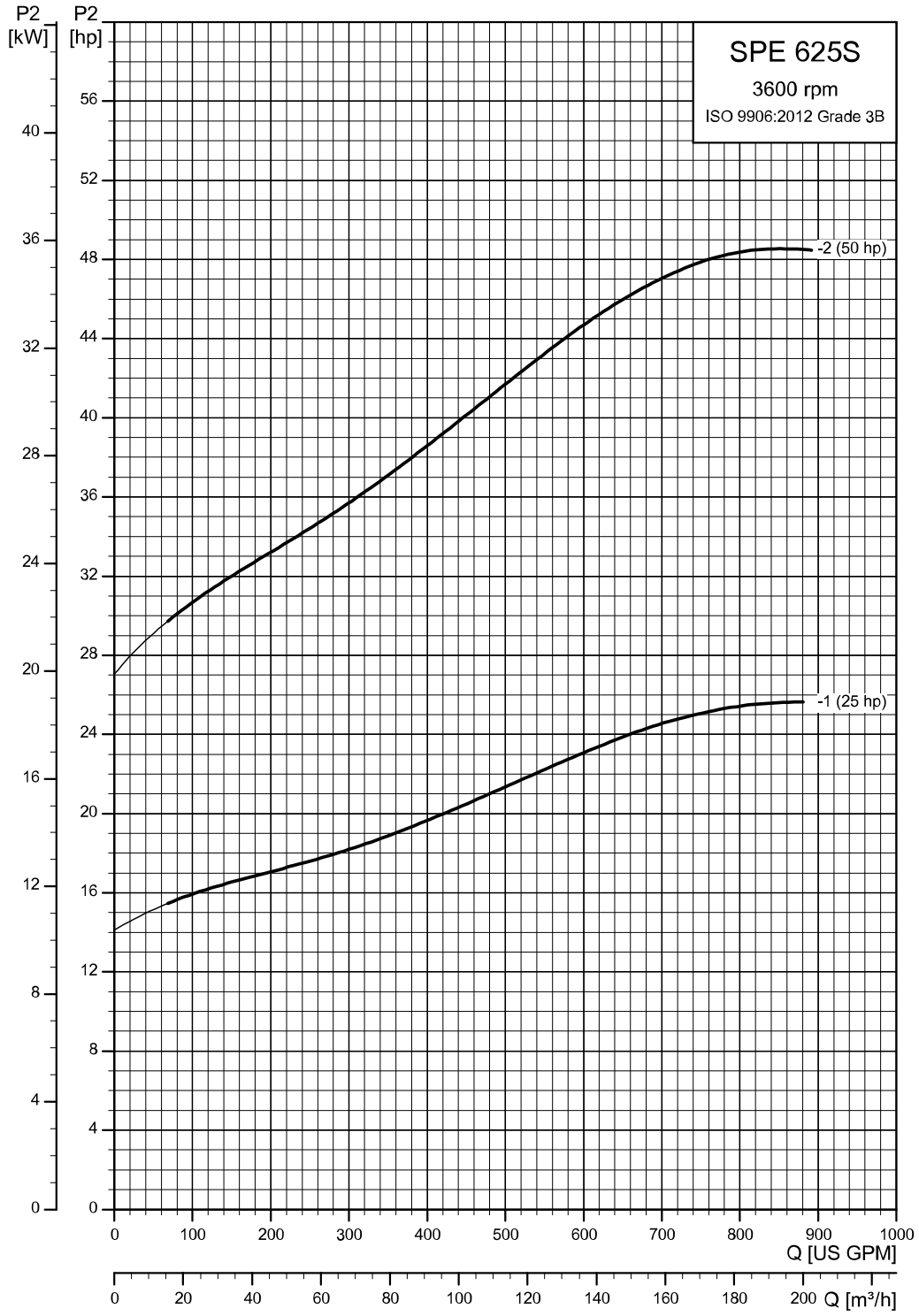
Pump model	Nom. head [ft]	Motor	Dimensions [in]					Net weight (complete) [lb]
		[Hp]	A	B	C	D	E	
625S, 60 Hz - rated flow rate 625 gpm (6" NPT)								
SPE 625S-1	106	25	53.88	28.23	25.65	6	8.31	204.1
SPE 625S-2	212	50	71.02	39.25	31.77	6	8.31	283.7

Note:
Performance conforms to ISO 9906:2012, Grade 3B.
Minimum submergence is 10 ft.

