

DESIGN TIPS FOR FLOOD CONTROL PUMPING STATIONS

The pointers given below are used by Grundfos staff when analysing the requirements of new pumping stations. Although useful, they are of course generalised recommendations only and cannot replace individual, job-specific advice. Firstly, the general considerations required when designing a flood control pumping station are presented, followed by more specific design examples.

Steps to consider when designing pumping stations

Carefully going through all these steps creates the best foundations for success and will help keep overall costs to a minimum.

- Review the head and flow calculations, paying close attention to how they are calculated. Check the expected minimum, average and peak flows. One should also check if the head requirement varies; this will have a profound influence on the duty point of the pump.
- Check the site physically to confirm flow and head if possible – particularly if it is a replacement job. Things may well have changed greatly since the station was first designed.
- Determine the number of pumps required from the specified flow and head requirements.
- Determine the pump type to be used.

What pump to choose?

Generally speaking, we recommend propeller pumps for low-head applications and mixed-flow pumps for medium-head applications. We also find that installing submersible pumps in columns can have substantial advantages over other pump types,

for example long-shaft turbine pumps, used in flood control applications.

These include:

- Reduced civil costs
- No shaft alignment problems
- Reduced installation time and cost
- Takes up less floor space
- Silent operation
- Flood-proof
- Fewer auxiliary elements required
- Increased reliability
- Reduced superstructure required
- Reduced maintenance, including reduced maintenance costs
- Greater flexibility
- High efficiency

Installation type

The best choice of installation is, of course, job-specific. However, column installation often offers scope for lower construction costs. The flexibility of column-type installation allows for everything from free outflow (above or below water level) to pressurised solutions. Column-type installations can also be inclined.

Sump design

The sump design has a crucial impact on the pump's total lifespan. A less-than-optimal sump design could potentially result in poor performance and/or mechanical strain due to vibrations and cavitation at the inlet to the pump(s). A poor design can easily lead to sedimentation of sand and rags, which in turn can cause additional cavitation and vibration problems.

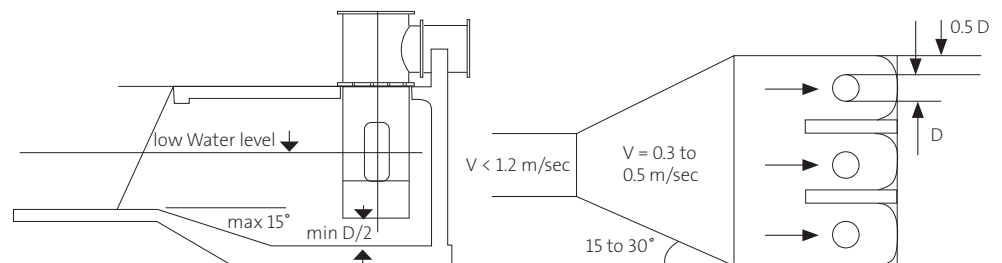
The main design requirement for a sump design is to provide optimal inlet conditions for the pumps. The flow being delivered to the pump units should be uniform, steady, and free of swirls or entrained air.

Column-installed pumps are high-volume pumps, making them sensitive to suction chamber conditions; great care must be taken to ensure safe and long-lasting operation. The dividing walls – and the positioning of the pumps – must be done in a manner which avoids surface vortices, air ingestion and entrainment, and turbulence.

The following factors should be considered:

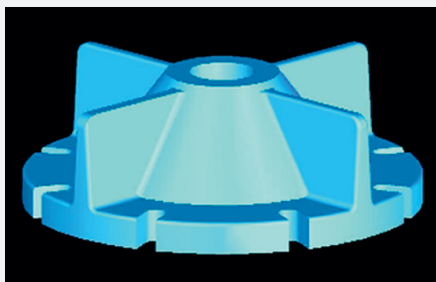
- The velocity and distribution of the fluid in the inlet channel should be with a uniform flow. The angle of the bottom should have an inclination of 10 to 15 degrees.
- The velocity of the water in the inlet channel should be less than 1.2 m/s.
- The over all velocity of the water in the pumping station should be between 0.3 and 0.5 m/s.
- The effects of flow disturbances should be dissipated as far as possible from the pump intake.
- Stagnation regions should be avoided. If the design creates such stagnation regions, they should be filled with concrete before operation commences.
- Care should be taken to avoid suction vortices in connection with pump immersion. As a rule of thumb, the immersion of the pump should be between one to two times the pump diameter, depending on flow rate. Specific recommendations must be obtained from the manufacturer in each case.
- The free distance between the pump and the sump bottom must also be observed. This should never be less than half the pump diameter in order to avoid cavitation.
- The pump and column installation should be placed symmetrically in the pump sump while taking care that there is sufficient distance from the outer diameter of the pump to all walls of the sump. The distance should be at least half the pump diameter.
- With more pumps in parallel is it recommended to have separation walls between the pumps so that they are not influencing each other and the water is channelled uniform to the pump.
- The complete design should be subjected to careful analysis – this includes taking a careful look at screens and the possible need for a sludge pump.

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Beating cavitation

Cavitation – and the noise and vibrations associated with this harmful process – can be prevented by fitting an anti-cavitation cone below the pump. When installed just beneath the suction bowl, the cone prevents cavitation – and can also prevent vortices and fluid separation.

