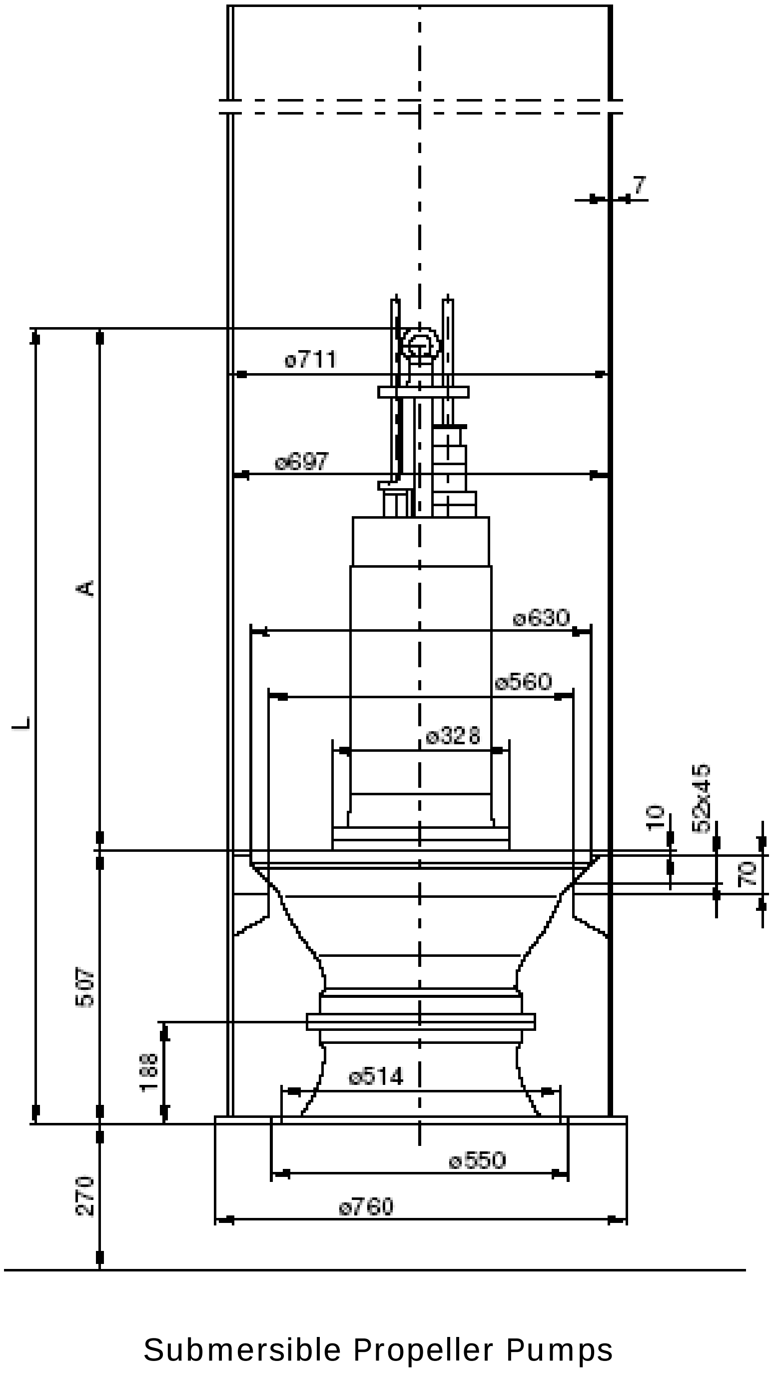
Information for Planning



Submersible Propeller Pumps

Type KPR 340

The axial propeller hydraulics developed by Wilo are used for pumping big volume flows at small heads. Combined with the reliable Wilo submersible motors this unit corresponds to the latest state-of-the-art. The big hydraulic performance range and the optimum efficiencies allow a multitude of applications. The propeller blades and the simply exchangeable wear ring of high-quality stainless steel material as well as the Wilo Block Seal are standard features and correspond to the high Wilo quality.

The KPR-pumps are suitable to pump clean water, service water and very muddy water. Due to the simple installation flood and storm water pumping stations can be designed in a much more cost-efficient way. Often the renovation of old pumping stations is possible without structural modifications. Due to the different installation variants you can always choose the most favourable version depending on the local conditions.

The installation of these units is very simple and safe. The pump is lowered in a steel pipe or a concrete sump and automatically centres itself in a conically formed ring. The net weight of the pump and the axial thrust provide the protection against torsion; the intermediate O-ring makes the connection pressure-tight. An adjustment of the unit is not required. Due to a subsequent adjustment of the propeller blades by hand the hydraulic pump duty can be changed in a big range (in case of bigger duty only with sufficient motor dimensioning).

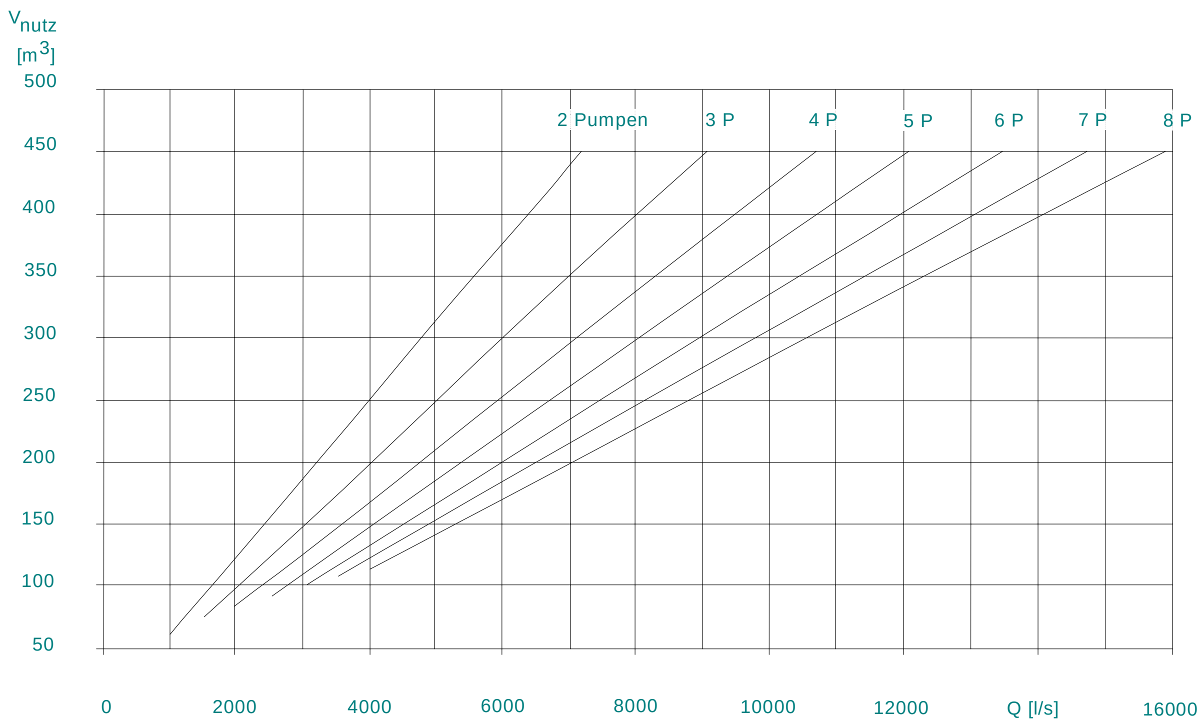
Recommended pump sump dimensioning:

Basically the sump dimensioning for propeller pumps is the same as for other hydraulics.
Since, however, axial pumps are sensitive to disturbances in the intake area, corresponding precautions must be taken, such as:

- separate intake chamber for each pump
- constant velocity profile development
- no twists
- minimal ground vortexes
- sufficient min. water level to avoid hollow vortexes and cavitation
- intake velocity as constant as possible

