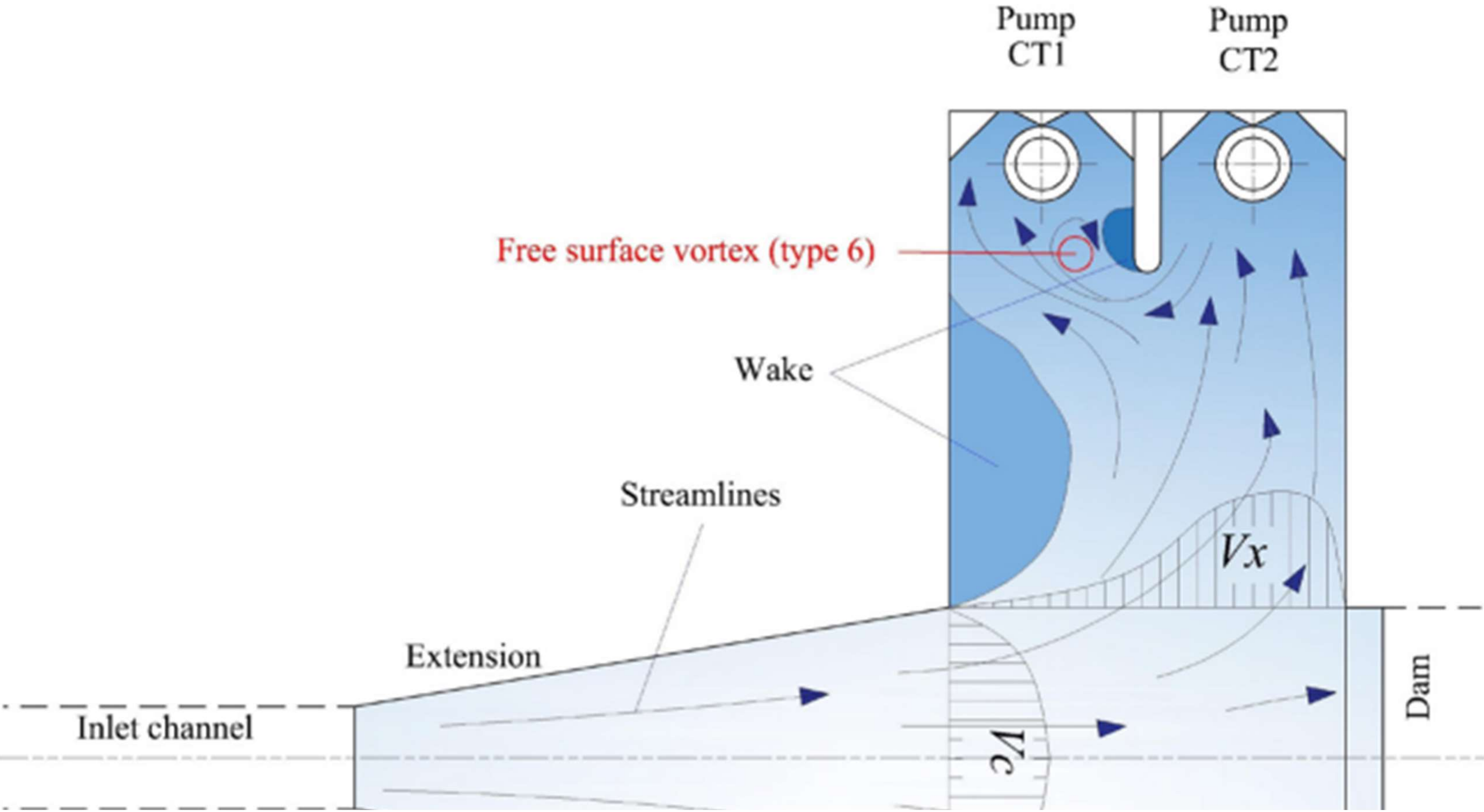
Cooling Tower Sump pump Intake Design

One of the biggest problems when designing a pump intake on a cooling tower sump is the risk of air intake in the pipeline or flow disturbances that **can damage or reduce the pump efficiency**.

To avoid these problems, **ANSI HI 9.8** brings some guidelines for pump intake design. These guidelines must be followed unless, as excepted by ANSI HI, the geometry is tested and prototyped to prove it works. (See section 9.8.5).