Related information

Material specification (SPE 385S-SPE 1100S)
Connecting pieces / Adaptors

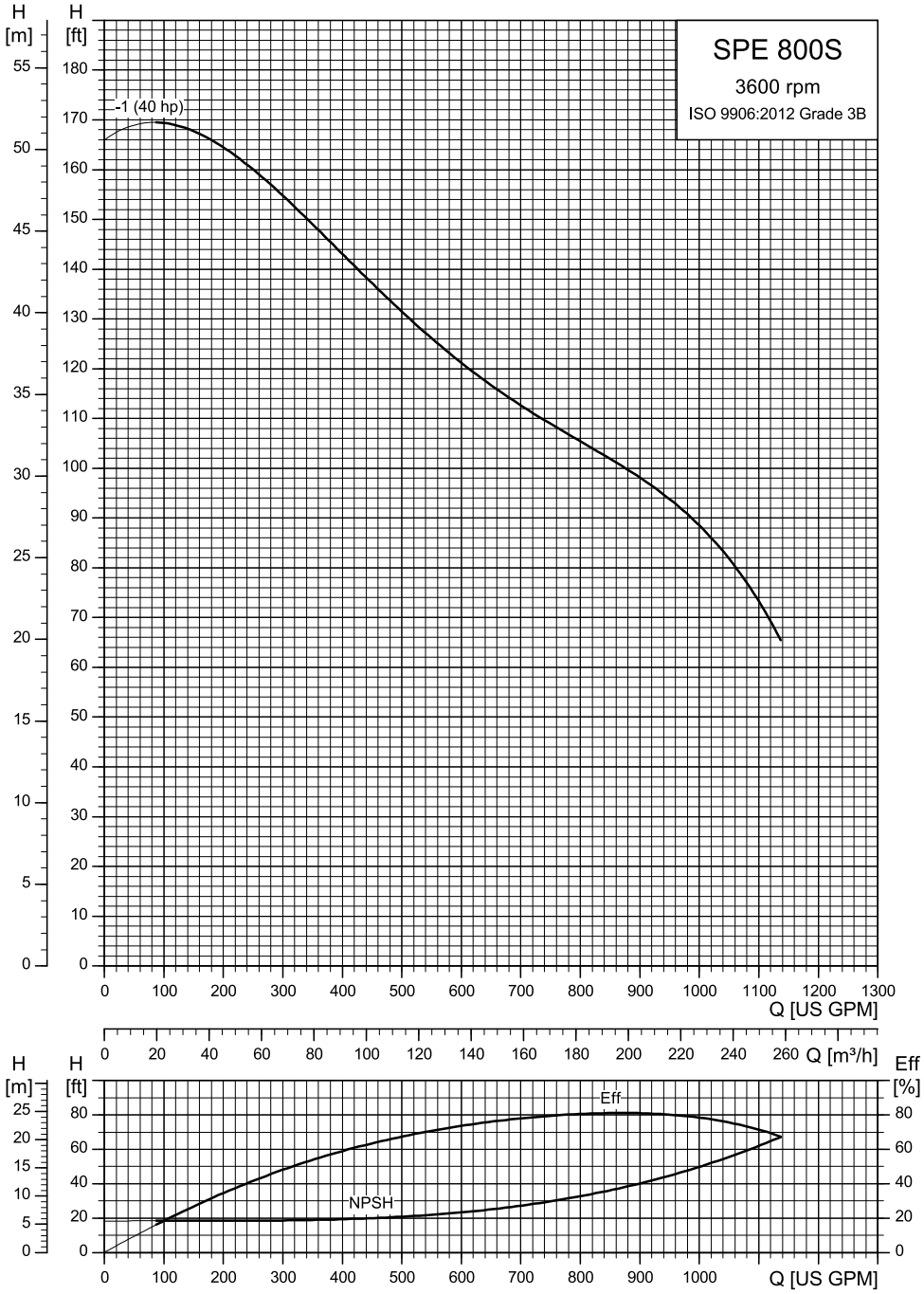
Power curves



TM081086

SPE 800S

Performance curves



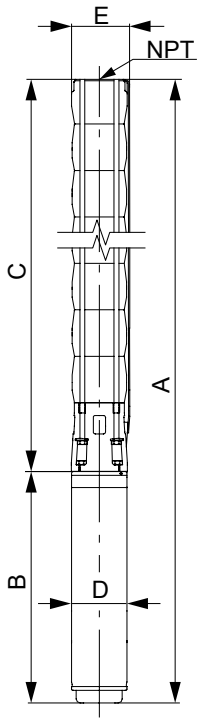
TM081087

Related information

How to read the curve charts

Dimensions and weights

SPE 800S (800 gpm) pump