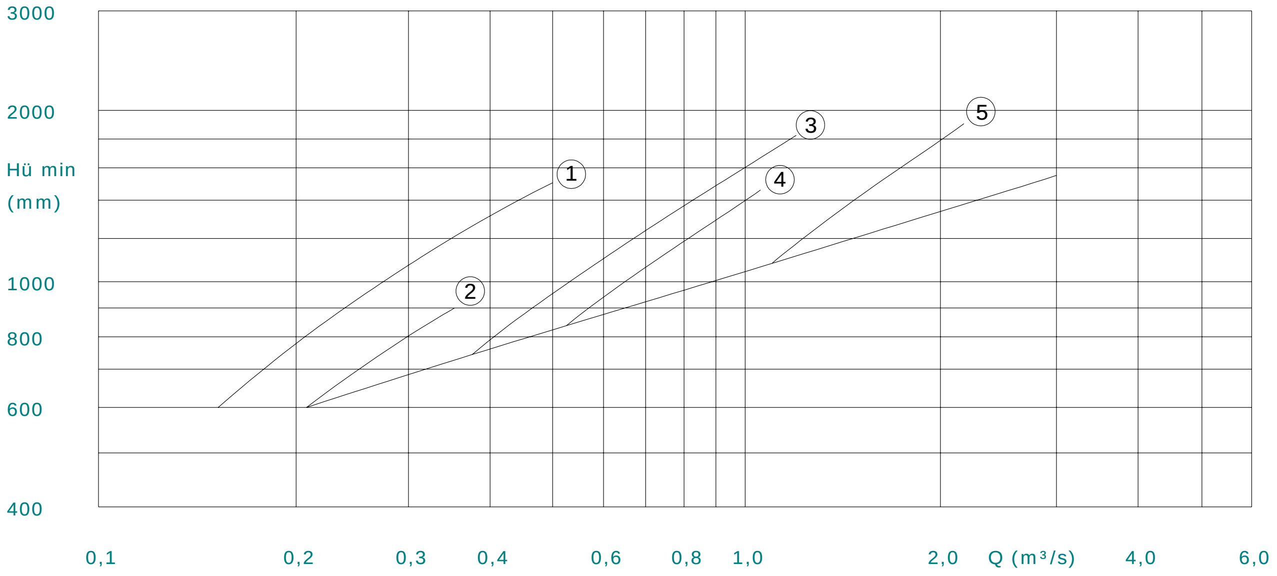
Generally it is advisable to pump the intake capacity by several pumps. All installed pumps together must be able to pump at least the specified capacity. For reasons of maintenance and storage of spare parts the pumps should be of one and the same type . In order to guarantee an especially high safety of the pumping station a spare pump should be installed.

Diagram1:
Effective volume for axial pumps at 10 starts per hour:



To guarantee a trouble-free operation of the machine (e.g. in continuous operation) it is absolutely necessary not to fall below the min. water level above the impeller. A further lowering would lead to hollow vortexes and cavitation and consequently cause a damaging of the pump.
The diagrams show the min. water level at the most favourable duty points of the respective pump type. For the dimensioning of the station a special test by means of the pump diagram ($NPSH_{required}$) is absolutely required.

<u>Diagram2:</u>
Min. water level to avoid hollow vortexes:



1 KPR 340 / n = 1450 min^{-1}

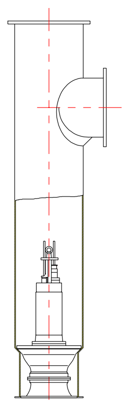
2 KPR 340 / n = 950 min^{-1}

3 KPR 500 / n = 950 min^{-1}

4 KPR 500 / n = 740 min^{-1}

5 KPR 760 / n = 585 min^{-1}

Diagram 3
Head loss H_{VR}, steel pipe sump with lateral discharge piece



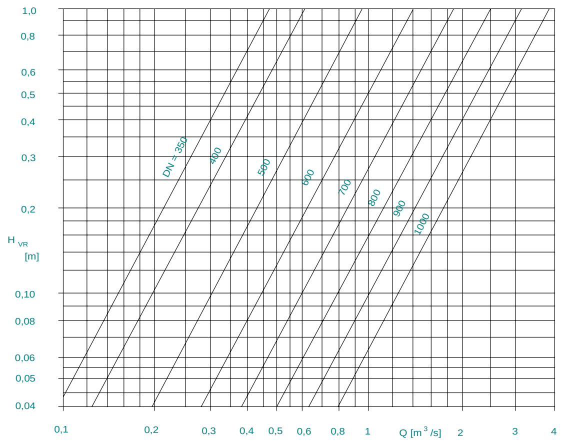
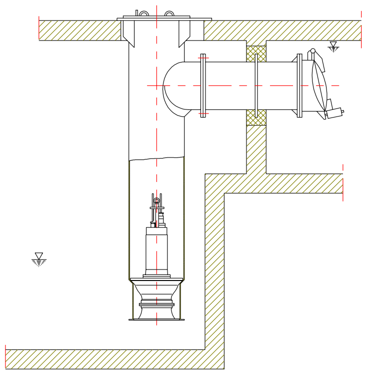


Diagram 4
Head loss H_{vtot} , steel pipe sump with short discharge pipe line and check valve



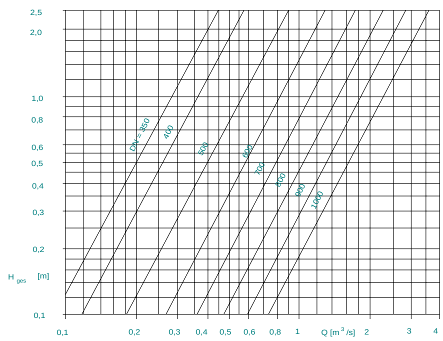
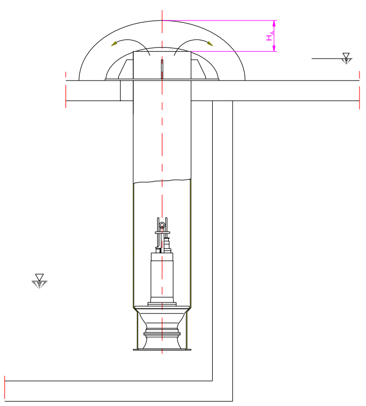
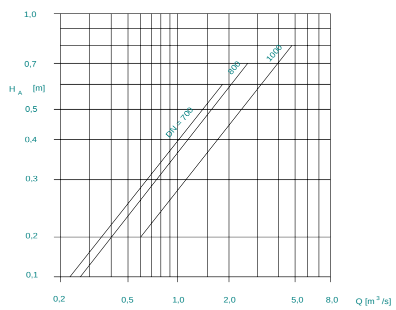


Diagram 5
Discharge head Ha, vertical pipe discharge





Required useful volume for one pump

$V_N = 0{,}9 \times Q / Z$ V_N [m^3]
Q [l/s]

Reference values for the number of starts/hr 'Z':
Motor power up to 12 kW : Z = 20 /h
13 up to 150 kW : Z = 15 /h
above 150 kW : Z $\leq$ 10 /h

This equation is valid for the following operation type:
With rising water level the pumps switch on consecutively and then switch off again in the same way.
However, the usual operation type is:
With rising water level the pumps switch on consecutively and then switch off all together at min. water level. In this case the partial volumes must be multiplied by a factor.

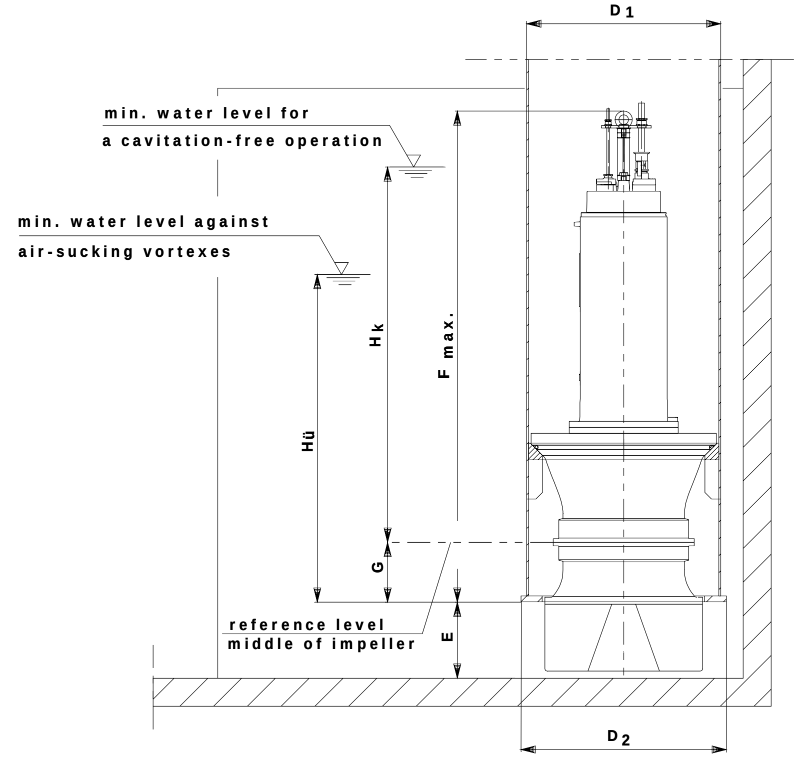
<u>Table 1:</u>
Calculation of the partial volumes:

Number of pumps installed	Calculation of the proportional useful volumes
1	$V_1 = Q_1 \times 0{,}9 / Z$
2	$V_2 = 0{,}392 \times Q_2 \times 0{,}9 / Z$
3	$V_3 = 0{,}264 \times Q_3 \times 0{,}9 / Z$
4	$V_4 = 0{,}216 \times Q_4 \times 0{,}9 / Z$
5	$V_5 = 0{,}188 \times Q_5 \times 0{,}9 / Z$
6	$V_6 = 0{,}167 \times Q_6 \times 0{,}9 / Z$
7	$V_7 = 0{,}152 \times Q_7 \times 0{,}9 / Z$
8	$V_8 = 0{,}140 \times Q_8 \times 0{,}9 / Z$

The total useful volume (no installations, baffles, etc.) is the sum of the partial volumes.

