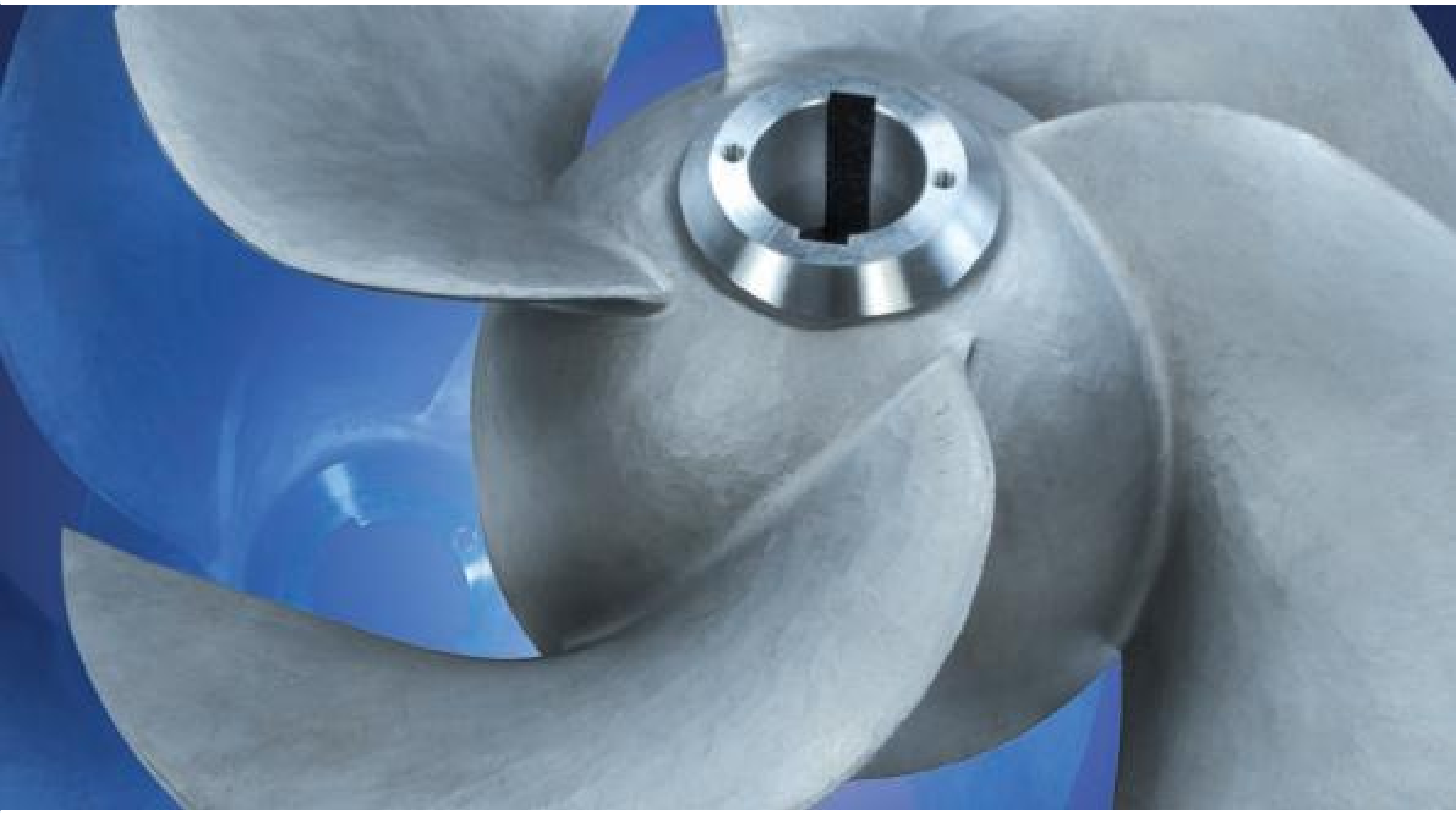
Planning information
Amacan® submersible pumps in discharge tubes



1.
The Amacan series

1.1
Impeller types and performance ranges

Wherever higher flow rates have to be handled, submersible pumps in discharge tube design have proved their worth in a wide range of applications. These submersible motor pumps can be optionally fitted with three different impeller types enabling them to deal with a wide variety of fluids – from grey water, which is reasonably clean, right up to waste water or activated sludge. Selecting the right impeller type for a particular application will depend upon the nature of the pumped fluid and the pumping task. The following selection charts provide information on the performance of the different impeller types and help designers to choose the right Amacan pump type and size for the pumping task in question. When making a selection, it is not only important to be aware of which impeller type is the right match for the pumped fluid, in some cases additional requirements in the design of the pump station and the choice of the technical equipment must be observed for certain impeller types.

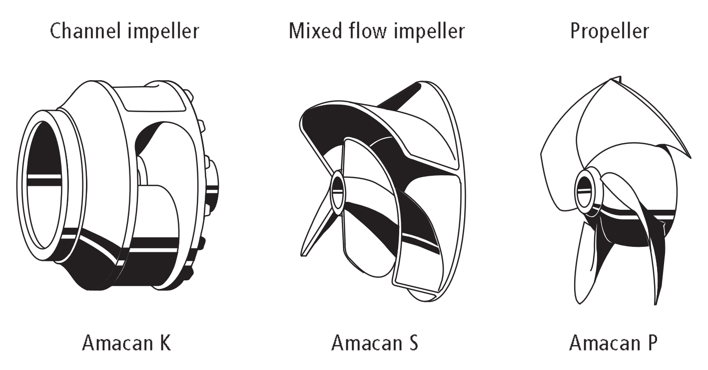


Fig. 1.1-a: Available impeller types for Amacan pumps

Fluids pumped	Notes and Recommendations
Waste water	- Check the free passage through the impeller - Pre-cleaned via a sreen or weir
River water	- Pre-cleaned via sreen or shingle trap
Storm water / waste water	- Check the free passage through the impeller - Pre-cleaned via a sreen or weir - With a propeller a special casing wear ring may be necessary
Activated sludge	- Max. 1% dry solids content
Seawater	- Check possible material combinations or fit anodes with six-monthly check-ups