- The main goal is to straighten the flow in the direction of the pump intake and avoid cross-flows in its vicinity that create asymmetric flow patterns.
- **As a general guide, cross-flow velocities are relevant if they exceed 50% of the pump bay entrance velocity.**



Pump CT1
Pump CT2
Free surface vortex (type 6)
Wake
Streamlines
Vx
Extension
Inlet channel
Vc
Dam

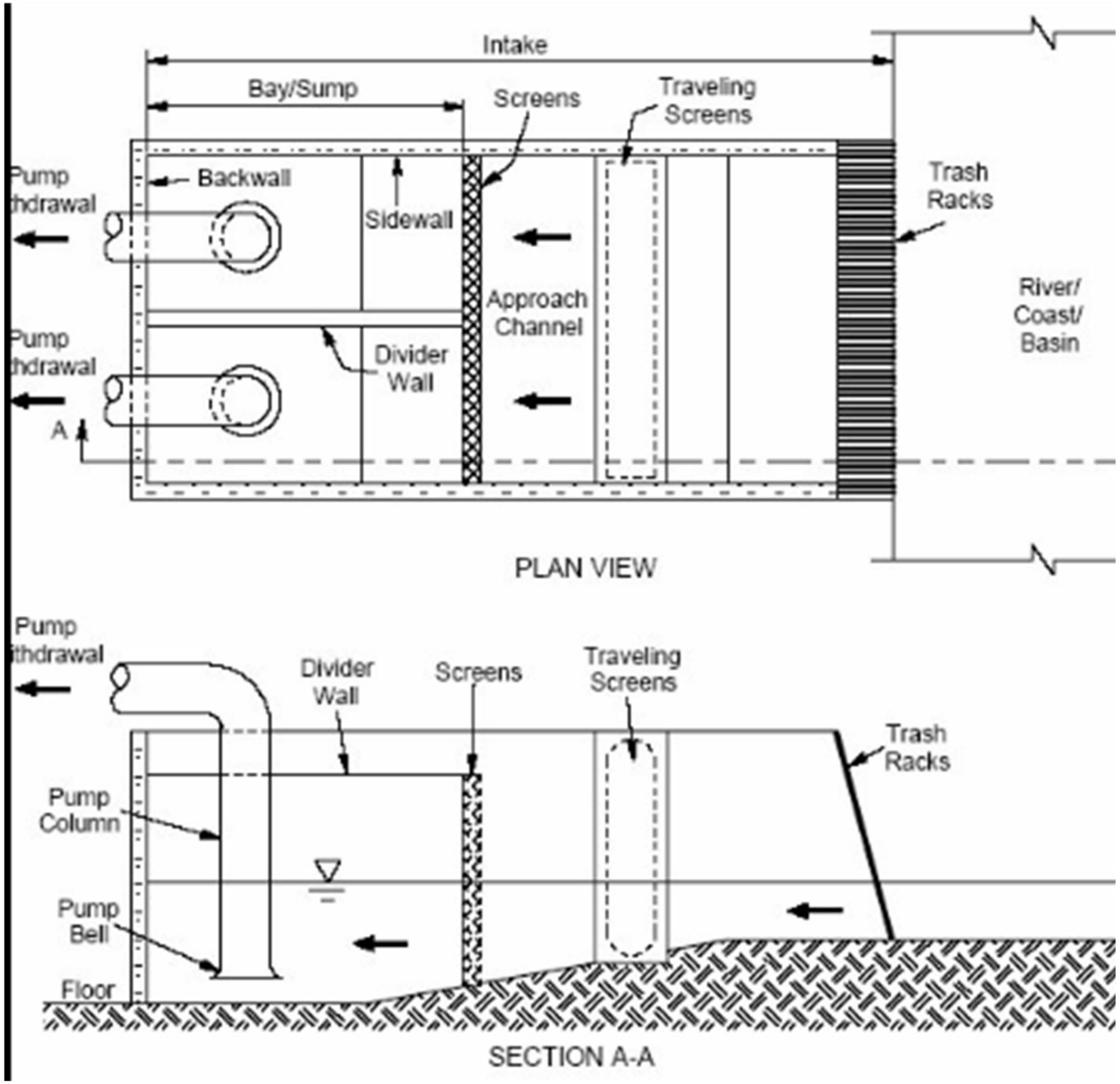
If multiple pumps are installed in a single intake structure, **dividing walls** placed between the pumps result in more favorable flow conditions.