In case of a different number of starts/hr the values read must be multiplied by a correction factor , in fact with:
Z = 8 /h x 1,25
Z = 12/h x 0,83
Z = 15/h x 0,66

$$H_{man} = H_{geod} + H_v + \frac{v^2}{2g}$$ The discharge losses should be absolutely taken into consideration.



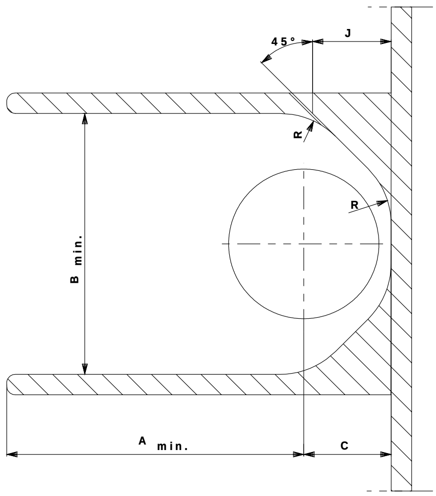
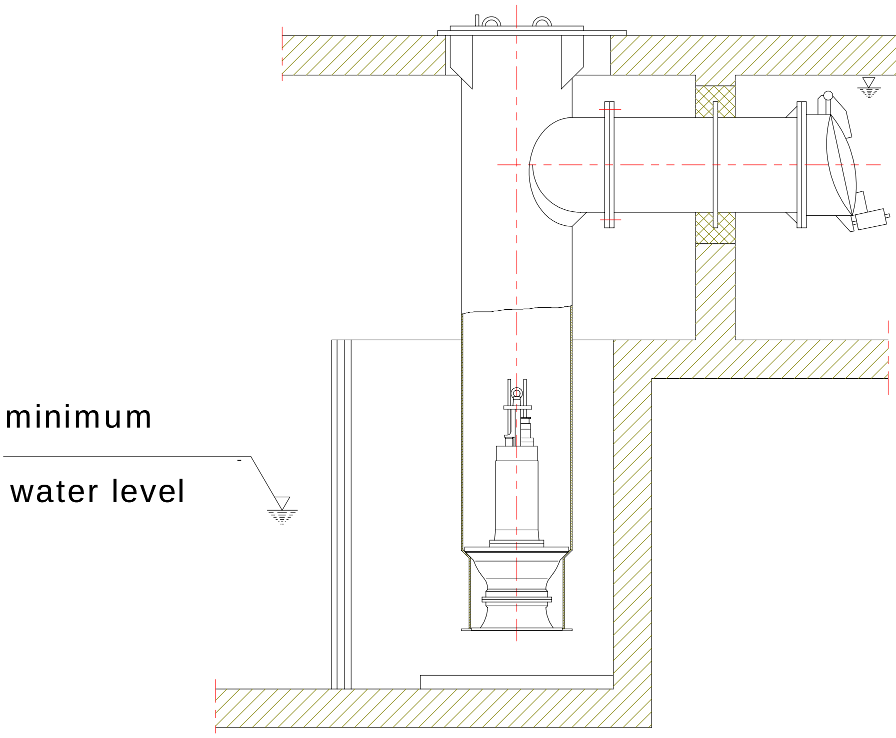


Table 2: [Maße in mm]

Pump type	n min-1	Impeller free ball passage	A min	B min	C	D1	D2	E	F max	G	Hü min	Hk min	J	R
KPR 340	1450	50	1100	900	440	720	760	270	1531	190	see diagram	min. water level f cavitation-free operation Hkmin³Hü-G³NPSH requ.	250	250
	950		1100	900										
KPR 500	950	70	1700	1500	500	813	860	320	2033	270			450	450
	740		1600	1400										
KPR 760	585	80	2500	2000	600	1020	1060	520	2760	380			600	600

Calculation example:



Given:	flow rate:	Q=2000 l/s
	tot.man.head:	H_{geo}=3.2m
	no. of starts/hr:	Z=15/h
Chosen:	no. of pumps:	2
	flow rate per pump:	$\frac{2000\ l/s}{2}$ = 1000 l/s
	approx. pump selection:	KPR ... with 950 r.p.m.
	sump pipe:	DN 800

From diagram 1:
Useful volume for total flow rate: Q_{tot}=2000 l/s
Bei Z=10/h: V_{use}=126.5 m^3
Bei Z=15/h: V_{use}=126.5 m^3 x 0.66=83.5 m^3

From table 1:
Partial volume: V_1=(0.9 x 1000)/15=60 m^3
Consequently the switch-on/off levels for the two pumps can be defined.

From table 2:
Now one can take the required dimensions, such as e.g.:

Length of the intake chamber - baffle A_{min}=1700 mm
Width of the intake chamber - baffle B_{min}=1500 mm
etc.

From diagram 2:
The min. water level $H_ü$ = 1600 mm is read.
Due to the NPSH-value of the pump taken from the curve sheet = 9,5 m the min. water level must not be increased; consequently the following condition is met:
$H_{kmin} \geq H_ü\text{-}G \geq NPSH_{pump}$

Now the sump dimensions are specified:

Chosen: sump width: =3,4 m
sump length: =8,5 m
corresponding base area: A =28,9 m²
true specific volume of pumps and concrete structures: $V_{install}$ = 2,8 m³

Max. water level difference:

$$\Delta H = \frac{V_{use} + V_{install}}{A_s}$$

$$\Delta H = \frac{83{,}5m^3 + 2{,}8m^3}{28{,}9m^2} = 2{,}98m$$

Now the switch-on/off levels of the pumps are calculated from top to bottom.

Pump 1: partial volume: $V_1 = 60m^3$

percentage of the installations: $$\frac{60m^3}{83{,}5m^3} x 2{,}8m^3 = 2{,}01m^3$$

Consequently: $$\Delta H_1 = \frac{60m^3 + 2{,}01m^3}{28{,}9m^2} = 2{,}14m$$

Pump 2: partial volume: $V_2 = 23{,}5m^3$

percentage of the installations: $$\frac{23{,}5m^3}{83{,}5m^3} x 2{,}8m^3 = 0{,}79m^3$$

Consequently: $$\Delta H_2 = \frac{23{,}5m^3 + 0{,}79m^3}{28{,}9m^2} = 0{,}84m$$

And total: $$\Delta H = \Delta H_1 + \Delta H_2 = 2{,}14m + 0{,}84m = 2{,}98m$$

The switch-on point of both pumps (2,98 m from top) is the min. water level $H_ü$

From diagram 3:

For a pump flow rate of 1000 l/s and discharge piece DN 700 (economical flow velocity in the discharge piece max. 3 m/s) the total loss of the station is:

$$Hv_{tot} = 0{,}78m$$

Consequently the total head is:

$$H_{tot} = H_{geo} + Hv_{tot} = 3{,}2m + 0{,}78m = 3{,}98m$$

Now the suitable curve can be selected from the respective overview chart.