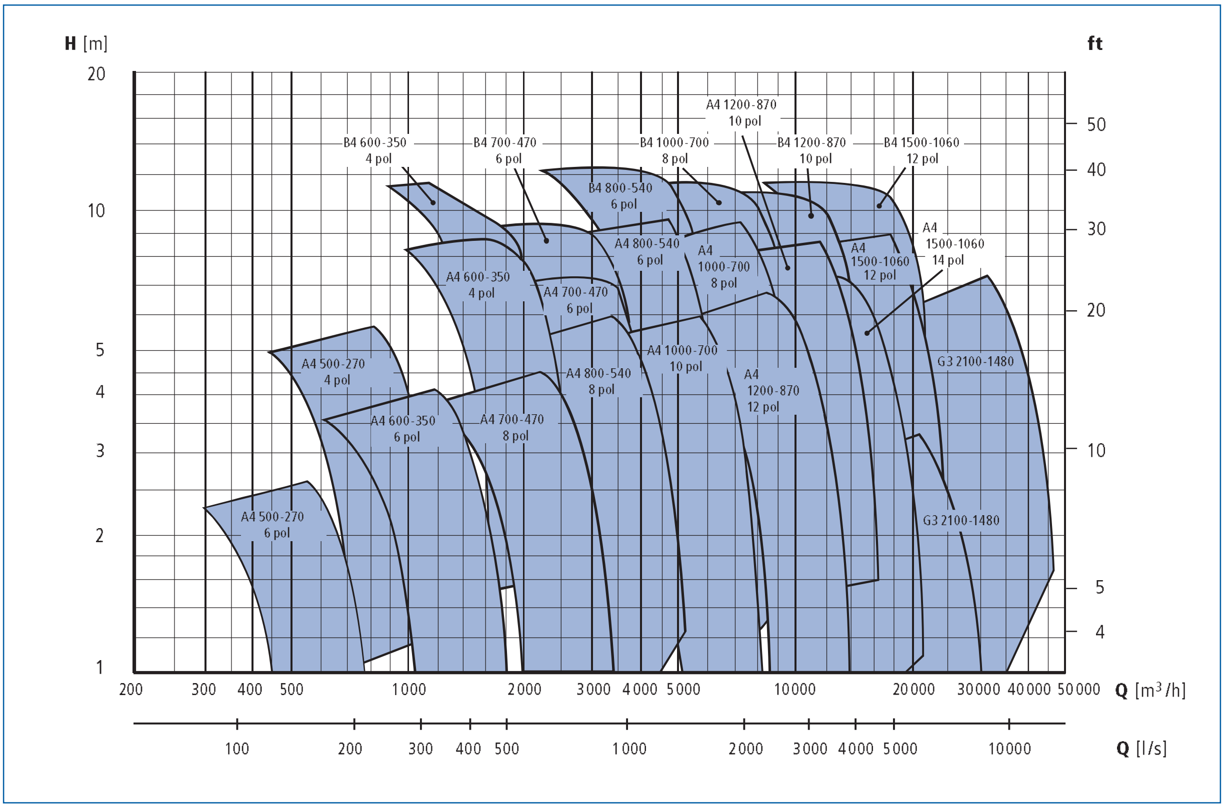


Fig. 1.1-b: Selection chart Amacan P pumps (50 Hz)