For pumps with design flow greater **than 315 l/s (5.000 gpm)** dividing walls between pumps are **required**.


CT1
CT2
a)

To assure a satisfactory hydraulic performance, the basic design requirements are:

- **Adequate depth of flow** to limit velocities in the pump bays
- **Adequate bay width**, to limit maximum pump approach velocities to 0.5 m/s (1.5 ft/s)



Intake
Bay/Sump
Screens
Traveling Screens
Backwall
Sidewall
Trash Racks
Pump ithdrawal
Pump ithdrawal
Approach Channel
Divider Wall
River/ Coast/ Basin
A
PLAN VIEW
Pump ithdrawal
Divider Wall
Screens
Traveling Screens
Trash Racks
Pump Column
Pump Bell
Floor
SECTION A-A

To prevent strong air core vortices a **minimum submergence (S)** is required.

It’s based on Froude number, defined as:

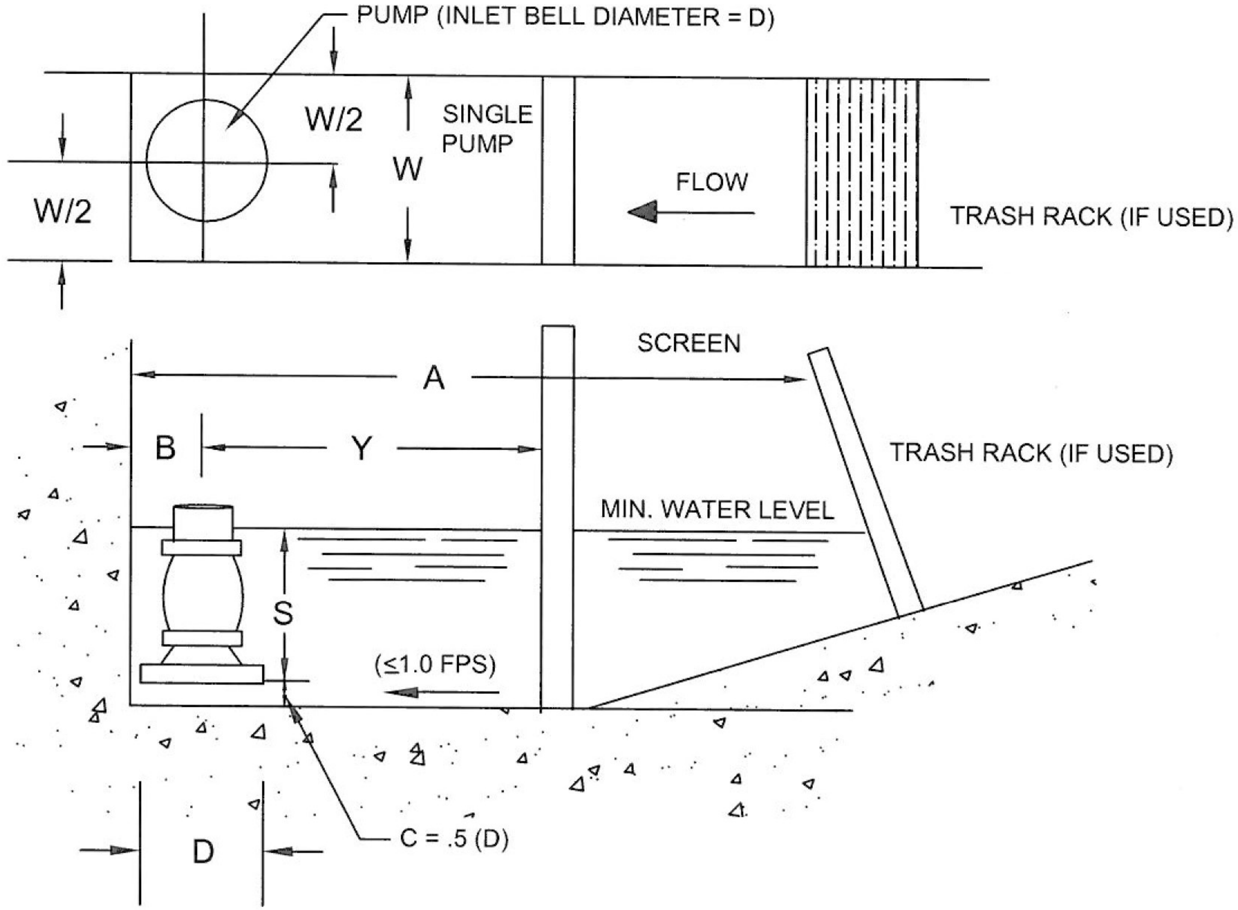
$$F_D = V(gD)^{0.5}$$

Where:

$F_D =$	Froude Number
$V =$	Velocity at suction inlet = Flow/Area
$D =$	Outside diameter of the bell
$g =$	Gravitational acceleration

And finally, submergence (S) is calculated as:

$$S = D(1 + 2.3F_D)$$

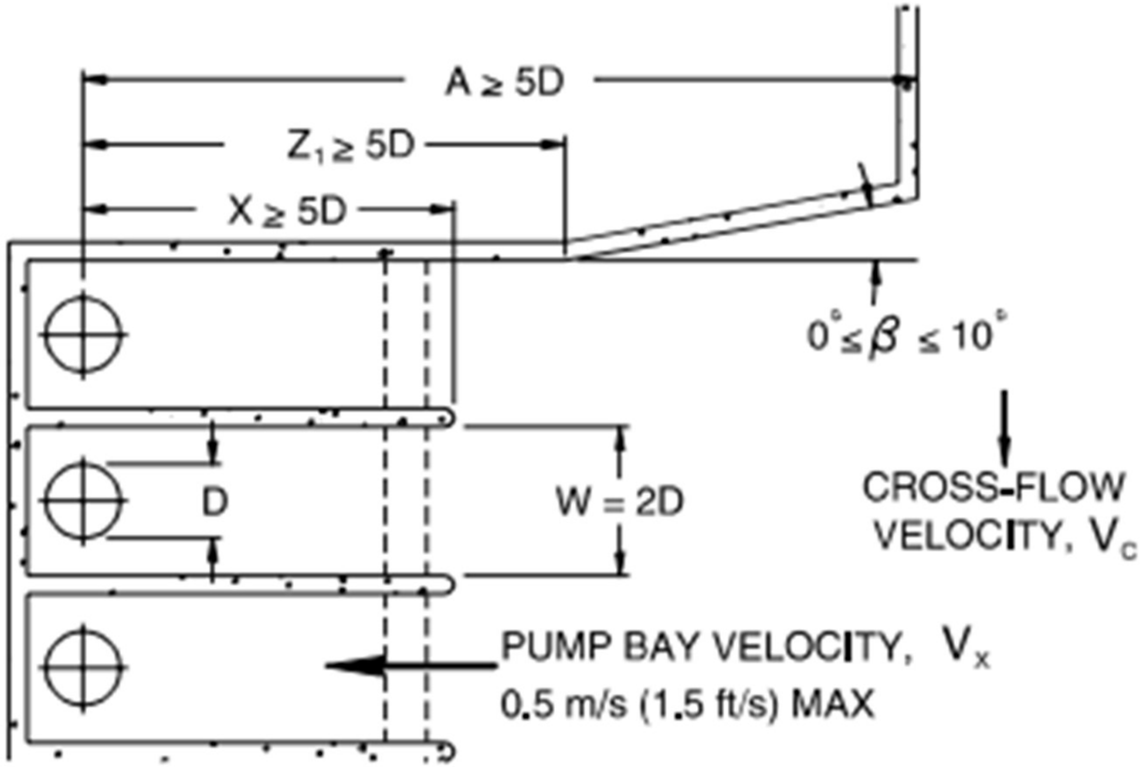


Sump dimensions are calculated based on inlet diameter (D), to keep the proportion and flow properties.

Table 9.8.1 explains each and every Dimension.
Table 9.8.2 defines the appropriate design sequence

The drawings are self-explanatory, but since there are a lot of parameters, give yourself time to digest the information

- Keep the width between the two wall (W) equals to 2D max.
- (X) is meant to straighten flow in the direction of the pump.
- (β) does not need to be much bigger than (X), but if you enlarge your sump, make it with a low angle to avoid perpendicular flow.
- (X), (Z) and (A) can be equal.