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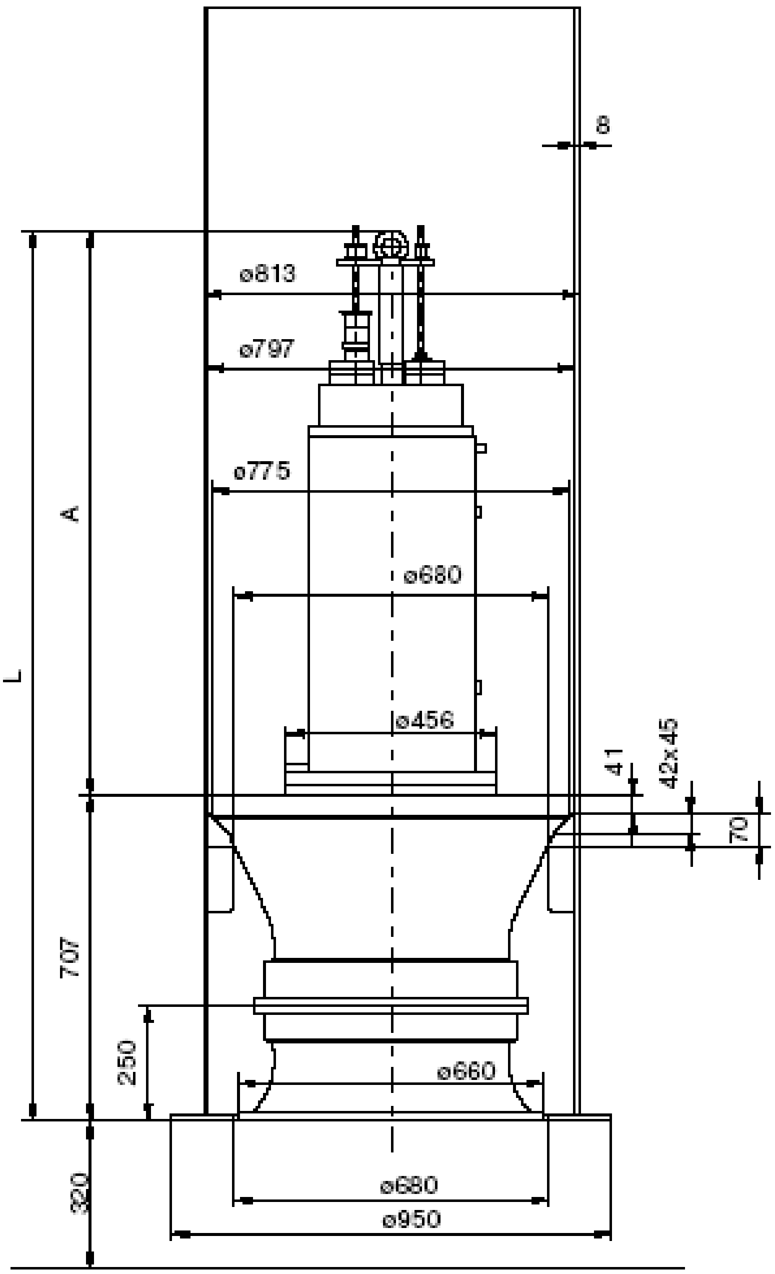

Submersible Propeller Pumps

Type KPR 500

The axial propeller hydraulics developed by Wilo are used for pumping big volume flows at small heads. Combined with the reliable Wilo submersible motors this unit corresponds to the latest state-of-the-art. The big hydraulic performance range and the optimum efficiencies allow a multitude of applications. The propeller blades and the simply exchangeable wear ring of high-quality stainless steel material as well as the Wilo Block Seal are standard features and correspond to the high Wilo quality.

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The installation of these units is very simple and safe. The pump is lowered in a steel pipe or a concrete sump and automatically centres itself in a conically formed ring. The net weight of the pump and the axial thrust provide the protection against torsion; the intermediate O-ring makes the connection pressure-tight. An adjustment of the unit is not required. Due to a subsequent adjustment of the propeller blades by hand the hydraulic pump duty can be changed in a big range (in case of bigger duty only with sufficient motor dimensioning).

Recommended pump sump dimensioning:

Basically the sump dimensioning for propeller pumps is the same as for other hydraulics.
Since, however, axial pumps are sensitive to disturbances in the intake area, corresponding precautions must be taken, such as:

- separate intake chamber for each pump
- constant velocity profile development
- no twists
- minimal ground vortexes
- sufficient min. water level to avoid hollow vortexes and cavitation
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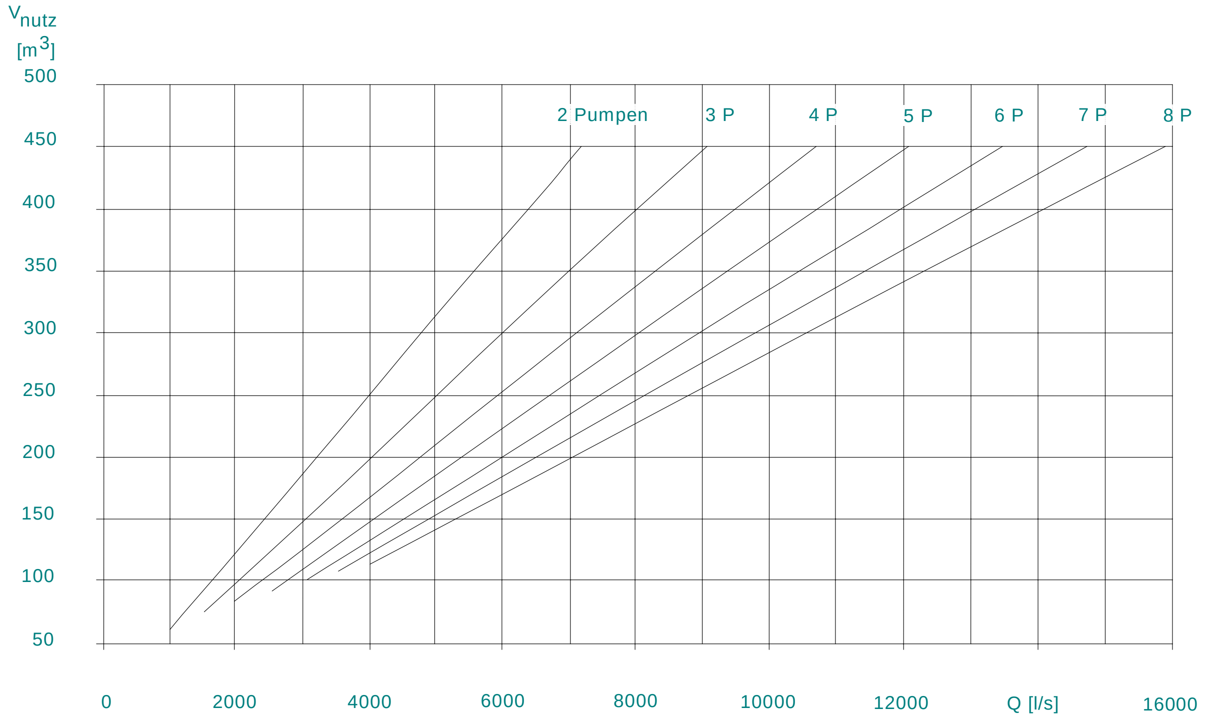
Generally it is advisable to pump the intake capacity by several pumps. All installed pumps together must be able to pump at least the specified capacity. For reasons of maintenance and storage of spare parts the pumps should be of one and the same type . In order to guarantee an especially high safety of the pumping station a spare pump should be installed.

Diagram1:
Effective volume for axial pumps at 10 starts per hour:



To guarantee a trouble-free operation of the machine (e.g. in continuous operation) it is absolutely necessary not to fall below the min. water level above the impeller. A further lowering would lead to hollow vortexes and cavitation and consequently cause a damaging of the pump.
The diagrams show the min. water level at the most favourable duty points of the respective pump type. For the dimensioning of the station a special test by means of the pump diagram ($NPSH_{required}$) is absolutely required.

Diagram2:
Min. water level to avoid hollow vortexes:

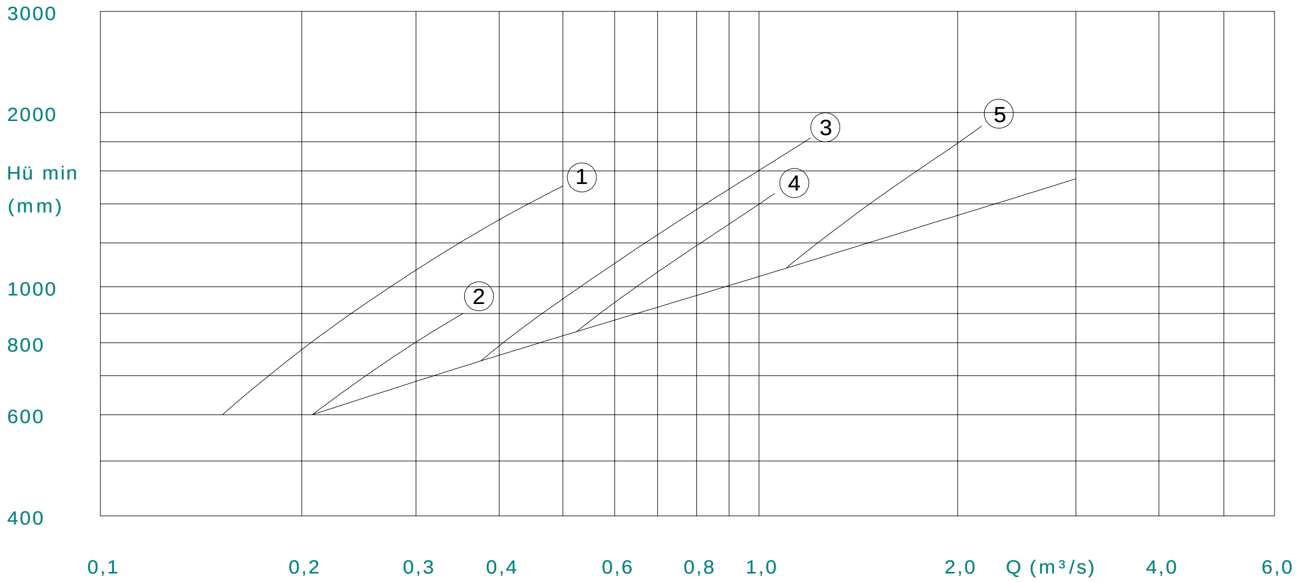


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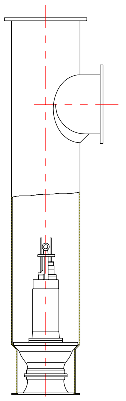
Diagram 3