TM081344

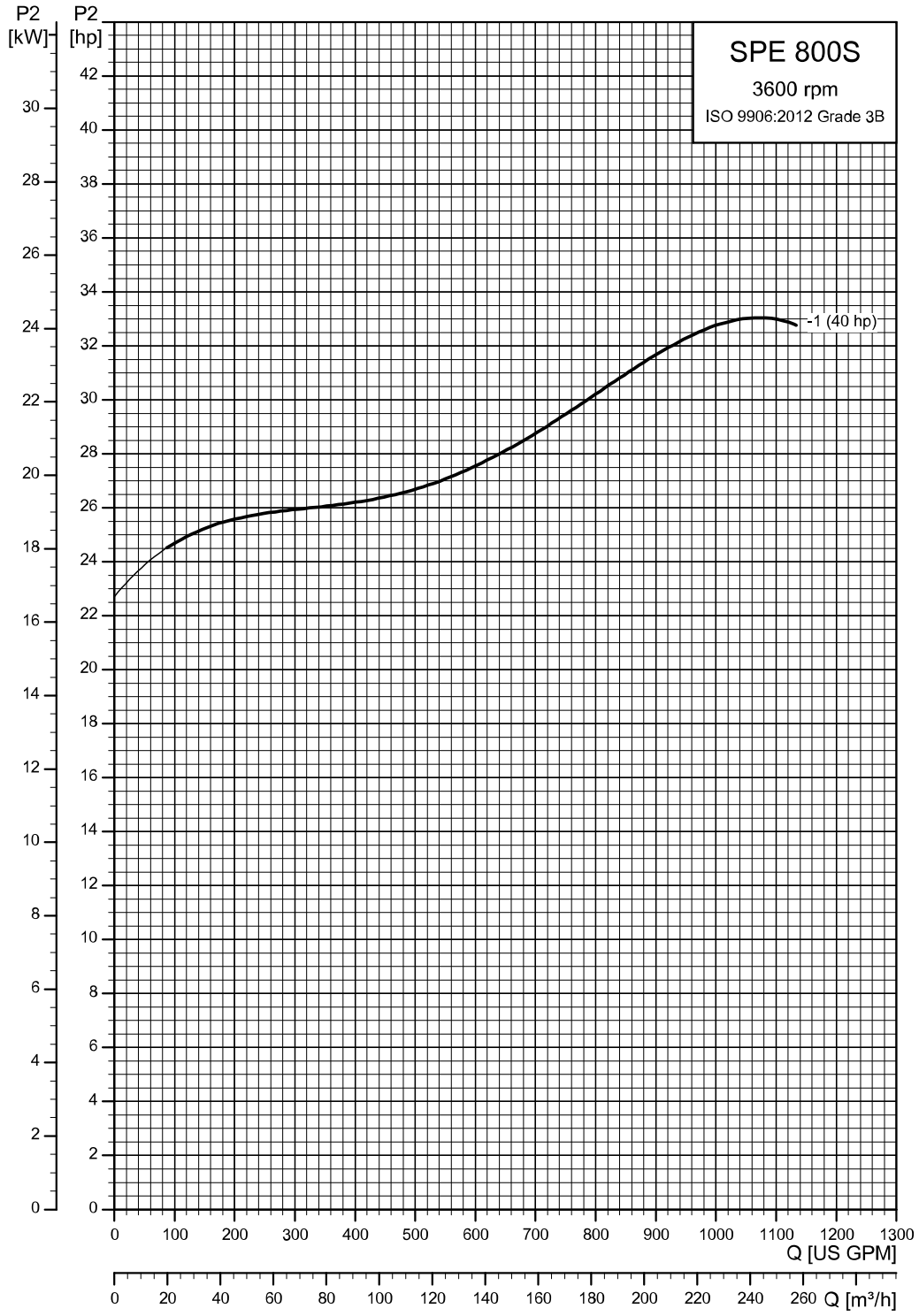
Pump model	Nom. head [ft]	Motor	Dimensions [in]					Net weight (complete) [lb]
		[Hp]	A	B	C	D	E	
800S, 60 Hz - rated flow rate 800 gpm (6" NPT)								
SPE 800S-1	102	30	59.78	34.13	25.65	6	8.31	241.8

Note:
Performance conforms to ISO 9906:2012, Grade 3B.
Minimum submergence is 25 ft.

