



OTC 18543

## Dalia Flowlines, Risers, and Umbilicals

M. Gloaguen, H. Bourdillon, F. Roche, and T. Boscal de Reals, Total E&P Angola, and P. Menier and A. Marion, Technip

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### Abstract

One of the largest Umbilical, Flowlines and Risers project ever awarded to a single Contractor for deepwater installation, the network to connect and control the 71 wells and 9 manifolds is extensive:

- 40 km of insulated pipe in pipe (12" into 17") production flowlines
- 45 km of 12" water and gas injection lines
- 6 off 1.7 km flexible water and gas injection risers
- 8 off 1.65 km flexible Integrated Production Bundle (IPB) risers
- 75 km of control umbilicals

Insulation of the production transport system was the challenge. With a crude temperature of 45°C at the wellhead and the required minimum temperature of 35°C on arrival at the FPSO, the problem was complex. Understanding that, due to the Joule Thompson effect of the riser gas lift, a "built in" loss of 5°C is induced and together with further losses through the subsea pipelines, some up to 6 km long, the agreed solution was "pipe in pipe" for the production flowlines. The innovative flexible IPB riser incorporating gas lift and heating "on demand" was the selected riser solution.

The IPB is new technology for deep water, developed by Technip for Dalia, and consists of a 12" nominal central flexible, surrounded by layers of heat tracing cables; small bore gas lift lines, optical fibres and many insulation layers with an Overall Heat Transfer Coefficient of approximately 3 W/m<sup>2</sup>K. After an earlier research and development programme, a further extensive qualification programme was conducted during the course of the project, culminating with the deep water testing phase offshore Brazil.

The IPB was then approved for fabrication and installation. This paper will describe the many challenges met during the project.

### Dalia Overview (Figures 1 to 5)

For further details refer to Dalia Paper OTC 18538.

Figure 1 gives the general field layout, showing the subsea wells, manifolds, flowlines, umbilicals and risers up to the FPSO. It is a large and complex network of various pipelines and umbilicals within an optimised design responding to the reservoir, well architecture and the operation parameters required.

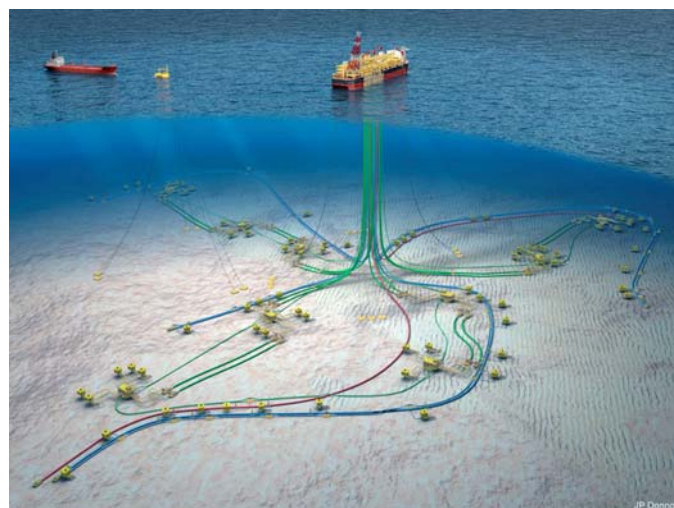


Figure 1 – General Field Layout with Flowlines and Risers

As the result of a design competition comparing several concepts offered by different contractors, the selected solution is different from Girassol. The overall flowlines layout covering an area of 100 km<sup>2</sup> comprises:

- 4 x 12" production loops connecting two or three production manifolds to the topside facilities using pipe in pipe insulated lines and 8 x 12" flexible IPB risers
- 4 x 12" rigid water injection lines incorporating inline Tees to connect the wells and 4 x 12" flexible risers to connect to the topsides
- 2 x 12" rigid gas injection lines incorporating inline Tees to connect the wells and 2 x 12" flexible risers to connect to the topsides