Head loss H_{VR}, steel pipe sump with lateral discharge piece



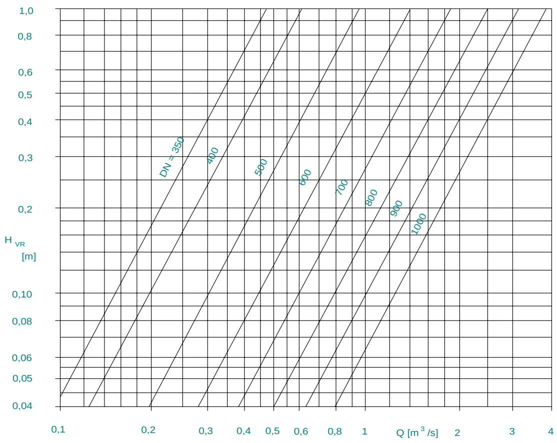
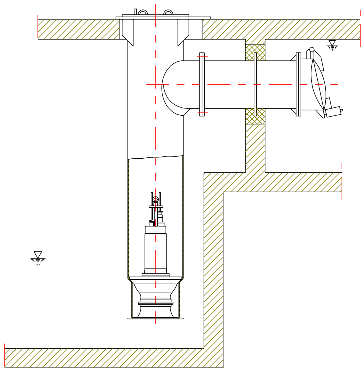


Diagram 4

Head loss H_{vtot} , steel pipe sump with short discharge pipe line and check valve



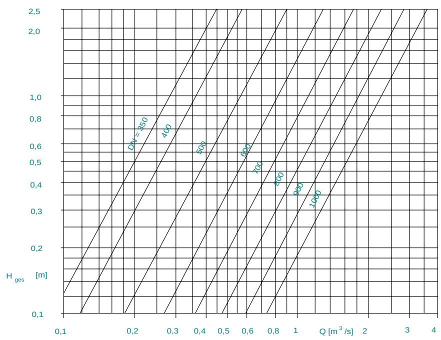
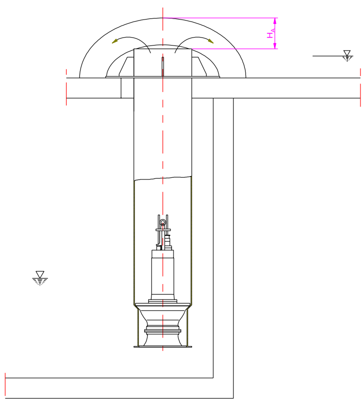
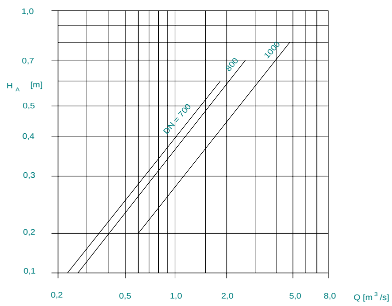


Diagram 5

Discharge head Ha, vertical pipe discharge





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The total useful volume (no installations, baffles, etc.) is the sum of the partial volumes.

In case of a different number of starts/hr the values read must be multiplied by a correction factor , in fact with:

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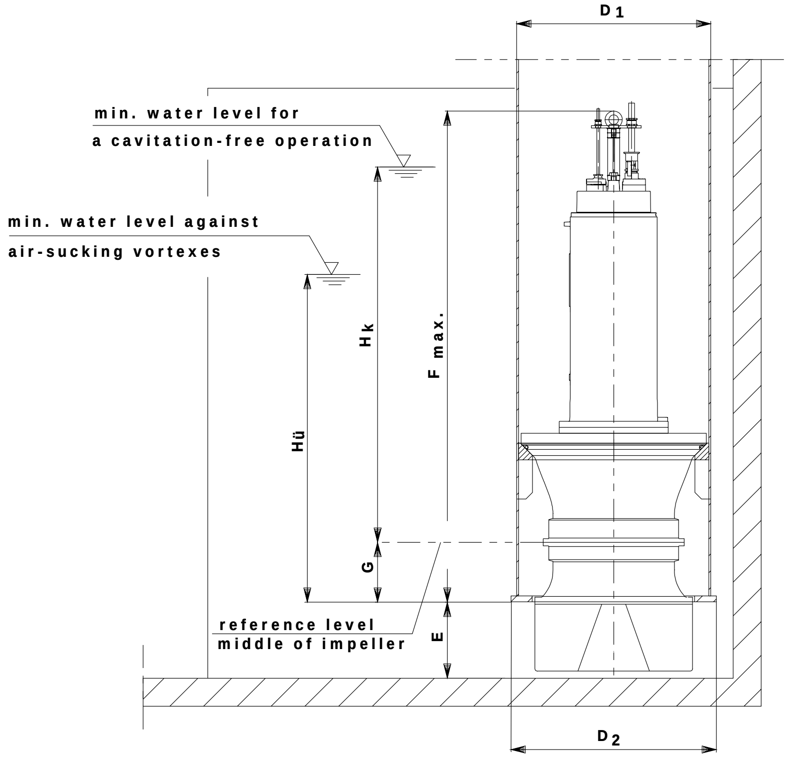

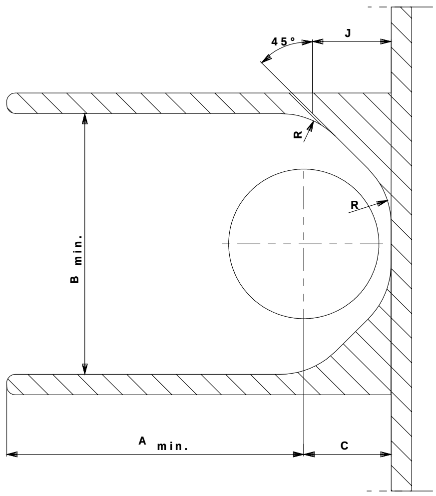

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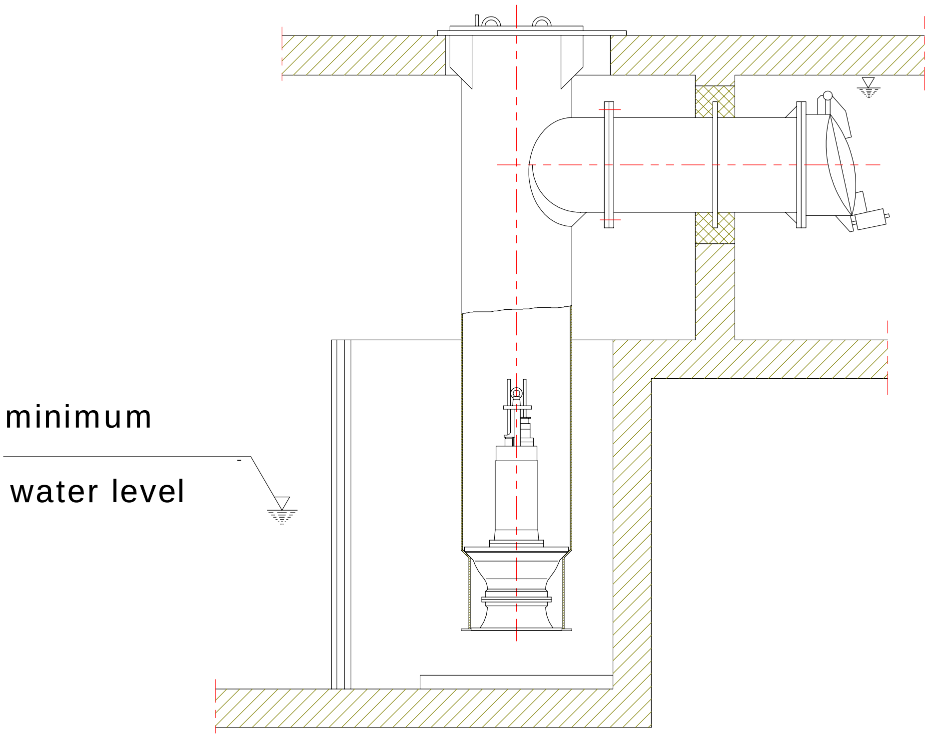

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	flow rate per pump:	$\frac{2000\ l/s}{2}$ = 1000 l/s
	approx. pump selection:	KPR ... with 950 r.p.m.
	sump pipe:	DN 800

From diagram 1:

Useful volume for total flow rate: Q_{tot}=2000 l/s

Bei Z=10/h: V_{use}=126.5 m^3

Bei Z=15/h: V_{use}=126.5 m^3 x 0.66=83.5 m^3

From table 1:

Partial volume: V_1=(0.9 x 1000)/15=60 m^3

Consequently the switch-on/off levels for the two pumps can be defined.