Related information

Material specification (SPE 385S-SPE 1100S)
Connecting pieces / Adaptors

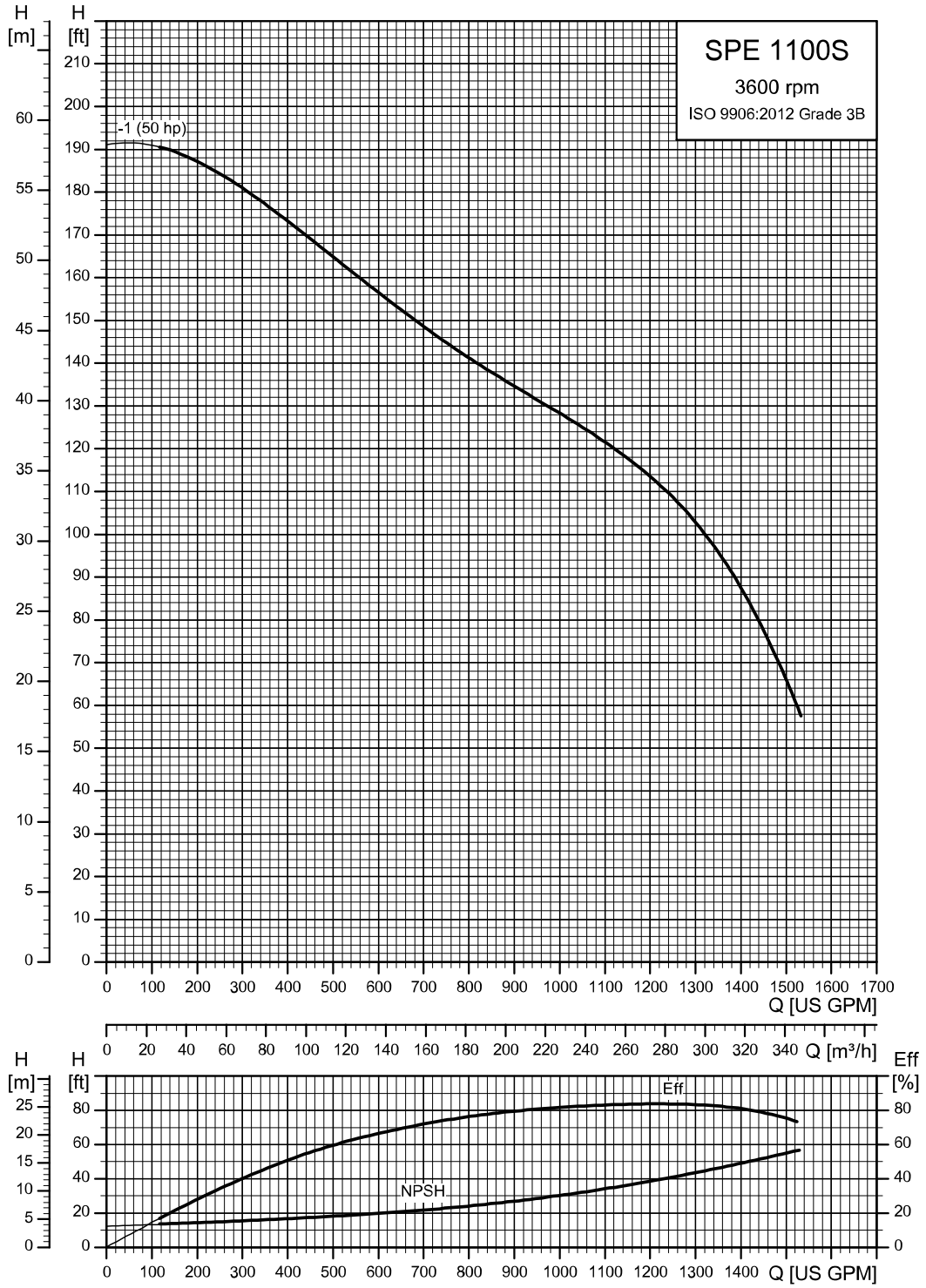
Power curves



TM081088

SPE 1100S

Performance curves

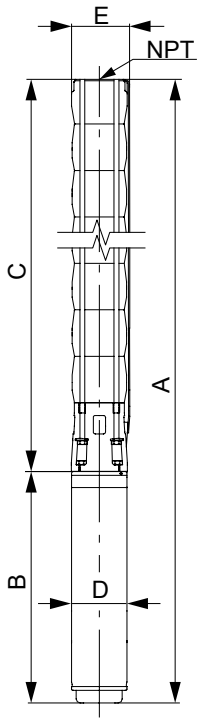


Related information

How to read the curve charts

Dimensions and weights

SPE 1100S (1100 gpm) pump



TM081344

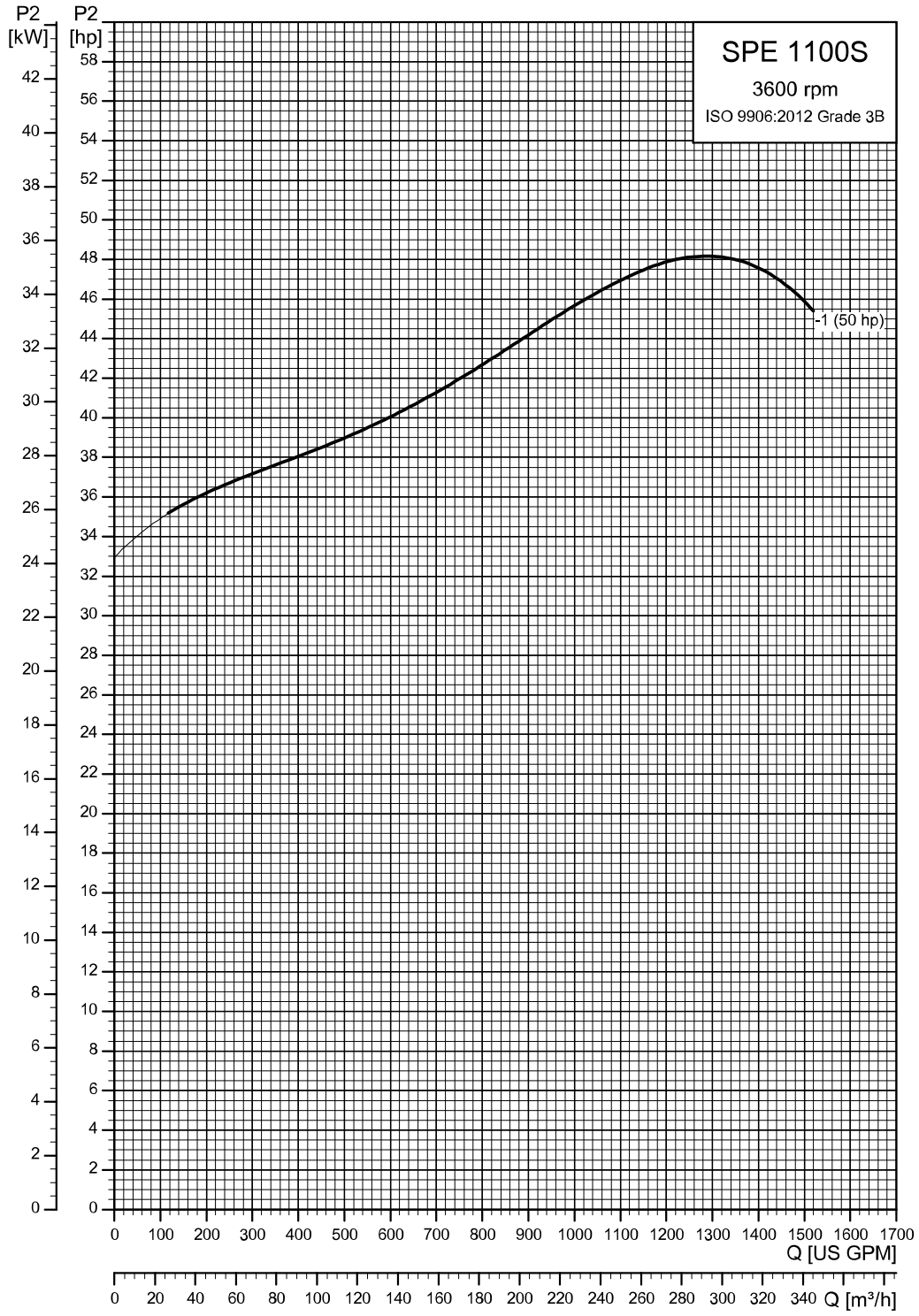
Pump model	Nom. head [ft]	Motor	Dimensions [in]					Net weight (complete) [lb]
		[Hp]	A	B	C	D	E	
1100S, 60 Hz - rated flow rate 1100 gpm (6" NPT)								
SPE 1100S-1	119	50	70.35	39.25	31.10	6	9.29	283.3

Note:
Performance conforms to ISO 9906:2012, Grade 3B.
Minimum submergence is 30 ft.

Related information

Material specification (SPE 385S-SPE 1100S)
Connecting pieces / Adaptors

Power curves



TM081090

8. Electrical data

3 × 410 V 3600 rpm, MS6000P submersible motor T60

Power [hp]	Full-load current I_n [A]	Full-load current SF I_n [A]	Motor efficiency [%]				Power factor				I_{st}/I_n	Build in length	Weight
