

Branching OUT



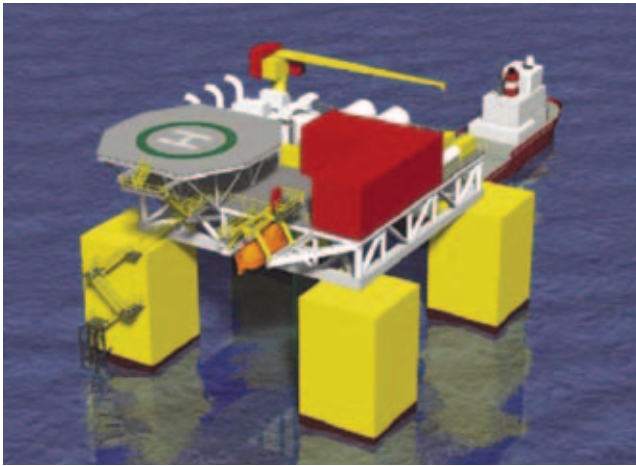
Stranded gas fields in remote areas are being considered for future development, but they require large capital expenditure and reliable sources of power. **Tienieke Postma** (left) and **Rama Gunturi** (right), Shell, assess the viability of the mini utility floater operating in these challenging areas.

The offshore oil and gas industry is moving towards developing stranded gas fields in remote parts of the world, generally located in deeper waters with harsh environmental conditions. Typically, subsea-to-beach and subsea processing technologies are used to tap into stranded gas fields. In addition, a floating liquefied natural gas facility is being considered for some of these fields.

Since Shell is looking at a number of such prospects – including northwest Australia, the northern North Sea and the Mediterranean Sea – the company is considering utility/compression floaters as a viable means to reducing the large capital expenditures involved in flow lines/umbilicals, as well as increasing

the reliability of the supply of power, control and chemicals across the long tieback distances of several hundreds of kilometres. Shell's mini utility floater (overleaf) shows promise in addressing the challenges inherent in subsea-to-beach development over great distances.

Shell's assessment targeted fields that are greater than 100km from shore. The mini utility floater was found to be cost-effective for the base-case field development offshore north-west Australia. The break-even distance changes with the water depth and the degree of flow assurance needed. ▶



Artist's impression of the mini utility floater.

Mini floater technology study

Shell sponsored a study of mini floater technology to develop a generic concept to support a subsea development that provides the following key functions in a cost-effective manner:

- power generation
- flow assurance
- communication
- control and automation.

While the environmental conditions of a cyclone-prone field offshore northwest Australia was taken as the base case, to provide a generic solution, prospects in the harsh-weather northern North Sea and the North East Mediterranean Deepwater were also included in defining functionality.

The mini utility floater technology was developed to ensure that the safety, installability and flexibility issues were carefully addressed. Safety is important with respect to floater access and ergonomic conditions for the crew. Installability must be considered to ensure a safe and cost-effective installation with the same resources as deployed for subsea facilities installation in remote regions. Flexibility is essential when deploying at various geographic locations and modular upgrading capability to suit specific project requirements.

Methodology

The study was done in four distinct phases:

- 1 Identify functionalities
- 2 Generic concepts
- 3 Select
- 4 Performance assessment

In phase 1, the functional requirements were identified and quantified to iteratively determine the initial topside weight, floater displacement and parametric dimensions. A brainstorming session in phase 2 generated over 20 concepts, identified major showstoppers and subsequently discarded several concepts. In phase 3, the remaining concepts were evaluated by means of a multi-criteria assessment. Phase 4 focused on floater performance against various functional and operability requirements. Heave motion sensitivity was the most significant part of the study from a platform access

point of view. Horizontal motions were relatively less significant because flexible risers will be used. The motion criteria determine the threshold sea states for access from either a helicopter or a supply boat, and the probability of occurrence of these sea states establishes the number of days of unavailability per year per location.