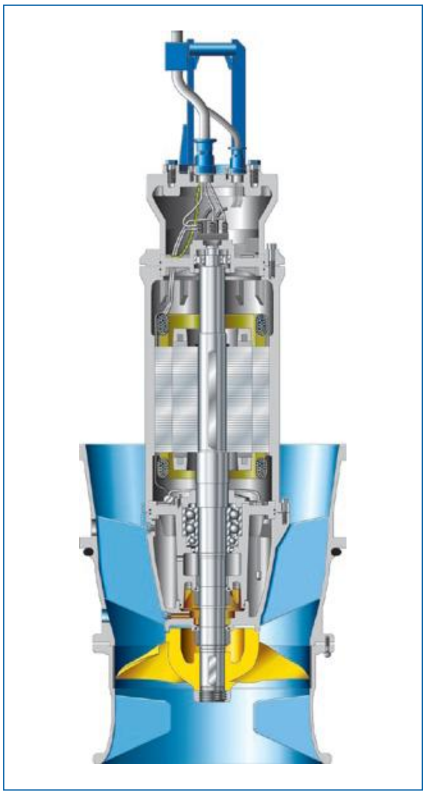


Fig. 1.1-c: Amacan P

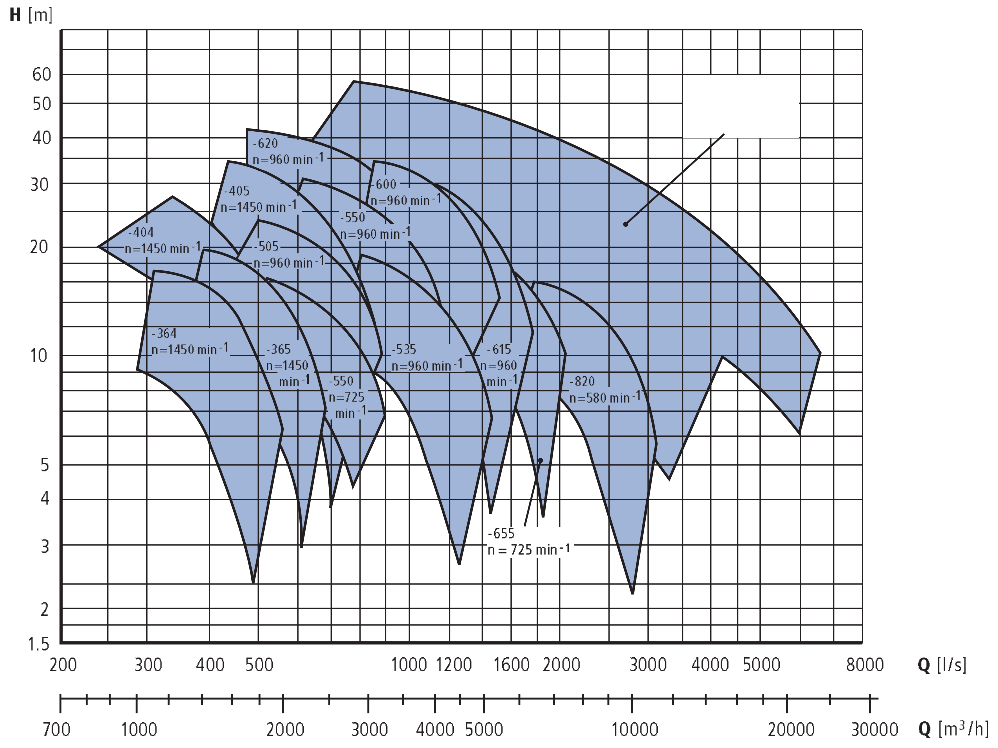


Fig. 1.1-d: *Selection chart Amacan S (50 Hz)*

Fig. 1.1-e: *Amacan S*

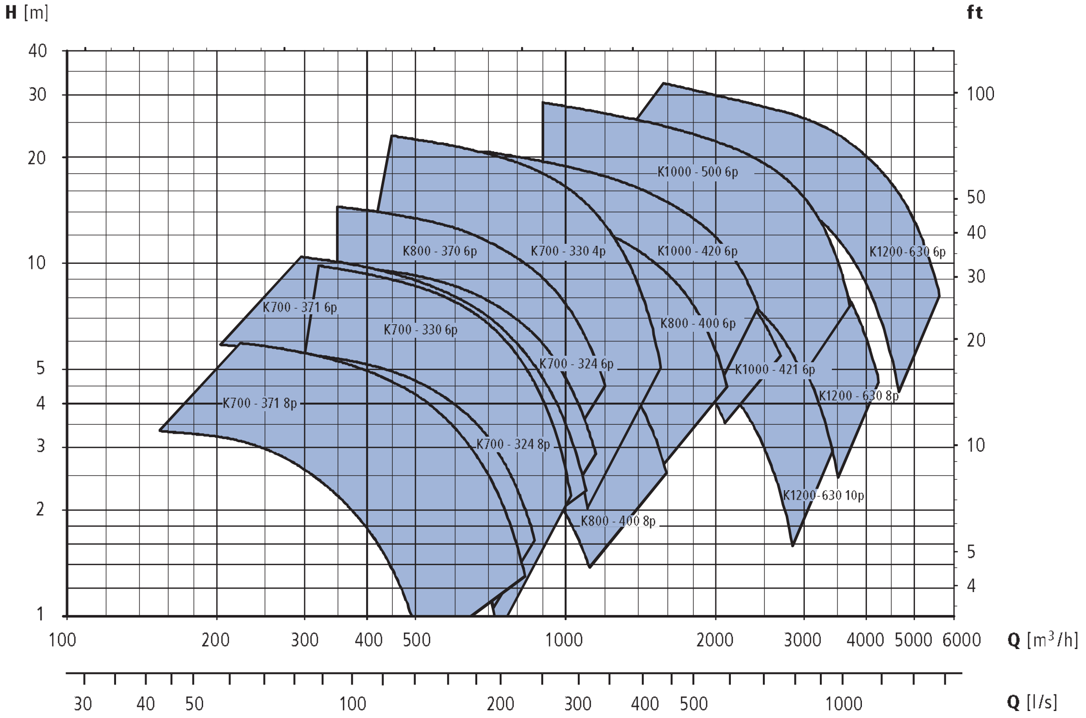


Fig. 1.1-f: Selection chart Amacan K (50 Hz)

Fig. 1.1-g: Amacan K

The design configuration of modern submersible motor pumps installed in discharge tubes has a number of advantages over that of conventional tubular casing pumps. For example, although these pumps have the same hydraulic capacity (impeller) they are considerably more compactly dimensioned (no long shaft assemblies, no additional bearing locations in the discharge tube). The handling of a submersible pump is significantly more straightforward, simplifying in particular maintenance and installation. In addition, buildings to accommodate electric motors or ventilation equipment are not required. The drive is an integral part of the submersible pump and hence is contained in the discharge tube.

For assembly and maintenance work on conventional pumps it is generally common practice to install large lifting equipment, the size of which will depend on the on-site installation depth. This lifting equipment represents a major investment even though it is only periodically used for repair work or pump installation / removal. In contrast, to carry out the same tasks the Amacan submersible motor pumps only require mobile cranes, which are far more cost effective. In order to fully exploit this advantage, appropriate access must be factored in at the planning stage.

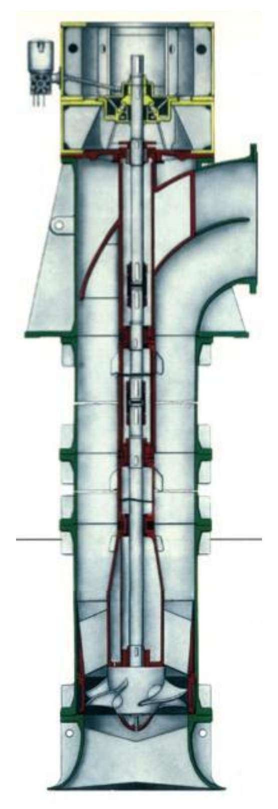


Fig. 1.1-h: Conventional tubular casing pump

Fig. 1.1-i: Installation of submersible motor pump with a mobile crane

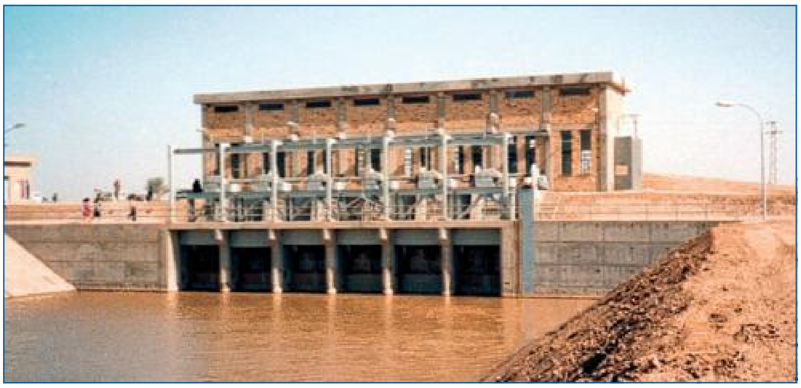


Fig. 1.1-j: Pump station with building

2.2
Pump installation planning

After all hydraulic aspects regarding the distribution of the volume flow have been considered and the appropriate pump size chosen, the geometry of the intake chamber must be determined.

Thanks to a flexible discharge tube design, Amacan pumps offer a vast range of installation options, making optimum pump station design possible. This gives system designers the flexibility to adapt the installation to any station design and system condition. Some installation options are briefly presented here.

