The offshore market is searching for reserves in ever deeper waters, a reality which makes the need for pin-point accurate current generation in a model basin more important than ever before. MARIN's JAAP DE WILDE and BAS BUCHNER discuss the role the new Offshore Basin will play in supporting the sector as it faces new deepwater challenges.

In the Offshore Basin, current affairs are the order of the day

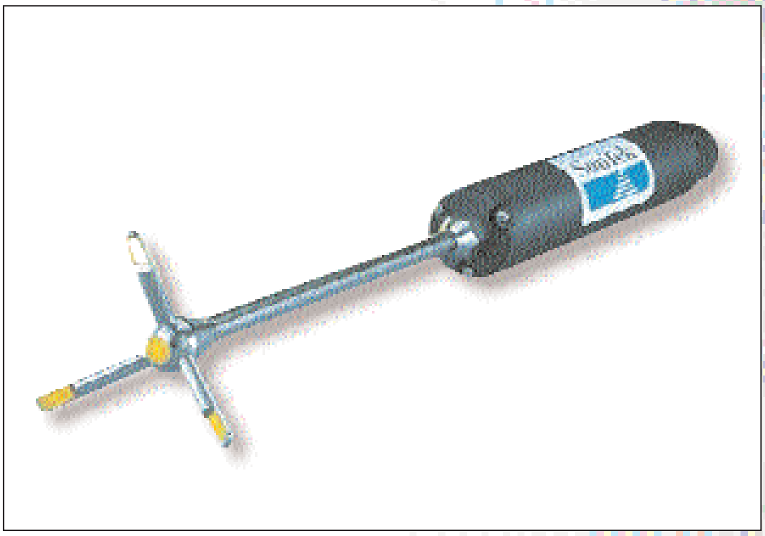
The sheer length of today's mooring lines and risers provide deepwater current forces with plenty of surface area on which they can act and this means steady and dynamic current loads are a very important design aspect.

Current circulation system

So the new current generation system in the Offshore Basin had to be something special. It had to be able to generate a large flow rate of more than 50 cubic metres per second, but it also had to be uniform and to display vertical velocity profiles with constant velocity. MARIN is deploying an entirely new current circulation system, consisting of six vertical layers with ingenious flow distribution and turbulence control.

With the ability to individually adjust the flow in each layer, the flow shearing of actual currents can be reproduced to specification.

Because a uniform horizontal flow distribution is required in the basin, large pressurised flow ducts with a perforation on one side are used on the inflow and outflow sides of the basin. The working of these flow ducts is quite similar to the way in which, for instance, the gas flow in large burners is distributed. Due to overpressure an equal flow distribution is obtained. The big challenge was to design a system suitable for the massive 35 m width of the tank.

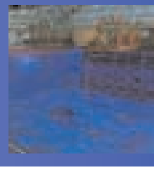


Acoustic Doppler Velocity (ADV) sensor.

Measuring high quality current

In the design process, the expertise and experience of the civil engineering Institute Delft Hydraulics was used, and a unique, compact and efficient design was produced. Indeed, all critical elements were tested using scale models. Generating a high quality current is one thing, but measuring it is another. MARIN needs to be able to accurately demonstrate to its clients the conditions in which the tests are carried out. Precisely at the location of the model in the basin, current shearing, uniformity of the flow field and the intensity of the turbulence in the current have to be measured.

There were two main challenges; firstly an instrument had to be devised which is at least a factor more accurate than the accuracy of the current under simulation. If, for example accuracy of 2.5% is required for a current velocity of 100 mm/s model scale and must be measured with 10% accuracy, an instrument is needed to measure



velocities as small as 0.25 mm/s - not many sensors can do that.

Secondly a positioning system has to be deployed which can keep the sensor steady in the flow at each required position. Any vibration of the sensor with respect to an earth fixed reference system, will be detected by the sensor as a time varying current velocity. When this is happening this signal simply cannot be distinguished from a real time varying current velocity. Consequently the turbulence intensity measurement will be disturbed. MARIN chose the latest generation Acoustic Doppler Velocimeter to measure currents. This instrument senses the acoustic Doppler shift of minute dust particles in the water at a frequency of 16 megahertz, which is in the frequency range of mid wave radio transmission. The sensor will be mounted on a streamlined frame, kept in position by means of two tensioned wires. The vertical traversing allows for measuring at any water depth between 0 and 10.5 m model scale.