Selected concept

The selected concept is either a tension leg platform (TLP) or a semi-submersible with similar hull configurations, but different mooring systems. The hull has a square deck and four square columns of 8m, with a column spacing of 25m, and an operational draft of 17m with a total displacement of 7,800 tonnes. The mooring system can either consist of 4x3=12 tethers for the TLP or 12 catenary mooring lines for the semi-submersible case, as below:

- power generation – 10MW
- well control ~ 50kW
- chemical injection ~ 1MW
- separator on deck and future subsea liquid boosting ~ 4MW
- other (HVAC, communication ~200kW)
- flow assurance
- 200 tonnes chemicals storage tank
- injection pumps
- communication
- from well to floater: umbilical
- from floater to shore: satellite communication
- distributed control systems provide direct subsea well interface.

The different mooring systems are suitable for various geographic locations and increased versatility of the total solution by covering a large range of water depths and environmental conditions with a standardised hull. The aim is to enable fabrication at a wide range of yards and to minimise offshore installation activities. Therefore, the hull-shape of the selected concept is kept simple and the overall size of the system is designed to be as small as possible. Topside integration, hook-up and commissioning are carried out near shore and the integrated floater can be wet-towed to the offshore location.

Floater performance assessment

The heave natural period of the semi-submersible is around 15.7 seconds and the natural period of the TLP is around 1.02 seconds. The heave response amplitude operators (RAO) of the TLP is in the order of magnitude of $10^{-3}m/m$ (because of the stiffness of the tendons), while the RAO of the semi-submersible of order $1m/m$. The large heave response of the semi-submersible occurs at a wave period in the range 14-17 seconds.

Very severe cyclones (in NWS) tend to generate waves in this period range and will result in significant heave response. This should not pose significant feasibility problems, since the mooring and the hull can be designed for these rare conditions and the unit will not be manned under these severe cyclones. However, in the North Sea, waves with periods in this range will often occur and it is likely that the fatigue design of such a semi-submersible for use in the North Sea may prove challenging. Thus the feasibility of the semi-submersible for this area needs to be examined more closely in subsequent phases of this development. Otherwise, the TLP concept may be considered, as the motion response of the TLP is not in the wave period range.



Floater performance was assessed for:

- absolute vertical displacement and pitch of the helicopter deck
- relative displacement at the waterline, for supply boat accessibility
- relative displacement of the deck for wave overtopping/slamming.

The availability of the helicopter deck has been identified for both the North West Shelf in Australia and the northern North Sea area for the TLP and the semi-submersible. The availability (probability of non-exceedence) is based on the response spectrum of the floater and the scatter diagram for the location. The availability of the boat landing has been determined for both locations and both concepts, in the same way as for the helicopter deck. The availability is based on the response spectrum of the floater and the scatter diagram for the location, but because of the lower availability for boat access, helicopter is the main mode of access to the mini-floater.

Future potential

Mini utility floater technology shows good potential as a subsea-to-beach development enabler in three aspects:

- Flexibility: the standardised design can be applied to the global gas portfolio.
- Installability: the floater can be built and integrated onshore and be brought to site with a wet tow; there is no need for unconventional and expensive installation vessels.

- Safety: compared with underwater buoys with comparable functionality that are in use, this floater provides significantly safer access and working conditions.

The floater offers significant capital expenditure savings, while reducing some of the technical risks associated with long distance umbilicals/power cables. At an approximate tie-back distance of 100km the mini utility floater breaks even with the integrated subsea-to-beach umbilical system alternative. The mini utility floater concept could be further matured and developed as a standardised modular building block for a portfolio of gas projects. Based on the floater performance assessment, a recommendation has been made as to where the semi-submersible and TLP may be applied as a mini utility floater. Shell has identified three geographic areas from its current portfolio: the Northwest Shelf offshore Australia, the northern North Sea and the Mediterranean Sea. ●

[Tieneke Postma]

Tieneke Postma is a civil and marine engineer for Shell Global Solutions. This mini-floater study was done as part of her MSc thesis work with Shell E&P and TU Delft.

[Rama Gunturi]

Rama Gunturi works for Shell Global Solutions Upstream Development, as a team leader for new business development. He has 24 years' experience in oil and gas projects across different regions. Gunturi's primary interests are in leading front-end concept developments for challenging offshore projects.



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 Kystveien 226, 4841 Arendal, Norway
 Tlf. : +47 370 97 430. Fax: +47 370 97 431
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