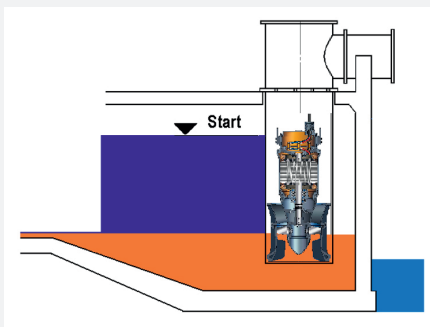


Fasten all chains and cables

Having chosen a tube installation, always make sure that chains and cables are securely fastened as they are placed in the flow of the pump. They must never be allowed to move with the flow. Loose chains or cables will be subject to wear and damage resulting in premature failure.

Screen design

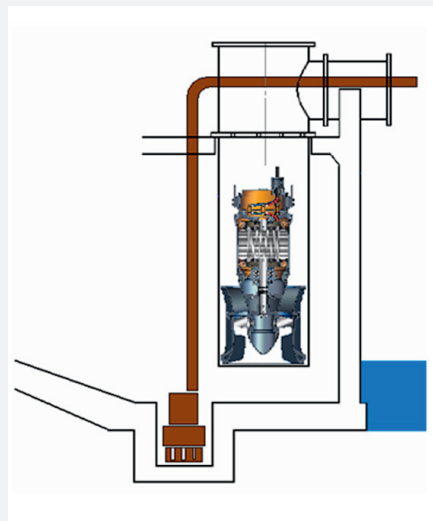
When considering screen design, the dead zone should be kept as small as possible to minimise scraper travel. Screens should be divided into several vertical panels and supported by vertical piers; they should never be supported horizontally. Observing this rule maximises the flow channel, thereby eliminating potential head increases and making it easy to clean and maintain the screens.



Handling sludge

During dry seasons, water levels recede. When this happens, the sludge in the remaining water settles in the sump. The situation can escalate by a slow inflow; in such situations additional sludge enters the sump and water evaporates. The end result may be that the impeller is buried in silt when the pump needs to start.

To keep the sump clean at all times, it is recommended to install a small sludge pump in a separate, small pump sump within the main sump. This sludge pump is used to empty the main sump in periods with less or no inflow to the main sump.



Using different pump sizes

The pumps used in flood control applications are often called upon to operate under normal weather conditions – not just in extreme flood situations. At the same time, the pumping station must be able to cope with much higher peak flows in flood situations. Finding the balance can be difficult – often, the final pumping station design ends up being quite unsuited for the two different scenarios. To overcome this challenge, the sump can be divided into two chambers – one for normal operation and another for peak flow situations. The two chambers of the sump must be divided by a low wall that allows the water to flow over into the second sump in flood situations. The pumps used for normal operation should be relatively small, operating in cascade or by means of frequency converter, whereas the peak flow pumps should be quite big, enabling them to cope with the extreme situation.

Monitoring and control

Flood control pumps are big investments, and service and repair is relatively costly. Even when the system is designed well and the pumps used are of high quality, wear is inevitable – as is the risk of failure. Monitoring the condition of pumps helps lower the total lifecycle cost of the flood control application. Proper monitoring and control will:

- protect expensive equipment
- help ensure optimum station operation
- reduce energy consumption
- help avoid overflow – and report any incident
- optimise service personnel schedules for preventative maintenance
- meet demand for more accurate reporting (e.g. to comply with stricter environmental legislation)

The changes in the pump conditions described above and the easy commissioning are the reasons for introducing performance on-demand control in Dedicated Controls from Grundfos.

Sensors help alleviate main risks

When pumps are submerged, there is a greater risk of water entering the motor through the cable gland and shaft seal. For that reason, most manufacturers incorporate an oil chamber with double sealing and also fit a range of sensors to protect the pumps – often far more than in smaller pumps. Typical sensors in large pumps include:

- Bearing temperature sensors (lower and/or upper)
- Motor temperature sensors
- Water-in-oil sensors monitoring the conditions of the shaft seal
- Terminal box moisture sensors
- Vibration sensor
- Winding isolation resistance

In addition to the above pump sensor, most applications also have a sensor to keep an eye on power consumption, voltage, operating hours, etc. Often, keeping an eye on changes in values is more important than responding to absolute values. During the commissioning stage, it will often be beneficial to experiment with different reference values to ascertain when action may be called for.

Service from the supplier

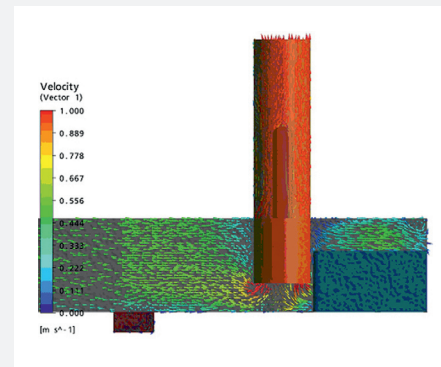
A lot of know-how and experience is available from the pump supplier which can provide value to the design of future pumping stations for flood control.

Today CFD simulations prove a useful tool. It enables the stakeholders to actually prove the chosen design, before carrying out the actual infrastructure investments. This makes it possible to evaluate, adjust and eliminate any risk. Upon request Grundfos can provide this CFD simulation.

The aim of the design tips are to help:

- reduce the overall, long-term costs of flood control pumping stations
- design while maintaining the balance between energy and reliable duty.

Hopefully they can help stakeholders in creating sustainable proposals and solutions for flood control.



About the author:

Mick Eriksen is an Application Manager at Grundfos Management, a pump and pumping solution provider. The tips featured in this article have been compiled from the input and experience of many field operatives.

For more information about flood control or Grundfos please visit www.grundfos.com/water-utility