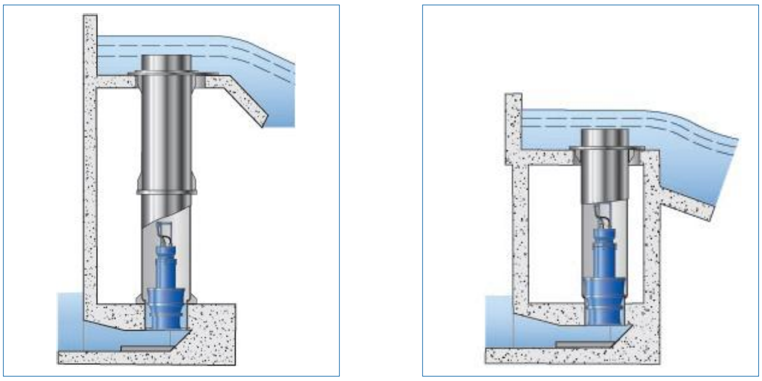


Fig. 2.2-a: Variants of discharge tube design with free discharge

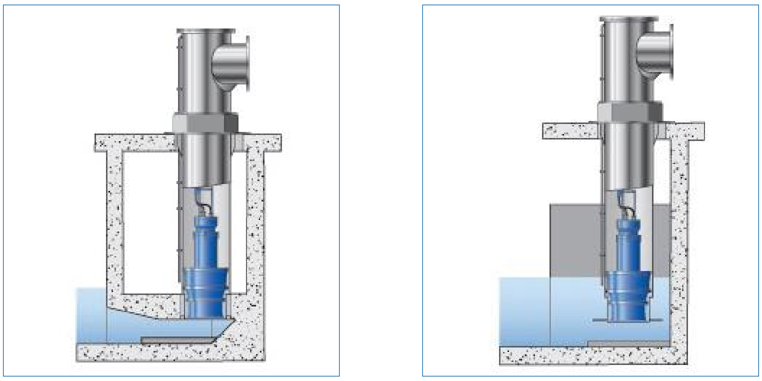


Fig. 2.2-b: Variants of discharge tube design with above-floor discharge nozzle

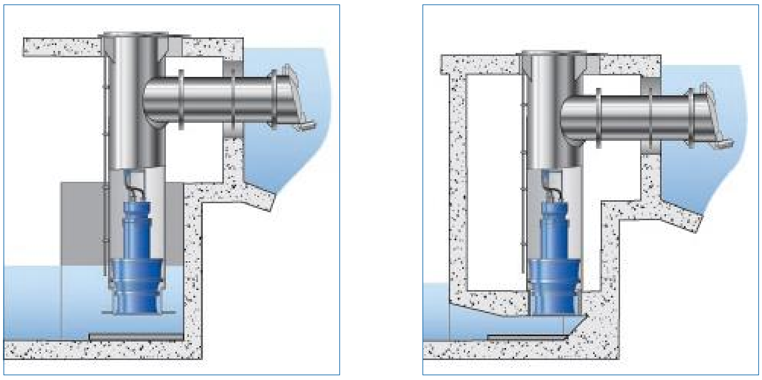


Fig. 2.2-c: Variants of discharge tube design with underfloor discharge nozzle

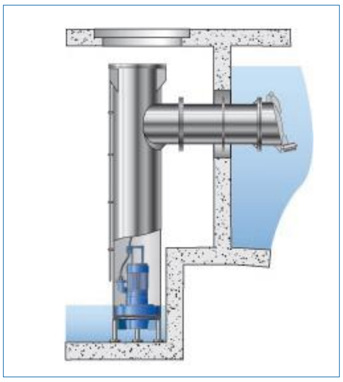


Fig. 2.2-d: Discharge tube design variant with underfloor discharge nozzle, top floor suitable for vehicles

2.2.1
Open intake chambers

If the water level in the pump sump is sufficiently high and the flow approaches the chamber directly from the front, with a tolerance of 10 degrees maximum, then this form of intake chamber design is the most cost-efficient variant.

The flow velocity must not exceed 1 m/s within the intake chamber. Flow approaching the pump at an angle of more than 10 degrees must be ruled out to avoid flow separation and vortex formation. This also applies in the event of altered operating conditions.

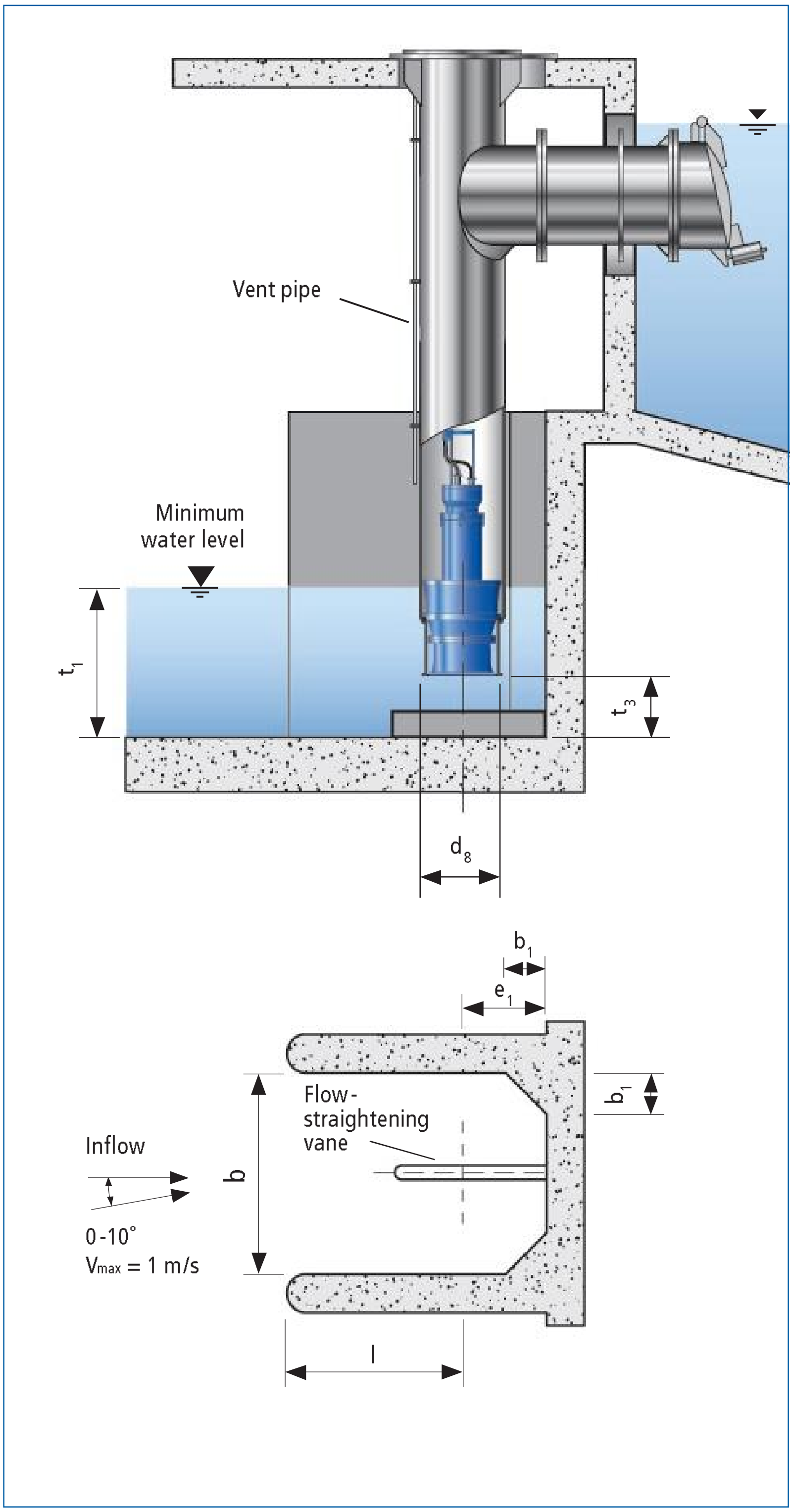
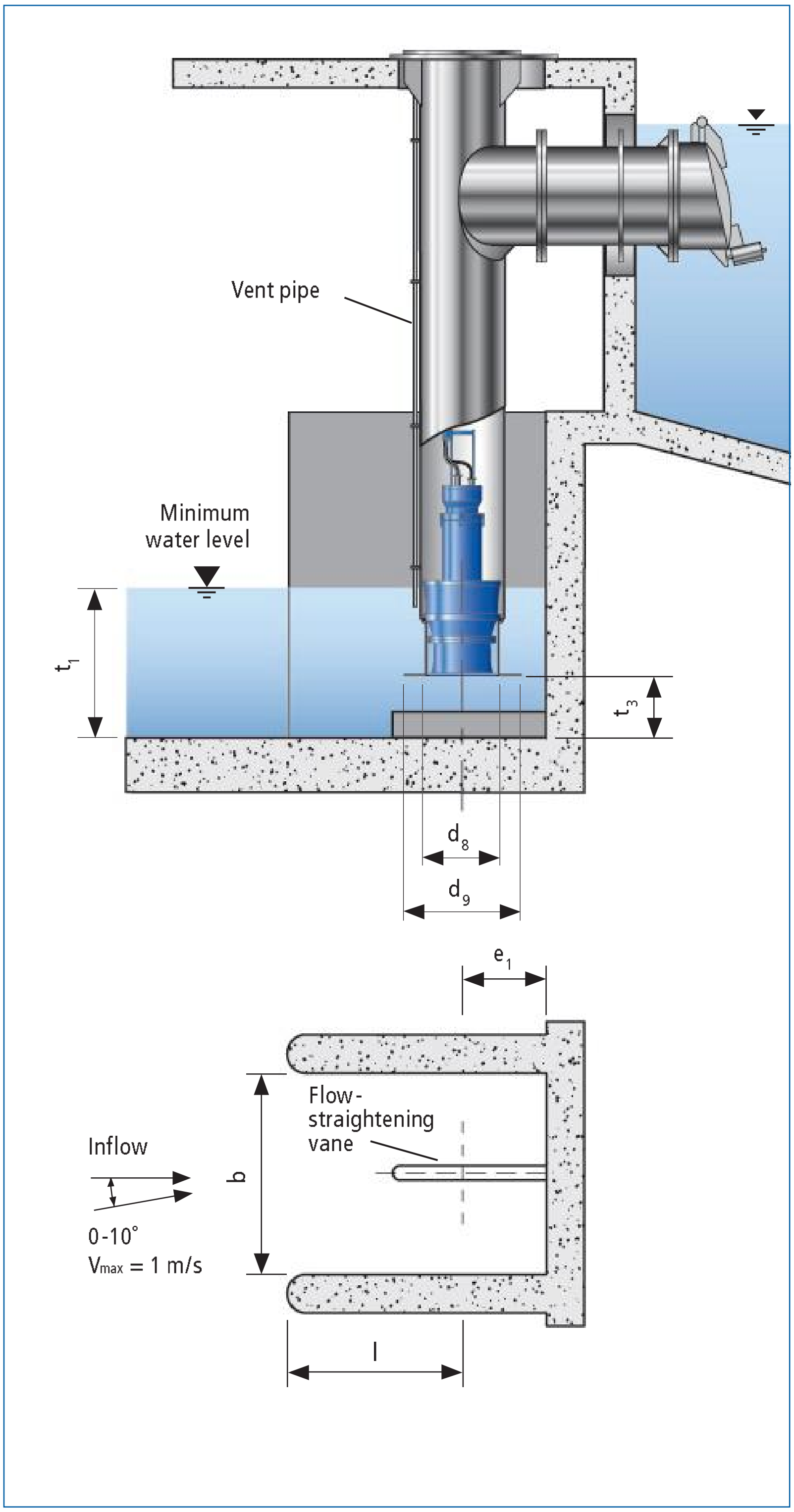


