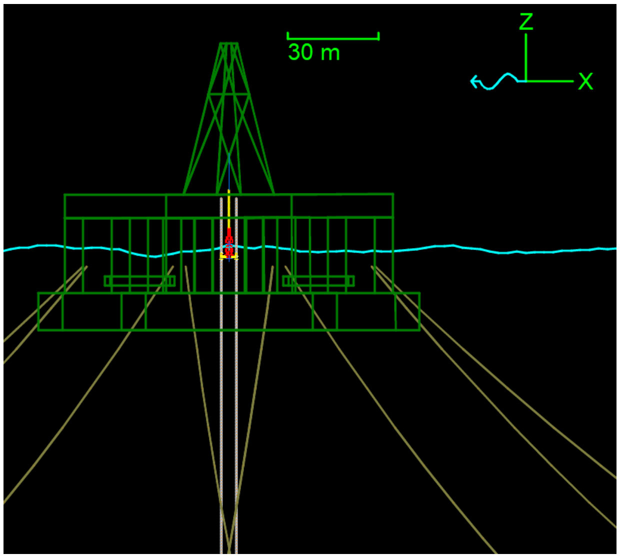
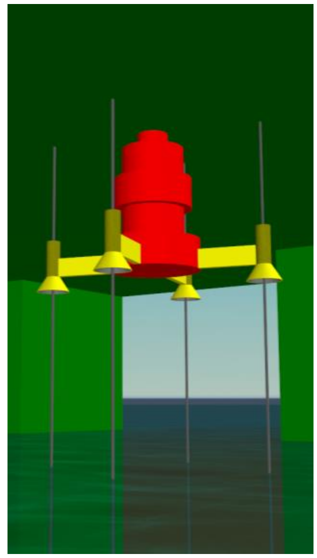
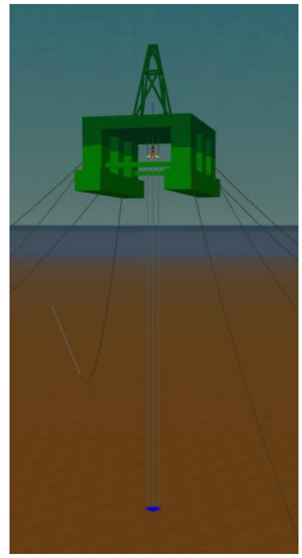
# B06 Running BOP





A blow out preventer (BOP) stack is lowered to the seabed for connection to a wellhead. Guide wires are used to restrain the BOP while it is lowered.

## Building the model

The drilling vessel uses *displacement RAOs* while the lowering is simulated in a low seastate. The BOP is modelled using a 6D *spar buoy* (shown in red in the model). A "wave packet", including the maximum expected wave, has been applied to the system.

The hydrodynamic properties for the *BOP* are set on a cylinder-by-cylinder basis. The individual cylinders allow environmental loads, acting on the buoy, to be captured accurately. However, in this case, the buoy will be restrained quite strongly by the guide wires and winch. If required, wind loading on the buoy could also be included. Slam loads are also applied by means of a slam coefficient applied to the lower-most cylinder in the stack.

Ensure that *view by groups* is selected from the model browser (right-mouse click in the *model browser* to find this option) and then open the data form for the *BOP* 6D buoy from the *BOP Group* of to see how these properties have been assigned. In this example, the slam force *exit* coefficient is left as zero, as we are only interested in the lowering operation.

We are using a winch (*Payout winch*) for lowering the BOP through the water column. The winch object has no mass, displacement, drag or added mass, therefore we will not capture all of the loading on the lowering gear. The BOP should be sufficiently restrained by the guide wires so that this approximation will not cause too much inaccuracy.

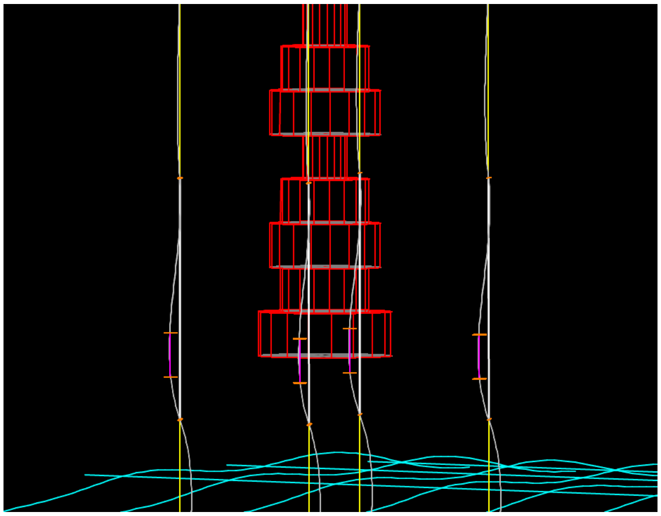
If the winch wire properties are significant then it can be changed to a line. *Line feeding* can then be used to model the change in length as it pays out. For further details about this option, refer to the Modelling, data and results | Lines | Modelling line feeding page of the help.