			η SF	η 50 %	η 75 %	η 100 %	Cos φ SF	Cos φ 50 %	Cos φ 75 %	Cos φ 100 %	[%]	[in]	[lbs]
5.0	8.0	8.8	77.6	83.2	86.1	87.2	0.98	0.97	0.96	0.96			
7.5	11.0	12.4	83.1	87.0	88.8	89.4	0.97	0.96	0.94	0.92		23.5	81
10	14.4	16.2	86.2	88.9	89.9	90.1	0.9	0.94	0.90	0.88			
15	21.4	24.2	87.2	90.4	91.8	92.4	0.98	0.96	0.95	0.94			
20	28.2	32.2	89.8	92.0	92.8	92.8	0.97	0.94	0.92	0.90	100	28.2	108
25	34.2	39.	91.0	92.6	93.0	93.0	0.96	0.93	0.90	0.88			
30	39.4	44.8	89.8	92.0	92.8	93.0	0.97	0.94	0.93	0.92		34.1	141
40	52.6	60.0	91.6	92.9	93.1	93.0	0.95	0.93	0.91	0.91			
50	72.6	82.	89.9	91.8	92.4	92.5	0.93	0.90	0.87	0.86		39.3	179

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.

Grundfos Communication Interface Units (CIU)

CIU

The CIU enables data communication through open and interoperable networks, such as the following:

- PROFIBUS DP
- PROFINET
- Modbus RTU
- Modbus TPC
- EtherNet/IP
- LON
- BACnet MS/TP
- BACnet IP
- Grundfos Remote Management (GRM) for complete control of pump systems.