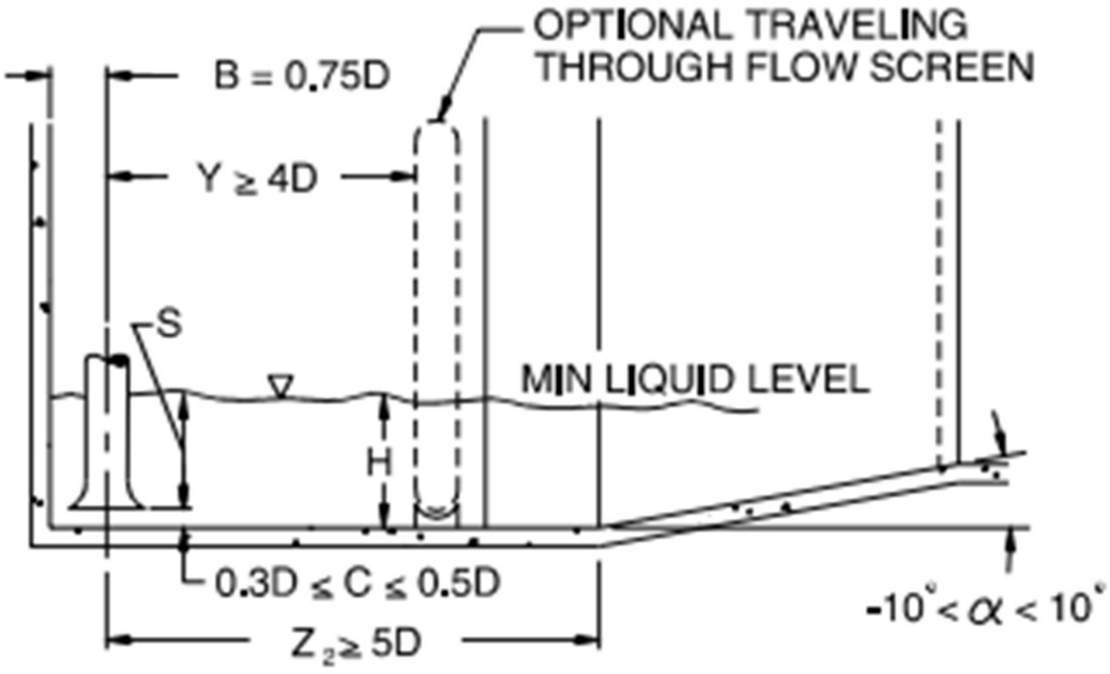


(B) Is the distance fro, the back wall to the center line of the suction and yes, it is pretty small.

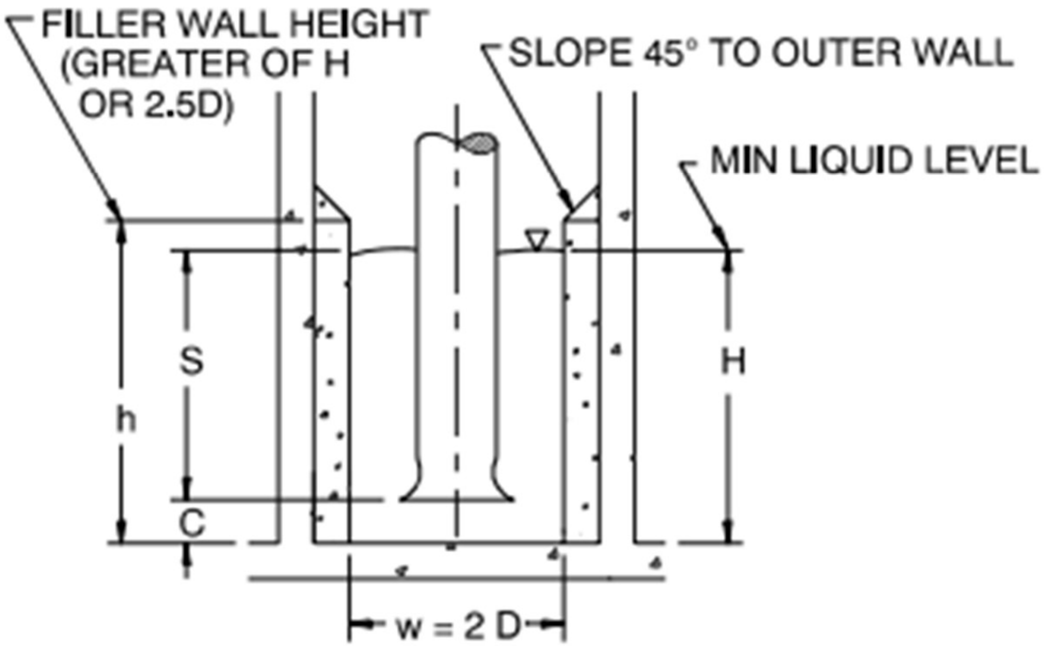
(C) Is the distance between the suction bell and the floor, and it is also small.