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Now one can take the required dimensions, such as e.g.:

Length of the intake chamber - baffle A_{min}=1700 mm

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etc.

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	true specific volume of pumps and concrete structures:	$V_{install}$ = 2,8 m³

Max. water level difference:
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$$\Delta H = \frac{83{,}5m^3 + 2{,}8m^3}{28{,}9m^2} = 2{,}98m$$

Now the switch-on/off levels of the pumps are calculated from top to bottom.

Pump 1: partial volume: $V_1 = 60m^3$

percentage of the installations: $\frac{60m^3}{83{,}5m^3} x 2{,}8m^3 = 2{,}01m^3$

Consequently:
$$\Delta H_1 = \frac{60m^3 + 2{,}01m^3}{28{,}9m^2} = 2{,}14m$$

Pump 2: partial volume: $V_2 = 23{,}5m^3$

percentage of the installations: $\frac{23{,}5m^3}{83{,}5m^3} x 2{,}8m^3 = 0{,}79m^3$

Consequently:
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And total: $\Delta H = \Delta H_1 + \Delta H_2 = 2{,}14m + 0{,}84m = 2{,}98m$

The switch-on point of both pumps (2,98 m from top) is the min. water level $H_{ü}$

From diagram 3:

For a pump flow rate of 1000 l/s and discharge piece DN 700 (economical flow velocity in the discharge piece max. 3 m/s) the total loss of the station is:

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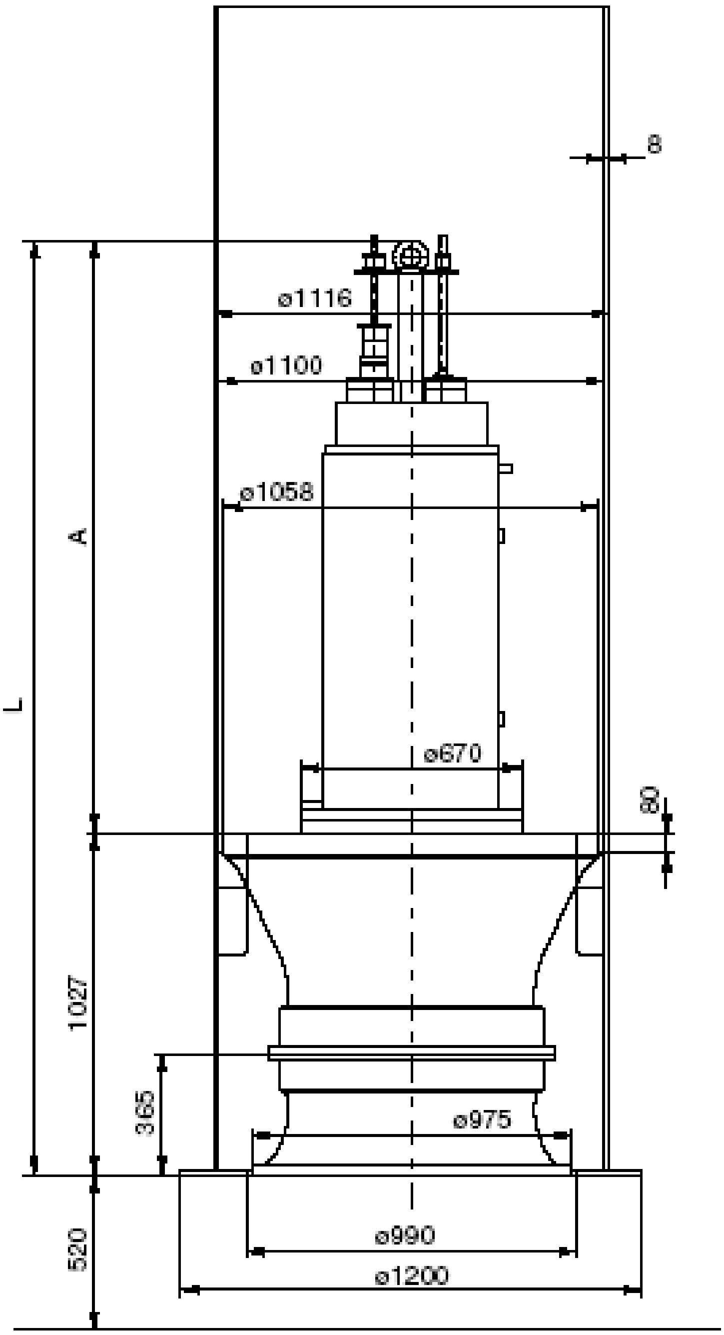

Submersible Propeller Pumps

Type KPR 760

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Recommended pump sump dimensioning:

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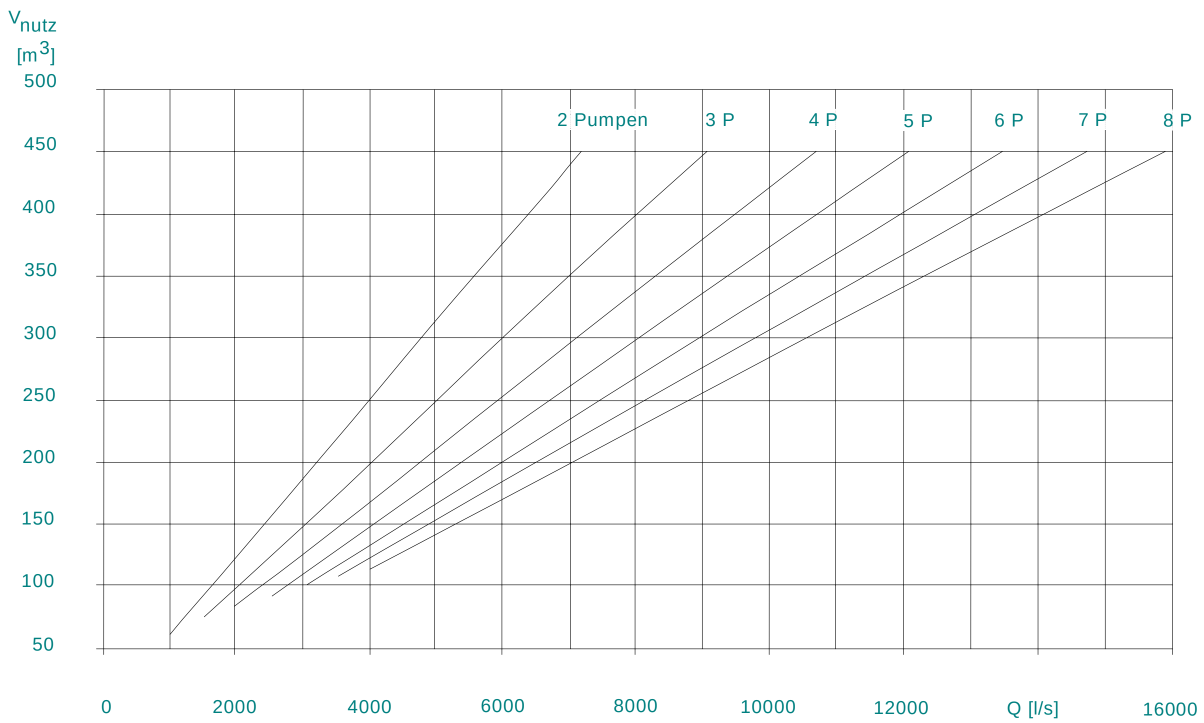
Since, however, axial pumps are sensitive to disturbances in the intake area, corresponding precautions must be taken, such as:

- separate intake chamber for each pump
- constant velocity profile development
- no twists
- minimal ground vortexes
- sufficient min. water level to avoid hollow vortexes and cavitation
- intake velocity as constant as possible

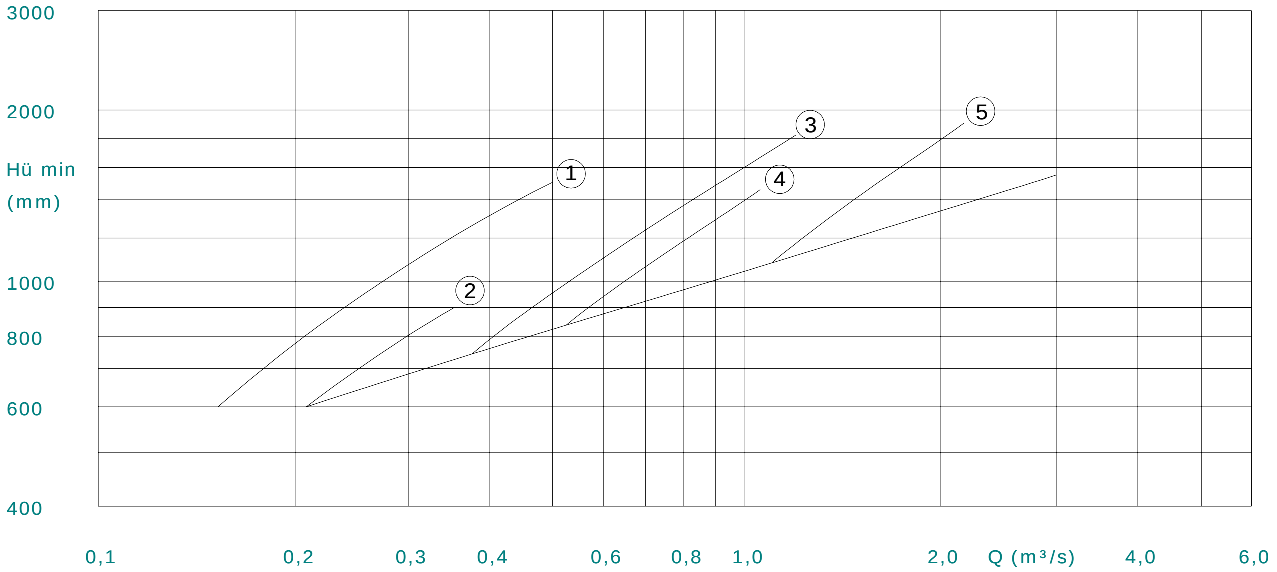
Generally it is advisable to pump the intake capacity by several pumps. All installed pumps together must be able to pump at least the specified capacity. For reasons of maintenance and storage of spare parts the pumps should be of one and the same type . In order to guarantee an especially high safety of the pumping station a spare pump should be installed.

Diagram1:
Effective volume for axial pumps at 10 starts per hour:



To guarantee a trouble-free operation of the machine (e.g. in continuous operation) it is absolutely necessary not to fall below the min. water level above the impeller. A further lowering would lead to hollow vortexes and cavitation and consequently cause a damaging of the pump.
The diagrams show the min. water level at the most favourable duty points of the respective pump type. For the dimensioning of the station a special test by means of the pump diagram (NPSH $_{required}$) is absolutely required.

Diagram2:
Min. water level to avoid hollow vortexes:



1 KPR 340 / n = 1450 min^{-1}

2 KPR 340 / n = 950 min^{-1}

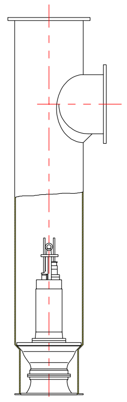
3 KPR 500 / n = 950 min^{-1}

4 KPR 500 / n = 740 min^{-1}

5 KPR 760 / n = 585 min^{-1}

Diagram 3

Head loss H_{VR}, steel pipe sump with lateral discharge piece



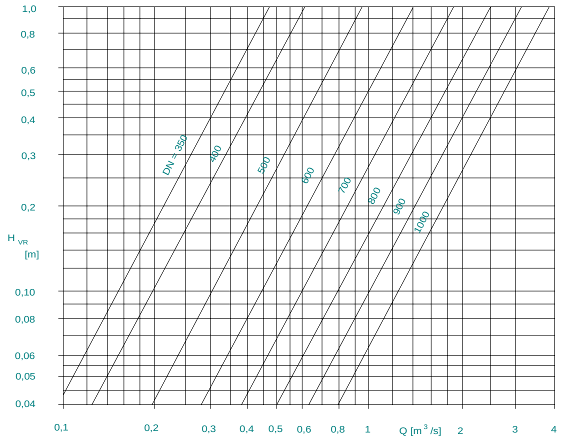
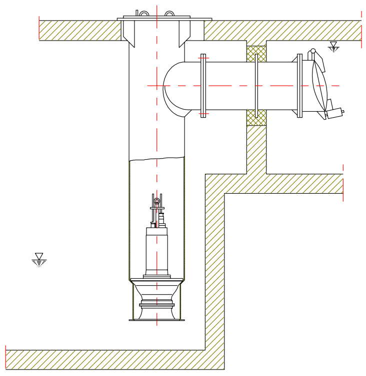


Diagram 4

Head loss H_{vtot} , steel pipe sump with short discharge pipe line and check valve



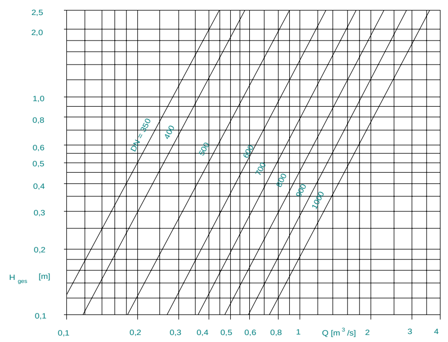
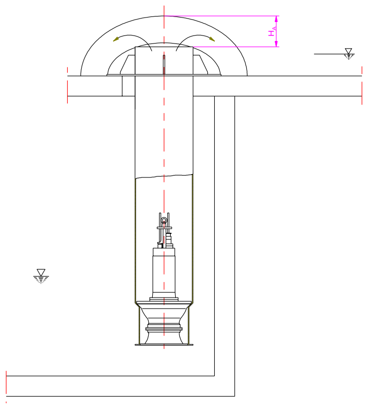
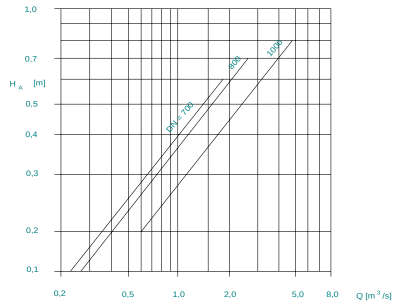


Diagram 5

Discharge head Ha, vertical pipe discharge





Required useful volume for one pump

$V_N = 0,9 \times Q / Z$ V_N [m³]
Q [l/s]

Reference values for the number of starts/hr 'Z':
Motor power up to 12 kW : Z = 20 /h
13 up to 150 kW : Z = 15 /h
above 150 kW : $Z \leq 10$ /h

This equation is valid for the following operation type:
With rising water level the pumps switch on consecutively and then switch off again in the same way.
However, the usual operation type is:
With rising water level the pumps switch on consecutively and then switch off all together at min. water level. In this case the partial volumes must be multiplied by a factor.