Applications

Grundfos CIU offers easy installation and commissioning. All units are based on standard functional profiles for an easy integration into the network.

The CIU units enable communication of operating data between pumps and the following:

- PLC
- SCADA system
- Building management system.

Benefits

The CIU offers the following benefits:

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

For data communication between an SPE pump and a main network, a CIU unit with a CUE is required.

Fieldbus support for these products is indicated in the table below.

To create a CIU xxx version, a CIU 900 + CIM xxx interface must be ordered.

CIU unit	Fieldbus protocol	Product numbers	
		CIU 900	CIM
CIU 100	LON	99448387	96824797
CIU 150	PROFIBUS DP		96824793
CIU 200	Modbus RTU		96824796
CIU 260-EU [4]	3G/4G cellular		99439302
CIU 280-EU [5]	Grundfos iSOLUTIONS Cloud/GRM 3G/4G		99439724
CIU 300	BACnet MS/TP		96893770
CIU 500	PROFINET Modbus TCP BACnet IP EtherNet/IP GRM IP		98301408

4) Requires an antenna kit.

5) Grundfos Remote Management (GRM) is an easy-to-install, low-cost solution for wireless monitoring and management of Grundfos products. It requires an antenna kit. 3G/4G SIM card must have additional international PDU SMS roaming active.

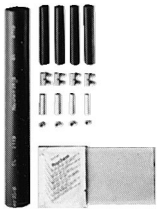
Antennas for CIU 260 and 280

Description	Product number
Antenna kit	99518079

Pt100 and accessories

Pt100 sensor, including cable for standard-, N- and R-versions	Cable length [ft]	Product number
	60	96913237
	120	96913253
	180	96913256
	240	96913260
	300	96913263

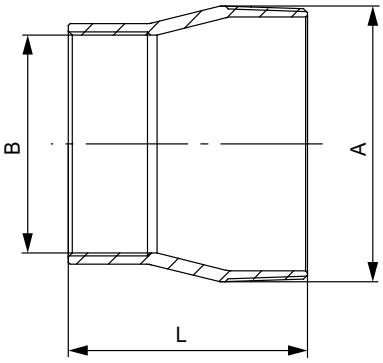
Staybolt kits for Pt100	Description	Product number
	Staybolt kit for Pt100. Material: EN 1.4401/AISI 316.	97550639
	Staybolt kit for Pt100. Material: EN 1.4539/AISI 90L.	96803373

Extension kit for sensor cable for Pt100		Description	Product number
	TM007885	Extension kit for Pt100 sensor cable. For watertight shrink-joining of the sensor cable. Extra sensor cable must be ordered separately.	99039717

Sensor cable		Description	Product number
	TM007882	Drop cable for extension: 4 × 0.0015 in^2 Mention length when ordering. Maximum recommended length: 1150 ft.	00RM5271

10. Mechanical accessories

Connecting pieces / Adaptors



TM012397

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

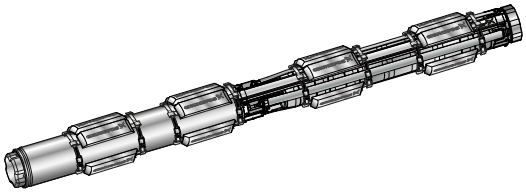
Type	Connecting piece	Dimensions			Product number	
		Thread-to-thread		L		
		A	B	[in]	304 stainless steel	316 stainless steel
385S	NPT 5 → NPT 4	NPT 5	NPT 4	4.76	190064	190586
475S	NPT 5 → NPT 6	NPT 5	NPT 6	5.91	190070	190592
625S **800S** **1100S**	NPT 6 → NPT 5	NPT 6	NPT 5	5.91	200135	200645

Zinc anodes

Application

Cathodic protection by 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

More information about zinc anode and product numbers are available in **SP accessories data booklet**.

Flow sleeves

Grundfos offers a complete range of stainless-steel flow sleeves for both vertical and horizontal operation. Flow sleeves are recommended for all applications in which motor cooling is insufficient. The result is a general extension of motor lifespan. Flow sleeves are to be fitted in the following 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 18 °F the temperature rises.
- If sedimentation or deposits occur around and/or on the motor.

More information about flow sleeves and product numbers are available in SPE accessories data booklet and on Grundfos Product Center.

https://product-selection.grundfos.com.

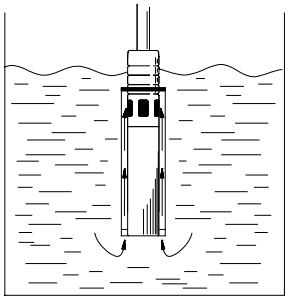
TM010750

TM010751

Flow sleeves

Example of a 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, ensuring optimum motor cooling. See the figure below.