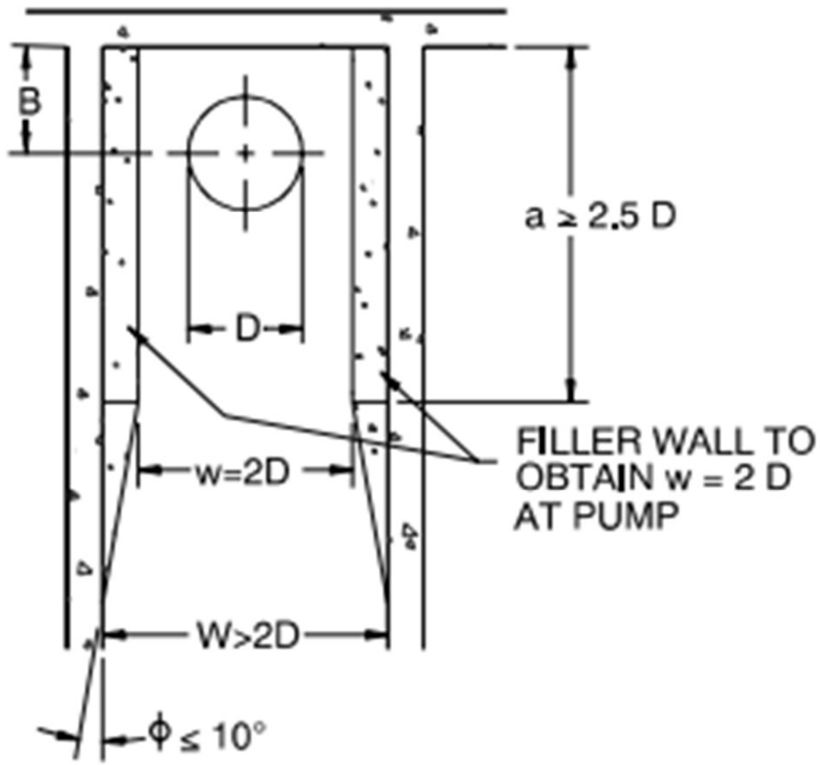
(S) Is the submergence.

(H) Is the minimum water level (S+C).



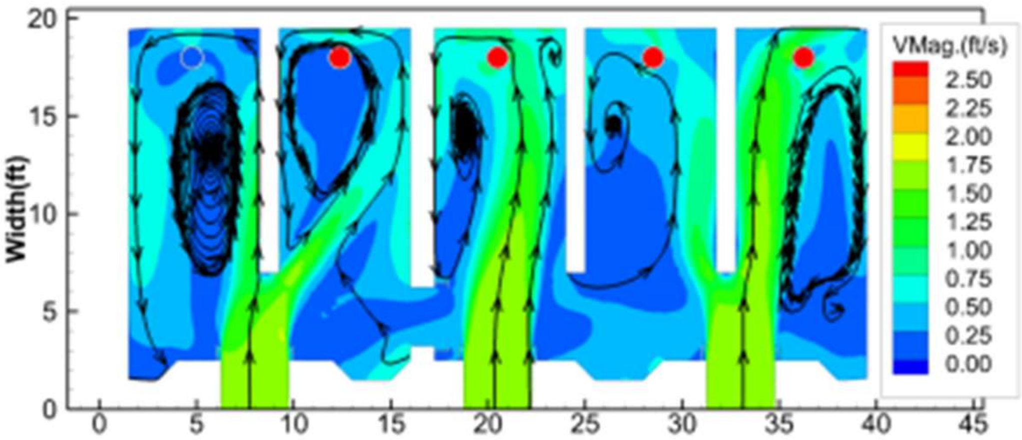
When you can't make the width (W=2D) the recommendation is to use a filler wall.