Fig. 2.2.1-a: Open intake chamber without suction umbrella (see the type series booklet for the actual dimensions)


Vent pipe
Minimum water level
t1
t3
d8
d9
e1
Flow-straightening vane
Inflow
b
0-10°
Vmax = 1 m/s
l

2.2.3
Covered intake chamber

A special type of chamber is the covered intake chamber. It allows the lowest minimum water levels without the occurrence of air-entraining surface vortices and can accommodate flows approaching at an angle of 0 to 90 degrees at 1 m/s max. However, this variant involves higher construction costs than the chamber types previously described. This type of chamber has more than proved its worth under unfavourable approach flow conditions and low water levels.

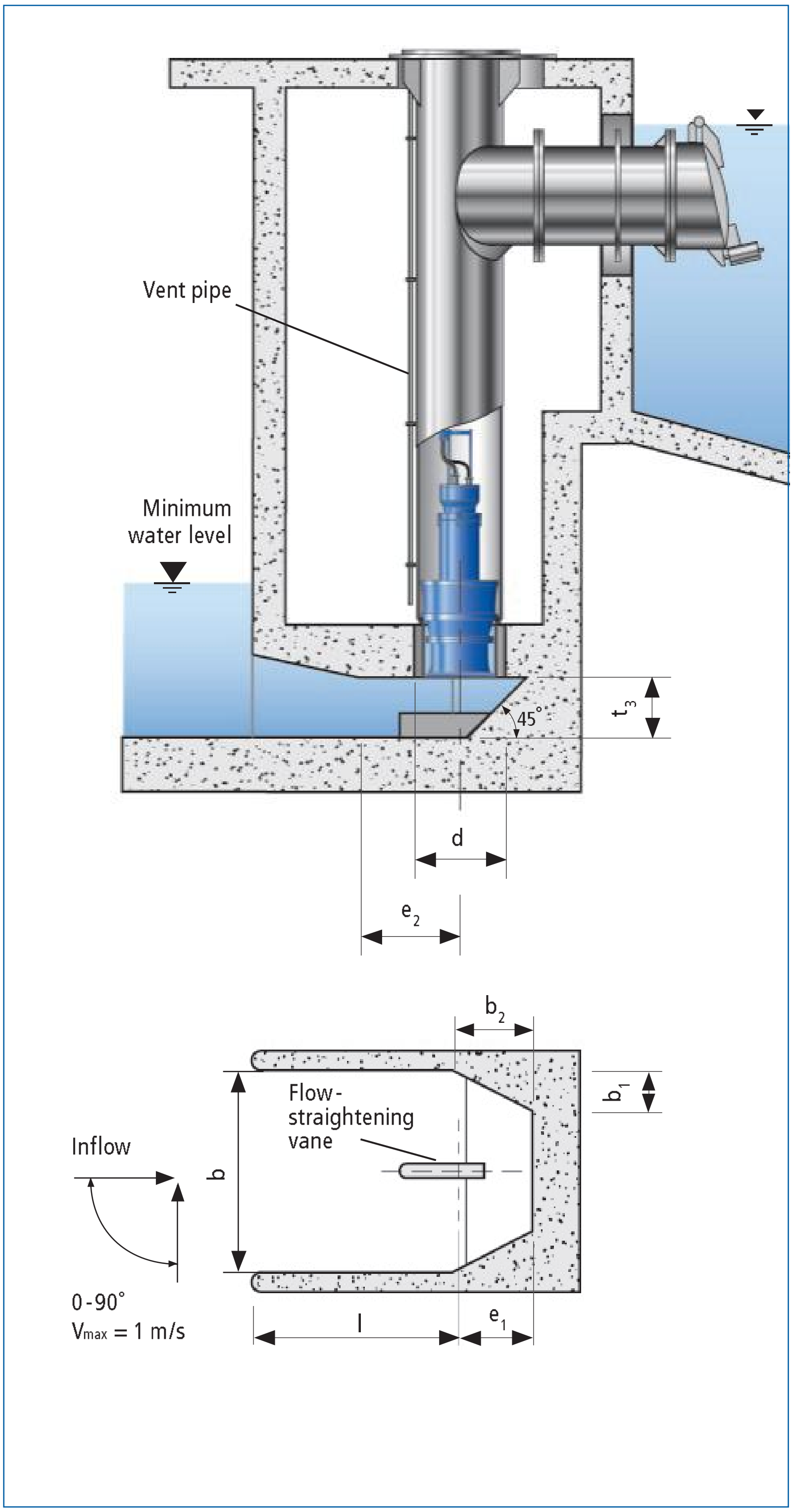


Fig. 2.2.3-a: Covered intake chamber
(see type series booklet or selection software for the actual dimensions)