TM010509

Flow sleeve function

The flow sleeve is designed so that the flow velocity past the motor is minimum 1.6 ft/s and maximum 10 ft/s to ensure optimum pump operating conditions.

Use the following formula to calculate the flow velocity:

$$V = \frac{Q \times 0.125}{D^2 - d^2} \quad [ft/s]$$

Q	GPM	Flow rate
D	inch	Sleeve diameter
d	inch	Pump diameter

11. Cable sizing

Cable dimensions at 3 × 410 V, 120 Hz motor supply, valid for AWG and MCM cables

Maximum submersible power cable length at 86 °F ambient temperature and a maximum conductor temperature of 140 °F																
Motor rating [hp]	AWG copper wire [ft]													MCM copper wire size [ft]		
	14	12	10	8	6	4	3	2	1	0	00	000	0000	250	300	40
5	484	763	1215	1915	3035	4758	5950	7410	9235	-	-	-	-	-	-	-
7.5	354	559	888	1399	2212	3458	4316	5361	6661	8224	-	-	-	-	-	-
10	284	448	713	1124	1782	2796	3498	4359	5437	6744	8350	-	-	-	-	-
15	-	284	451	711	1127	1766	2208	2749	3426	4244	5247	6438	7869	9075	-	-
20	-	-	-	563	890	1390	1734	2152	2672	3296	4054	4944	5998	6874	7900	9757
25	-	-	-	466	737	1154	1441	1792	2229	2757	3401	4162	5070	5832	6730	8374
30	-	-	-	-	620	971	1212	1507	1874	2318	2858	3496	4257	4894	5645	7018
40	-	-	-	-	-	728	907	1126	1396	1721	2114	2574	3118	3569	4095	5043
50	-	-	-	-	-	-	687	851	1054	1297	1590	1932	2334	2666	3051	3741

Note:

1. The table is based on a jacketed, 4-lead copper wire.
2. The maximum permissible temperature of the conductor is 140 °F.
3. Make sure that the portion of the total cable, which is between the service entrance and a motor starter/controller, does not exceed 25 % of the total maximum length to ensure reliable starter operation.
4. The table is based on a maintaining motor terminal voltage at 95 % of service entrance voltage, running at the maximum current stated on the nameplate.

Maximum submersible power cable length at 86 °F ambient temperature and a maximum conductor temperature of 167 °F																
Motor rating [hp]	AWG copper wire [ft]													MCM copper wire size [ft]		
	14	12	10	8	6	4	3	2	1	0	00	000	0000	250	300	40
5	484	763	1215	1915	3035	4758	5950	7410	9235	-	-	-	-	-	-	-
7.5	354	559	888	1399	2212	3458	4316	5361	6661	8224	-	-	-	-	-	-
10	284	448	713	1124	1782	2796	3498	4359	5437	6744	8350	-	-	-	-	-
15	-	284	451	711	1127	1766	2208	2749	3426	4244	5247	6438	7869	9075	-	-
20	-	-	357	563	890	1390	1734	2152	2672	3296	4054	4944	5998	6874	7900	9757
25	-	-	-	466	737	1154	1441	1792	2229	2757	3401	4162	5070	5832	6730	8374
30	-	-	-	392	620	971	1212	1507	1874	2318	2858	3496	4257	4894	5645	7018
40	-	-	-	-	466	728	907	1126	1396	1721	2114	2574	3118	3569	4095	5043
50	-	-	-	-	-	551	687	851	1054	1297	1590	1932	2334	2666	3051	3741

Note:

1. The table is based on a jacketed, 4-lead copper wire.
2. The maximum permissible temperature of the conductor is 167 °F.
3. Make sure that the portion of the total cable, which is between the service entrance and a motor starter/controller, does not exceed 25 % of the total maximum length to ensure reliable starter operation.
4. The table is based on a maintaining motor terminal voltage at 95 % of service entrance voltage, running at the maximum current stated on the nameplate.

12. Head loss

Friction loss tables

		SCH 40 steel pipe								
		.5"	.75"	1"	1.25"	1.5"	2"	2.5"	3"	4"
[US gpm]	[US gph]	ID 0.622"	ID 0.824"	ID 1.049"	ID 1.380"	ID 1.610"	ID 2.067"	ID 2.469"	ID 3.068"	ID 4.026"
		Friction loss in feet of head per 100 feet of pipe								
2	120	4.8								
3	180	10.0	2.5							
4	240	17.1	4.2							
5	300	25.8	6.3	1.9						
6	360	36.5	8.9	2.7						
7	420	48.7	11.8	3.6						
8	480	62.7	15.0	4.5						
9	540	78.3	18.8	5.7						
10	600	95.9	23.0	6.9						
12	720		32.6	9.6	2.5	1.2				
14	840		43.5	12.8	3.3	1.5				
16	960		56.3	16.5	4.2	2.0				
20	1,200		86.1	25.1	6.3	2.9				
25	1,500			38.7	9.6	4.5	1.3			
30	1,800			54.6	13.6	6.3	1.8			
35	2,100			73.3	18.2	8.4	2.4			
40	2,400			95.0	23.5	10.8	3.1	1.3		
45	2,700				29.4	13.5	3.9	1.6		
50	3,000				36.0	16.4	4.7	1.9		
60	3,600				51.0	23.2	6.6	2.7		
70	4,200				68.8	31.3	8.9	3.6	1.2	
80	4,800				89.2	40.5	11.4	4.6	1.6	
90	5,400					51.0	14.2	5.8	2.0	
100	6,000					62.2	17.4	7.1	2.4	
120	7,200						24.7	10.1	3.4	
140	8,400						33.2	13.5	4.5	1.2
160	9,600						43.0	17.5	5.8	1.5
200	12,000						66.3	27.0	8.9	2.3
260	15,600							45.0	14.8	3.7
300	18,000							59.6	19.5	4.9