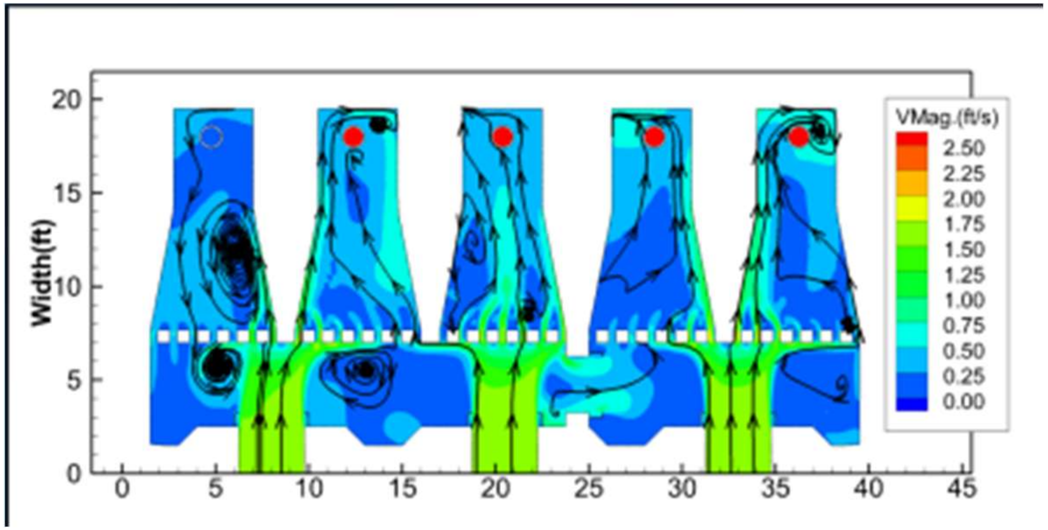




Look the comparison between a bay without (left) and with (right) the filler wall.

The swirl is much less and the current streams are more aligned with the direction of the flow



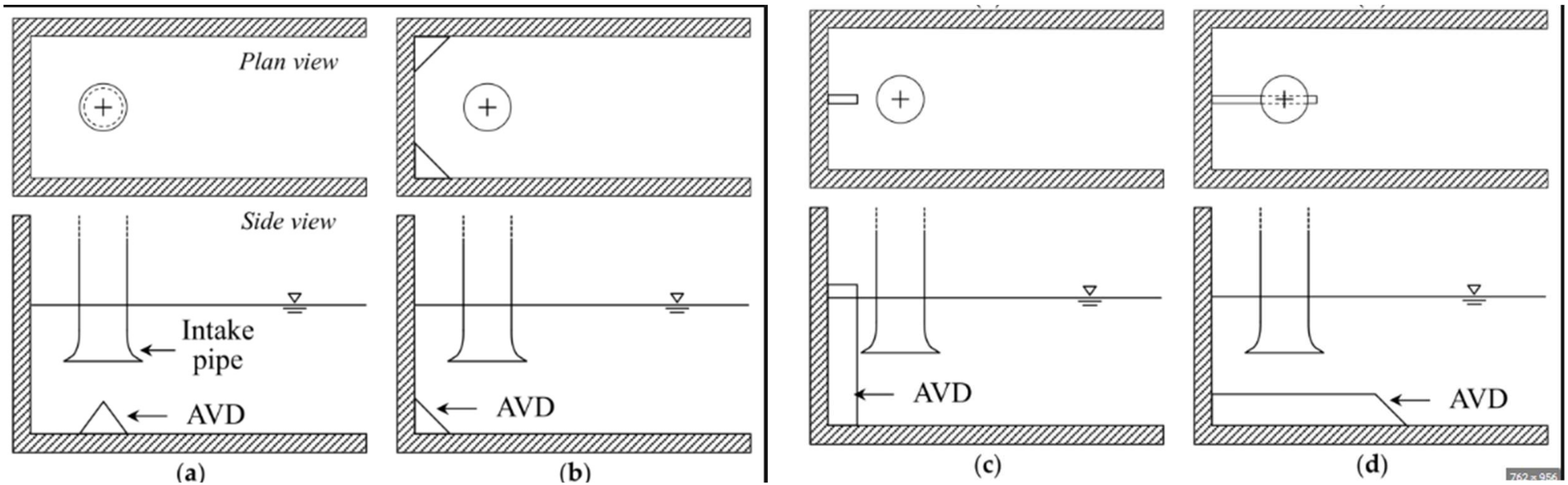


Remedial measures

If the design was not adequate and the system is not working as it should, some remedial measures can be adopted to improve flow conditions.