2.3
Pump sump design

The fluid storage space or the pump sump connects the pump station intake with the submersible pump in the discharge tube. There are as many variations in the design of this part of the intake structure as there are pump installation options. Only a few examples can be looked at in the following chapter; the dimensions in the drawings refer to these cases only. If project or modification conditions deviate from the examples described here, we recommend consulting KSB.

One feature of an optimum pump sump design is that there are no major steps or slopes with an inclination of more than 8 degrees on the sump floor. A distance of at least 4 to 5 D (D = discharge tube diameter) should be maintained from the last point of disturbance or floor alteration to the pump centreline. Higher steps or slopes (> 100 mm) should be avoided at all costs in order to prevent submerged areas of flow separation and floor vortices.

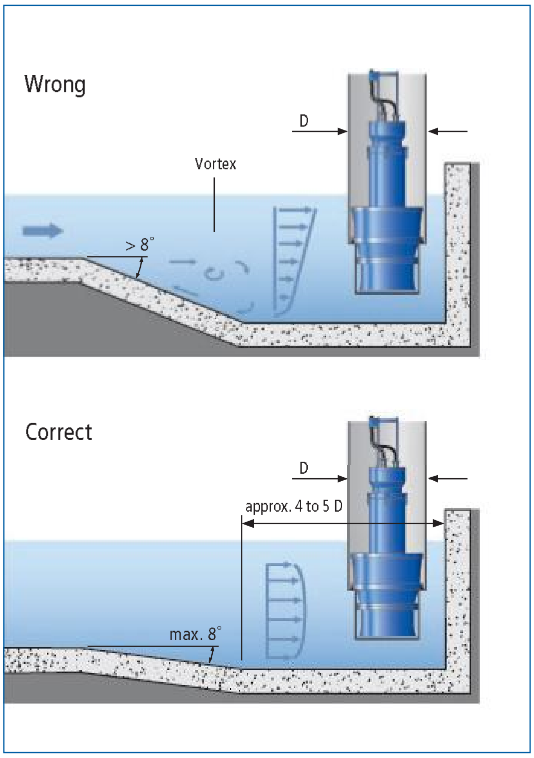


Fig. 2.3-a: Shape of sump floor

When the flow enters the pump station structure from a channel, either a diffuser-type enlargement (number of pumps n + chamber width x n+ (n –1) x wall thickness) or a so-called curtain wall is required. Which of these measures is appropriate for the project in hand, must be individually decided upon.

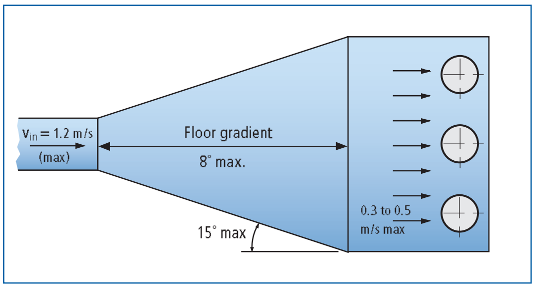
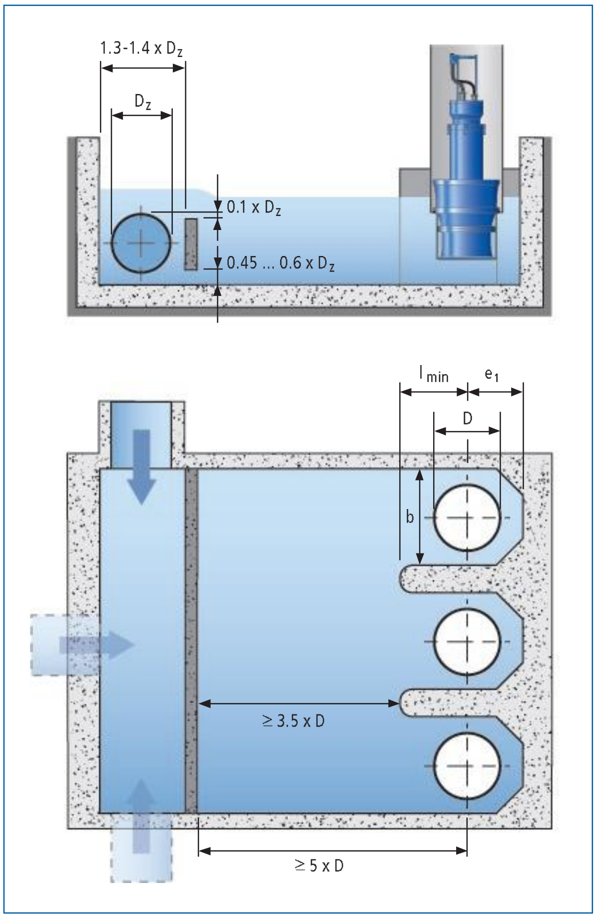


Fig. 2.3-b: Maximum permissible divergence angle for flow cross section and permissible velocities according to HI [5] and SN [12]


1.3-1.4 x D_z
D_z
0.1 x D_z
0.45 ... 0.6 x D_z
l min
e1
D
b
≥ 3.5 x D
≥ 5 x D

If the difference in height between the inlet structure and the pump sump is large it may be necessary to eliminate the risk of aeration by incorporating a weir-type structure. A difference in height of more than 0.3 m [7] already provides sufficient reason to take appropriate measures. The adjacent illustration shows a pump station with a considerable difference in height between the inlet channel and the pump sump and how this problem has been solved by fitting appropriate structures in the sump. Changes in flow direction can also be expected if only a few pumps are operating in a multiple-pump system. Here preliminary assessment of the situation could help to decide whether a covered intake chamber should be preferred to an open one.