		SCH 40 PVC pipe								
		.5"	.75"	1"	1.25"	1.5"	2"	2.5"	3"	4"
[US gpm]	[US gph]	ID 0.622"	ID 0.824"	ID 1.049"	ID 1.380"	ID 1.610"	ID 2.067"	ID 2.469"	ID 3.068"	ID 4.026"
		Friction loss in feet of head per 100 feet of pipe								
2	120	4.1								
3	180	8.7	2.2							
4	240	14.8	3.7							
5	300	22.2	5.7	1.8						
6	360	31.2	8.0	2.5						
7	420	41.5	10.6	3.3						
8	480	53.0	13.5	4.2						
9	540	66.0	16.8	5.2						
10	600	80.5	20.4	6.3	1.7					
12	720		28.6	8.9	2.3	1.1				
14	840		38.0	11.8	3.1	1.4				
16	960		48.6	15.1	4.0	1.9				
20	1,200		60.5	22.8	6.0	2.8				
25	1,500			38.7	9.1	4.3	1.3			
30	1,800				12.7	6.0	1.8			
35	2,100				16.9	8.0	2.4			
40	2,400				21.6	10.2	3.0	1.1		
45	2,700				28.0	12.5	3.8	1.4		
50	3,000					15.4	4.6	1.7		
60	3,600					21.6	6.4	2.3		
70	4,200					28.7	8.5	3.0	1.2	
80	4,800					36.8	10.9	3.8	1.4	
90	5,400					45.7	13.6	4.8	1.8	
100	6,000					56.6	16.5	5.7	2.2	
120	7,200						23.1	8.0	3.0	
140	8,400						30.6	10.5	4.0	1.1
160	9,600						39.3	13.4	5.0	1.4
200	12,000						66.3	20.1	7.6	2.1
260	15,600							32.4	12.2	3.4
300	18,000							42.1	15.8	4.4

Note:

Based on Schedule 40 steel and plastic fittings.

Friction loss figures are for screwed valves and are based on equivalent lengths of steel pipe.

13. Grundfos Product Center

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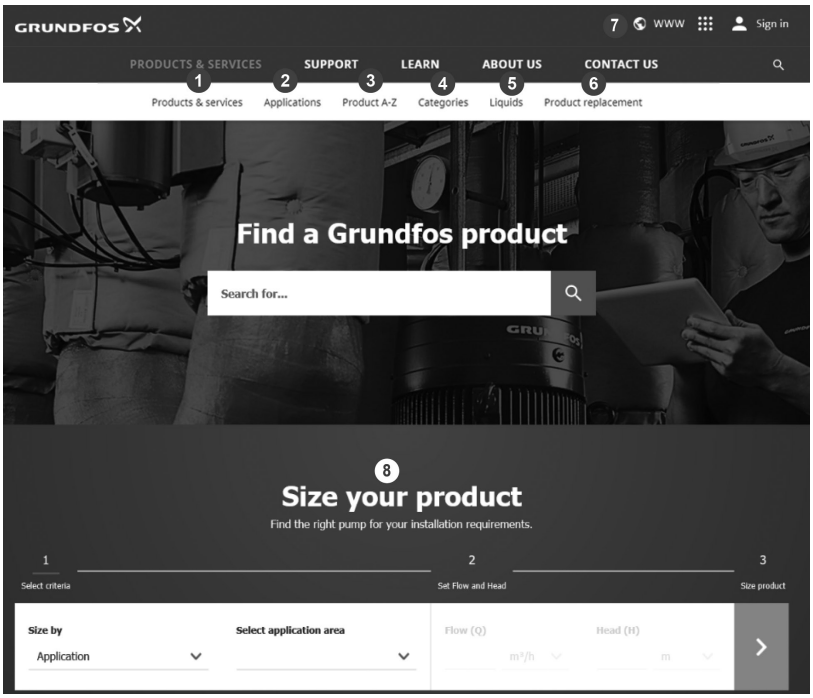

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