NOTE: These measures should not be used as a design component from the beginning. Keep them as a last resource.

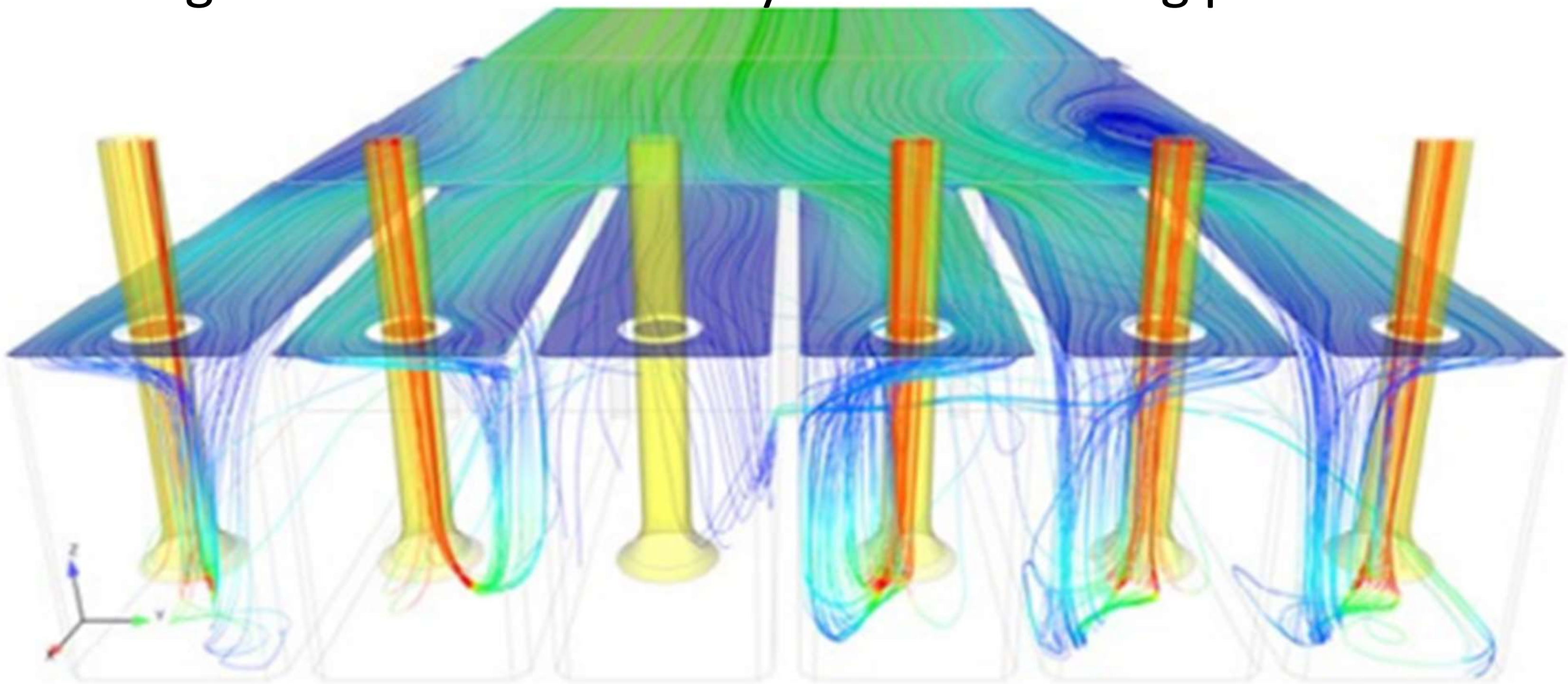
The goal of these devices is to avoid or break vortices after they form. See for example, case C is applicable if the distance (B) is too high and case D is applicable when distance (C) is higher than it should.



Besides ANSI HI guidelines, a lot of smart engineers have invested a lot of their time and resources to study the flow characteristics on pump suction.

Now with a higher computational power and CFD softwares it’s possible to optimize the layout before construction.

But ANSI HI guidelines should always be the starting point.



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