The guide wires are modelled as lines, which run from the semi-sub down to a template on the seabed. At the seabed end of each line, a section is modelled with a variable *outer diameter* (*Spike Profile*) to represent the guide spike on the template.

The BOP has four guides (coloured yellow) that slide down the guide wires and ultimately locate on the template spikes. *Line contact* is used to model this. Open the *line contact* data form from the *model browser*. Here, the different *Guide wire…* lines are *inside* the guides, which means that the penetrator 'balls' are located on the guide lines and the guides themselves are fitted with smooth spline surfaces. The [Modelling, data and results | Lines | Line contact | Data] page of the OrcaFlex help provides further details about this terminology.

In this model the *around* relationship could also have been used which would have switched which line of each pair was splined and which had penetrators. Each relationship has its own advantages and disadvantages and the best option to choose depends on a number of factors. Often either relationship is suitable.

In this particular model, the guide wires have high *axial stiffness* but very low *bending stiffness*. This is typical for a wire; however, this combination can result in some strange spline behaviour! If the *around* relationship was used then the spline would be fitted between the nodes of the guide wires. If the segmentation is quite coarse and a force is applied to the spline by the penetrator pulling on it (as happens in this model if the BOP moves sideways) then the nodes of the splined line can turn (due to the low bend stiffness) which forces the spline itself to deflect away from the line that carries it. In such a situation, the spline is forced to fit through each node, aligned with the node directions. This phenomenon is undesirable and is clearly visible in the example shown below.



The solution to this is to shorten the segment length; however, for a line that is 250m long, this could mean a lot more segments, which would subsequently increase the run time. An alternative is to do what we have done in this model, which is to use the *inside* line contact relationship instead. The segments on the guide wires still need to be quite short and the penetrators (located at the nodes) need to be positioned close enough to ensure that there is always at least one penetrator in contact with the spline surfaces of the guide tubes, but they can be longer than they would need to be with the *around* option. See the example [B01 Drilling riser] for further explanation of this type of line contact relationship.

Coming back now to the *line contact* data form, notice that the *containment enabled* option is ticked for all the relationships. The guide tubes are free flooding so OrcaFlex will calculate which parts of the guide wires are shielded by the guides.

The line contact relationships also help position the lines when running statics. The line contact model is active during statics, therefore the penetrator lines are forced inside their respective splined lines, as required.

*Elastic solid* type shapes are used to model the guide cones located on the bottom of the guide tubes; usually we recommend that thin-walled shapes are made thicker to reduce the risk of nodes accidentally picking up the outer surface of the shape rather than the inner. However, in this case, the contact between the wires and guide tubes sufficiently restrains the motion of the BOP and prevents this from happening, therefore the cones can be modelled with their 'real' dimensions.

During dynamics, the *Payout Winch* is ramped up to a maximum speed, and ramped down again when the BOP is near the seabed. You can view a graph of the payout rate by looking at the *variable data* set named *BOP Lower Rate*, from the *model browser*. Click the *profile* button to see the graph.

The purpose of this ramping is to avoid sudden shock loads in the winch, and to give a gentle set-down for the BOP onto the template.

## Results

Open workspace *B06 Running BOP lowering.wrk* and watch the replay of the whole simulation.

The impact of the waves passing the buoy, as it enters the water, can be seen in the top right-hand view. Note the moving vertical line on the time history of BOP *Z*. It shows where the simulation replay has reached.

Hold down the *Ctrl* key on your keyboard and left-click anywhere on the time history. Notice that the vertical line moves to where you have clicked, and the simulation replay pauses at the corresponding time. Continue to hold down the *Ctrl* key and try clicking & dragging the vertical line to see how it affects the simulation replay.

Next, open workspace *B06 Running BOP results.wrk* and note how the BOP *X* and *Y* positions vary with time. While the BOP is lowering on the guide wires, it is roughly aligned with its final position. When the guides come into contact with the alignment spikes, the BOP is aligned more precisely, before it finally comes to rest on top of the template.