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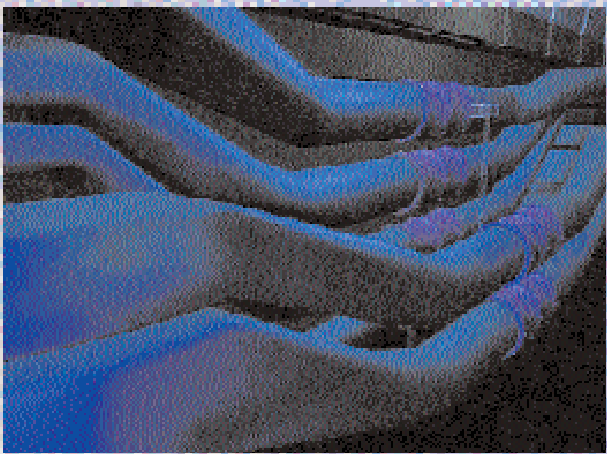
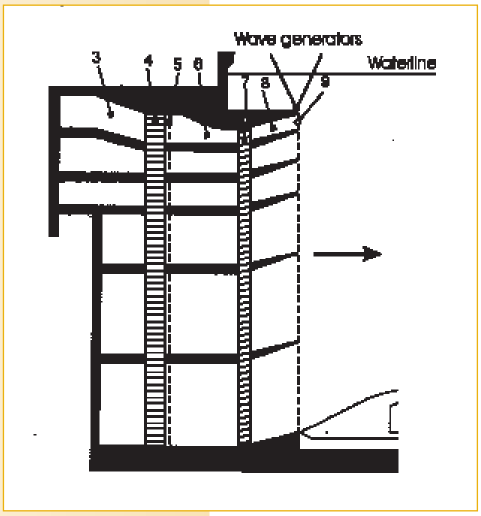


Impression of pump room with six approximately 1600 mm axial pumps and 90 degrees transition sections towards the inflow culverts.

Going with the flow

The uniformity and low turbulence of the flow in the basin is obtained by flow distributing in- and outflow culverts as presented in the figures 1 and 2.

The main function of the components (denoted 1-7 in the figures) are described below:

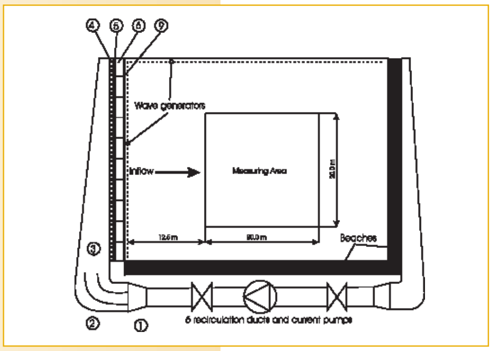


The diffuser (1) is required for a smooth transition between flow duct and culvert. The 90 degrees bend (2) is fitted with guide vanes to avoid flow separation.

The tapered culvert (3) is required to ensure constant flow velocity in the culvert.

The flow leaves the culvert through its perforated side wall (4) and jet breaker (5). The obstruction of the flow by the perforated wall is required to obtain the required uniform flow distribution (+/- 2.5%). The higher its solidity, the more uniform the flow distribution. However, the perforated wall also results in pressure losses.

The mixing chamber (6) is required for quieting the energetic jet flow from the openings in the perforated wall. The relatively large turbulence degree in this section decays sufficiently fast as a result of the small scale of the vorticity, which is related to the size of the jet openings.



The flow is then guided by flow guiding vanes (7) and the inclined inflow section (8).

Fine mesh turbulence grids (9) are used as a final step in the turbulence control.

In total six inflow and six outflow culverts are used, each having specific requirements with respect to the flow rate and dimensions. The structural layout presents 10 inflow sections of 3.6 m each to cover the total width of 36 m. For the six layers this means a total of 60 inflow sections.