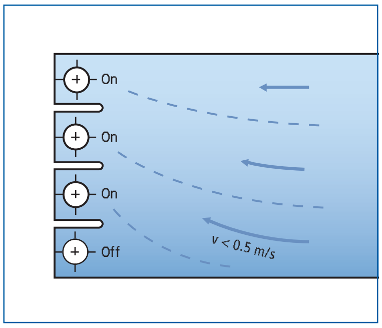


Fig. 2.3-d: Flow pattern developing with variable pump operation

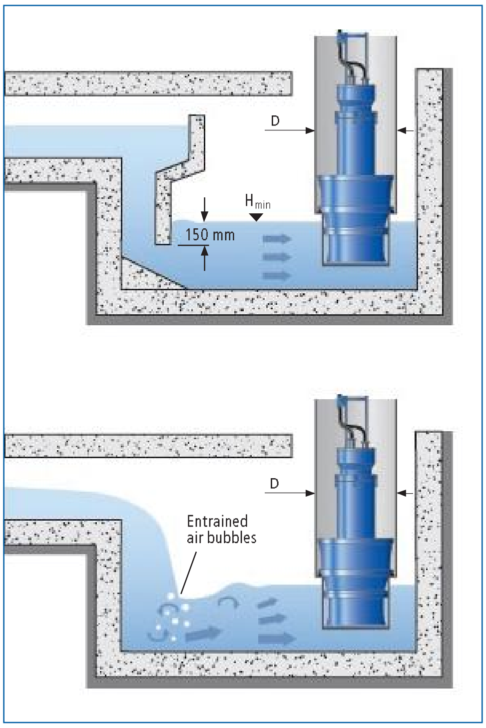


Fig. 2.3-e: Pump station with weir-type structure

If a divergence angle of more than 15 degrees is planned in the building to reduce inflow velocity v_i, additional steps such as the installation of flow distributors and/or baffles are necessary to prevent vortices caused by flow separation. The feasibility of these measures depends on the nature of the fluid pumped.

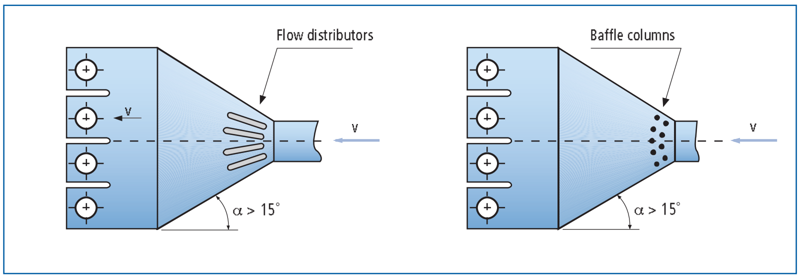


Fig. 2.3-f: Flow optimisation

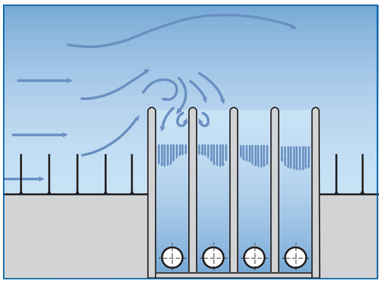


Fig. 2.3-g: Pump station with open chamber for water abstraction from a river

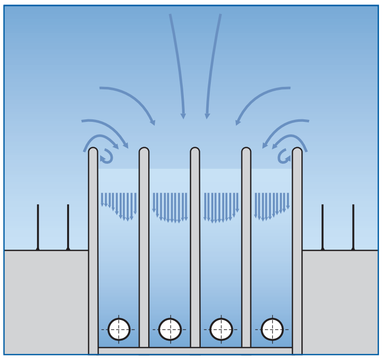
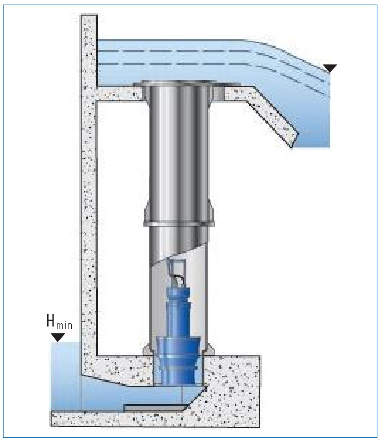
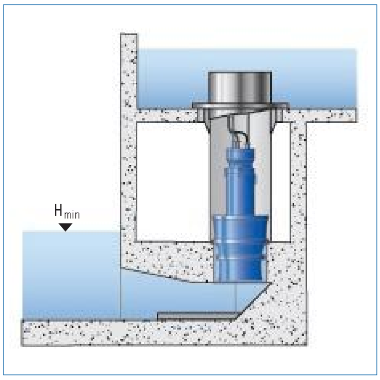


Fig. 2.3-h: Pump station with open chamber for water abstraction from stagnant waters

3.1
Design variants

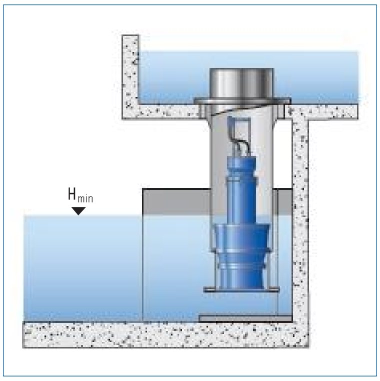


The support ring is set in concrete in the intake chamber area, then the concrete tube elements are used to construct the discharge tube. Such a design variant may be suitable for use in simple drainage and irrigation pump stations.



This illustration shows a covered intake chamber.
Here the discharge tube is, however, made from metal.

For this variant it is necessary that at the upper building level the discharge tube is appropriately sealed against the fluid pumped and supported to withstand the mechanical forces. The upper discharge tube edge has to be designed in accordance with the run-off conditions of the discharged fluid and the maximum flow velocities within the tube itself.



This discharge tube variant can, of course, also be employed in conjunction with open intake chambers. The final decision on the intake chamber design is taken on the basis of the required minimum water level relative to the volume flow rate of the pump and the approach flow direction (see diagram $t_1 = f(Q)$ in the type series booklet or selection software).

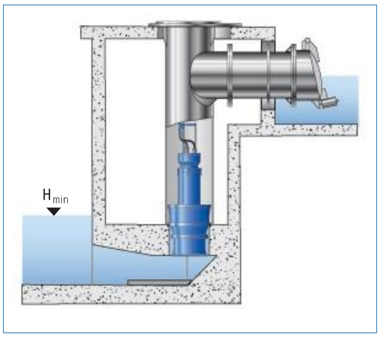


Fig. 3.1-d: Installation type CG

The next type of installation presented here is the underfloor installation. The horizontal discharge pipe outlet is situated below the upper building level. An additional, above-floor building structure, which is necessary in conventional pump stations, is not required here, resulting in a cost advantage.

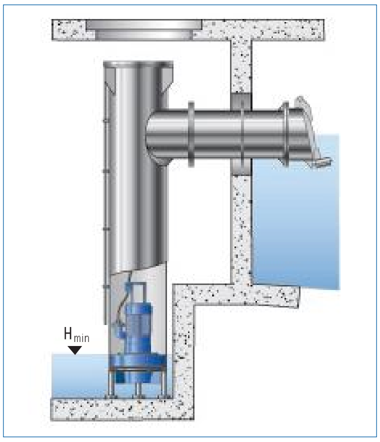


Fig. 3.1-e: Installation type CS

If the area above the pump station is intended for vehicular traffic, the discharge tube can, if necessary, be fitted with support feet resting on the floor underneath the inlet. After the discharge tube has been set up and mounted, the installation area is closed with a cover suitable for vehicles. The electrical cables are routed under the floor to the power supply.