Table 1:
Calculation of the partial volumes:

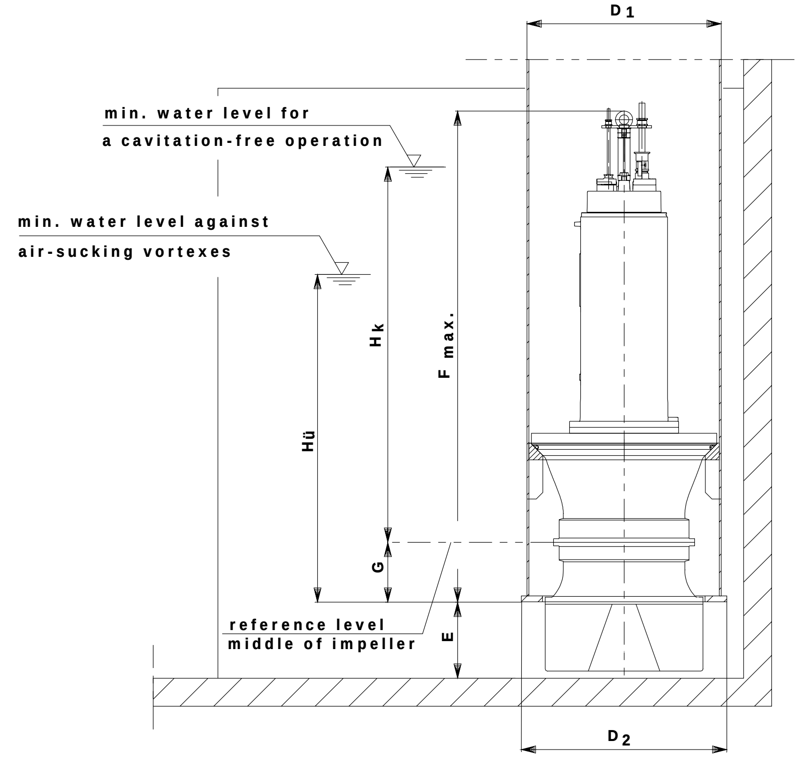
Number of pumps installed	Calculation of the proportional useful volumes
1	$V_1 = Q_1 \times 0,9 / Z$
2	$V_2 = 0,392 \times Q_2 \times 0,9 / Z$
3	$V_3 = 0,264 \times Q_3 \times 0,9 / Z$
4	$V_4 = 0,216 \times Q_4 \times 0,9 / Z$
5	$V_5 = 0,188 \times Q_5 \times 0,9 / Z$
6	$V_6 = 0,167 \times Q_6 \times 0,9 / Z$
7	$V_7 = 0,152 \times Q_7 \times 0,9 / Z$
8	$V_8 = 0,140 \times Q_8 \times 0,9 / Z$

The total useful volume (no installations, baffles, etc.) is the sum of the partial volumes.

In case of a different number of starts/hr the values read must be multiplied by a correction factor , in fact with:
Z = 8 /h x 1,25
Z = 12/h x 0,83
Z = 15/h x 0,66

$$H_{man} = H_{geod} + H_v + \frac{v^2}{2g}$$

The discharge losses should be absolutely taken into consideration.



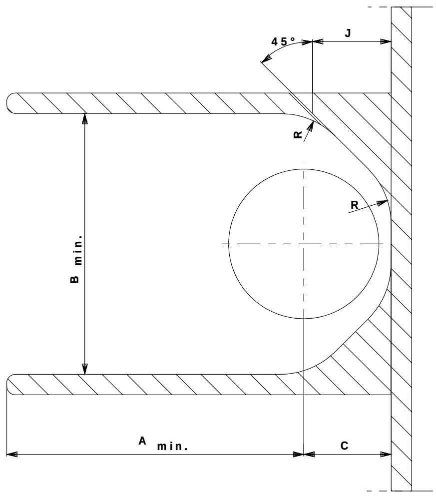
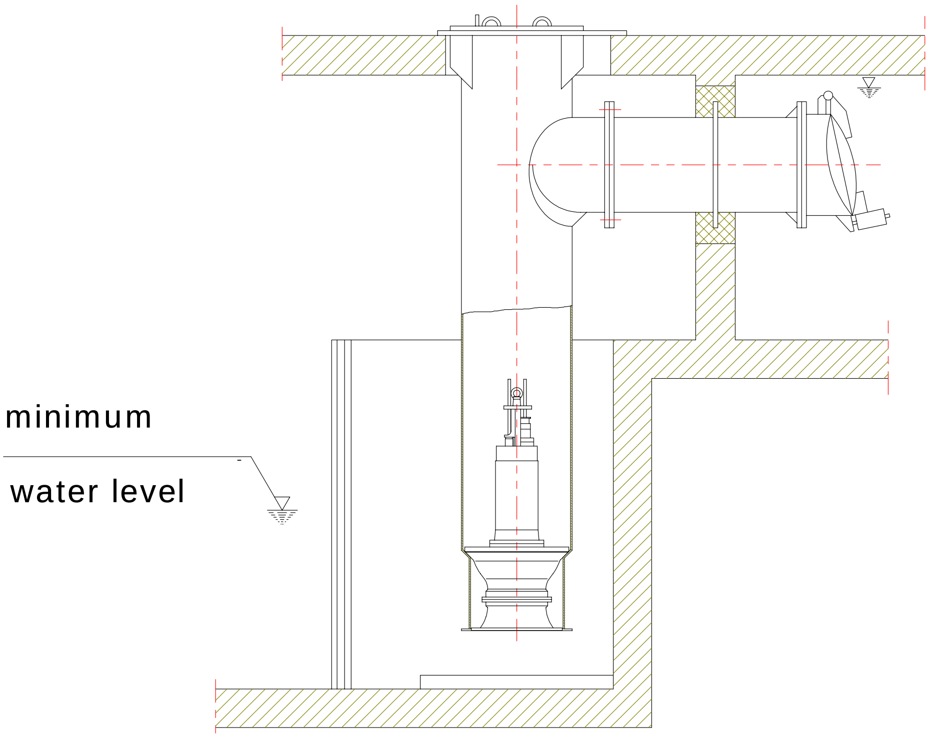


Table 2: [Maße in mm]

Pump type	n min-1	Impeller free ball passage	A min	B min	C	D1	D2	E	F max	G	Hü min	Hk min	J	R
KPR 340	1450	50	1100	900	440	720	760	270	1531	190	see diagram	min. water level f cavitation-free operation Hkmin³Hü-G³NPSH requ.	250	250
	950		1100	900										
KPR 500	950	70	1700	1500	500	813	860	320	2033	270			450	450
	740		1600	1400										
KPR 760	585	80	2500	2000	600	1020	1060	520	2760	380			600	600

Calculation example:



Given:	flow rate:	Q=2000 l/s
	tot.man.head:	H_{geo}=3.2m
	no. of starts/hr:	Z=15/h
Chosen:	no. of pumps:	2
	flow rate per pump:	$\frac{2000\ l/s}{2}$ = 1000 l/s
	approx. pump selection:	KPR ... with 950 r.p.m.
	sump pipe:	DN 800

<u>From diagram 1:</u>

Useful volume for total flow rate: Q_{tot}=2000 l/s

Bei Z=10/h:	V_{use}=126.5 m^3
Bei Z=15/h:	V_{use}=126.5 m^3 x 0.66=83.5 m^3

<u>From table 1:</u>

Partial volume: V_1=(0.9 x 1000)/15=60 m^3

Consequently the switch-on/off levels for the two pumps can be defined.

<u>From table 2:</u>

Now one can take the required dimensions, such as e.g.:

Length of the intake chamber - baffle	A_{min}=1700 mm
Width of the intake chamber - baffle	B_{min}=1500 mm

etc.

From diagram 2:
The min. water level $H_{ü}$ = 1600 mm is read.
Due to the NPSH-value of the pump taken from the curve sheet = 9,5 m the min. water level must not be increased; consequently the following condition is met:
$H_{kmin} \geq H_{ü} - G \geq NPSH_{pump}$

Now the sump dimensions are specified:

Chosen: sump width: =3,4 m
sump length: =8,5 m
corresponding base area: A =28,9 m²
true specific volume of pumps and concrete structures: $V_{install}$ = 2,8 m³

Max. water level difference:

$$\Delta H = \frac{V_{use} + V_{install}}{A_s}$$

$$\Delta H = \frac{83{,}5m^3 + 2{,}8m^3}{28{,}9m^2} = 2{,}98m$$

Now the switch-on/off levels of the pumps are calculated from top to bottom.

Pump 1: partial volume: $V_1 = 60m^3$

percentage of the installations: $\frac{60m^3}{83{,}5m^3} x 2{,}8m^3 = 2{,}01m^3$

Consequently:

$$\Delta H_1 = \frac{60m^3 + 2{,}01m^3}{28{,}9m^2} = 2{,}14m$$

Pump 2: partial volume: $V_2 = 23{,}5m^3$

percentage of the installations: $\frac{23{,}5m^3}{83{,}5m^3} x 2{,}8m^3 = 0{,}79m^3$

Consequently:

$$\Delta H_2 = \frac{23{,}5m^3 + 0{,}79m^3}{28{,}9m^2} = 0{,}84m$$

And total: $\Delta H = \Delta H_1 + \Delta H_2 = 2{,}14m + 0{,}84m = 2{,}98m$

The switch-on point of both pumps (2,98 m from top) is the min. water level $H_ü$

From diagram 3:

For a pump flow rate of 1000 l/s and discharge piece DN 700 (economical flow velocity in the discharge piece max. 3 m/s) the total loss of the station is:

$$Hv_{tot} = 0{,}78m$$

Consequently the total head is:

$$H_{tot} = H_{geo} + Hv_{tot} = 3{,}2m + 0{,}78m = 3{,}98m$$

Now the suitable curve can be selected from the respective overview chart.

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