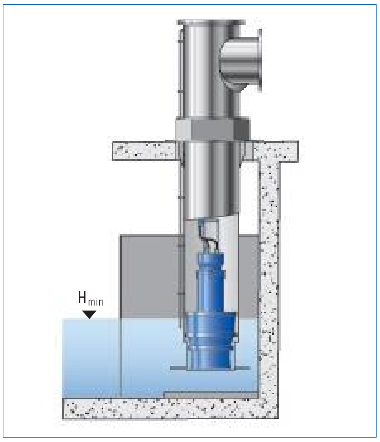


Fig. 3.1-f: Installation type DU

If some systems require the discharge flange to be connected above the floor, the installation type illustrated in Fig. 3.1-f can be chosen. A plate is mounted on the upper building level to accommodate the discharge tube forces. When deciding on the size of this plate it is important to consider the maximum forces developing during pump operation (pump weight, piping forces, torques resulting from pump operation, etc.).

3.2
Details on discharge tube design

The manufacturing quality of the discharge tube is important for the proper functioning of the pump or pump station. As the pump is centered and positioned in the discharge tube on a 45-degree bevel, resting on a rubber ring provided at the pump casing (the pump is seated by its own weight plus the axial thrust developed during pumping), particular attention must be given to this area during manufacturing. Poor concentricity and surface finish may cause the pump to rest on some points but not all of the inclined support area, resulting in inadequate sealing with some flow passing back to the suction side. As a consequence, the pump does not achieve the volume flow rate required for the connected system.

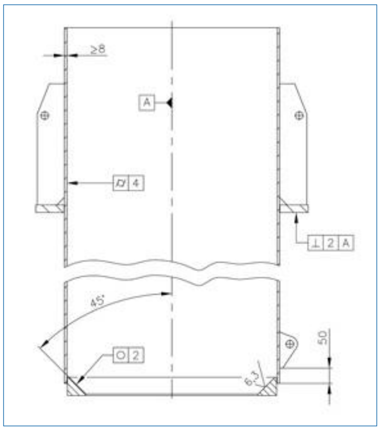
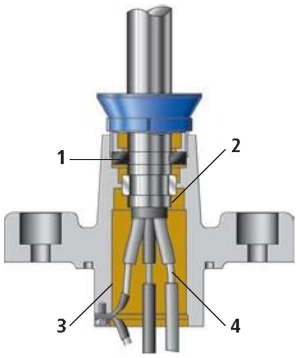


Fig. 3.2-a: Support area of pump in discharge tube for Amacan K

3.3
Cable connections

The pumps of the Amacan series are all equipped with an absolutely watertight cable entry system. This KSB patented system protects against the pumped fluid penetrating the motor space or terminal box of the pump if the cable insulation has been damaged during assembly or operation. The insulation of the individual cable cores is stripped and the wire ends are tinned. This section is fixed in the cable gland system with spacers and then embedded in synthetic resin. A rubber gland provides additional sealing.



1 Long rubber gland
2 Outer cable insulation
3 Individual cores are additionally cast in resin
4 Individual core insulation stripped, wire ends tinned and embedded in cast resin

Fig. 3.3-a: Sectional drawing of an absolutely watertight cable entry system on a pump

This sealing principle is used for both power and control cables. When the pump is installed in the discharge tube, it is necessary to mechanically support the cables' own weight and at the same time protect them against flow turbulence. For this purpose KSB has developed a patented cable holder. The cables (power and control cables) are attached to a stainless steel carrier rope using rubber profiles and a clip. The rope is then screwed to the discharge tube cover or to a cross bar in the case of an open discharge tube. This guarantees that the cables have a long service life and the cable entry into the motor housing is absolutely tight.

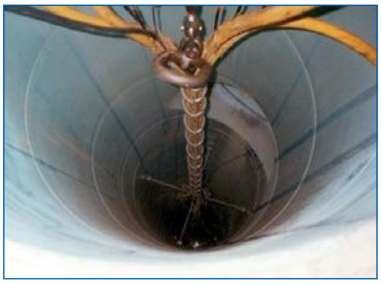


Fig. 3.3-b: Example of a rope with cable holder for an installation depth of 50 m

To ensure the cables are smoothly routed through the discharge tube cover either welded-in sleeves or shaped rubber gromets are used. The choice of cable passage depends in the main on the form of the discharge tube and the system pressure. If the tube variant is one closed with a cover, the cables must be supported by a separate holder underneath the cover to support the cables' own weight and protect them against flow turbulence in the discharge tube, as described above.

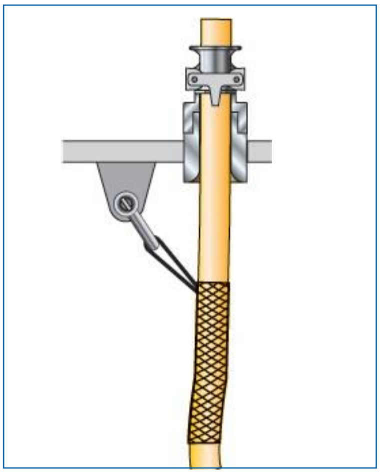


Fig. 3.3-c: Cable suspension and cable entry into discharge tube

If the discharge tube is open, the cables are routed vertically out of the tube and are then attached to a cross bar. If Amacan pumps are installed at greater installation depths, then additional supports should be fitted to hold the cable carrier rope in position. The object of these supports is to reduce the influence of the turbulent flow on the rope. These supports rest against the discharge tube wall.

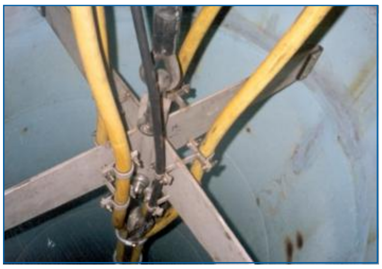


Fig. 3.3-d: Supports for cable guidance in the discharge tube

When ordering the pump it is necessary to specify the exact installation depth so that the precise length of the cables and ropes as well as the number of supports can be determined. If the specifications of both planning and execution stages differ, the following two situations may arise: If the rope is too short, the pump will not be firmly seated in the discharge tube and the reaction moment of the pump may damage the cables during start-up. If the cables are too long or not tight enough, the flow may cause the lifting rings of the cable assembly to hit against the discharge tube thereby damaging discharge tube, rope and cables.

In order to determine the correct number of lifting rings on the rope, it is also important to know the lifting height of the davit, lifting frame or crane.

If the components described above are not ordered along with the pump, other solutions may have a very negative influence on the pump's functioning. Power and control cables are, for instance, very often attached to the rope with simple cable straps; this, however, will lead to the destruction of the cable insulation and/or core breakage inside the cable during pump operation.

Fig. 3.3-e: Cable attachment using simple cable straps

For installation depths greater than 5 m the cable holder and carrier rope design becomes increasingly important for trouble-free pump operation.