



TÉCNICO
LISBOA



ORDEM
DOS
ENGENHEIROS

subsea 7



The CLOV Hybrid Riser Towers

6 July 2016

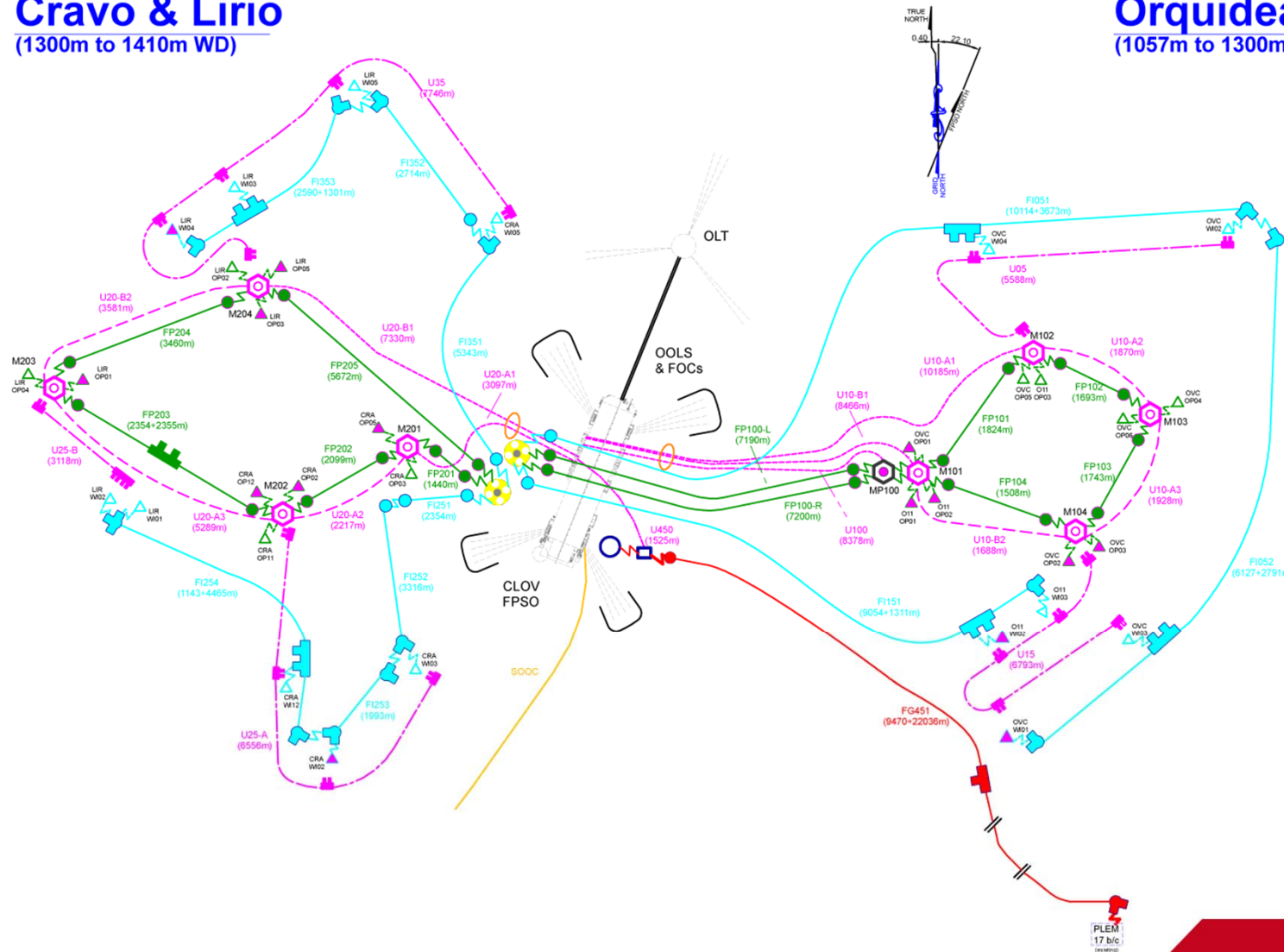
Jérémy de Barbarin

MATECH 2016 – JETM 2016

CLOV Field Architecture

Cravo & Lirio (1300m to 1410m WD)

Orquidea & Violeta (1057m to 1300m WD)



HRT: A Key Area of Focus for the CLOV Project

- The most complex piece of equipment of the whole field development.
- Only 5 units in operations around the globe on 3 different fields, 4 of these previously designed and installed by Subsea 7.
- HRT delivery directly on the critical path to first oil.

CLOV HRT General Arrangement

Buoyancy tank

URTA

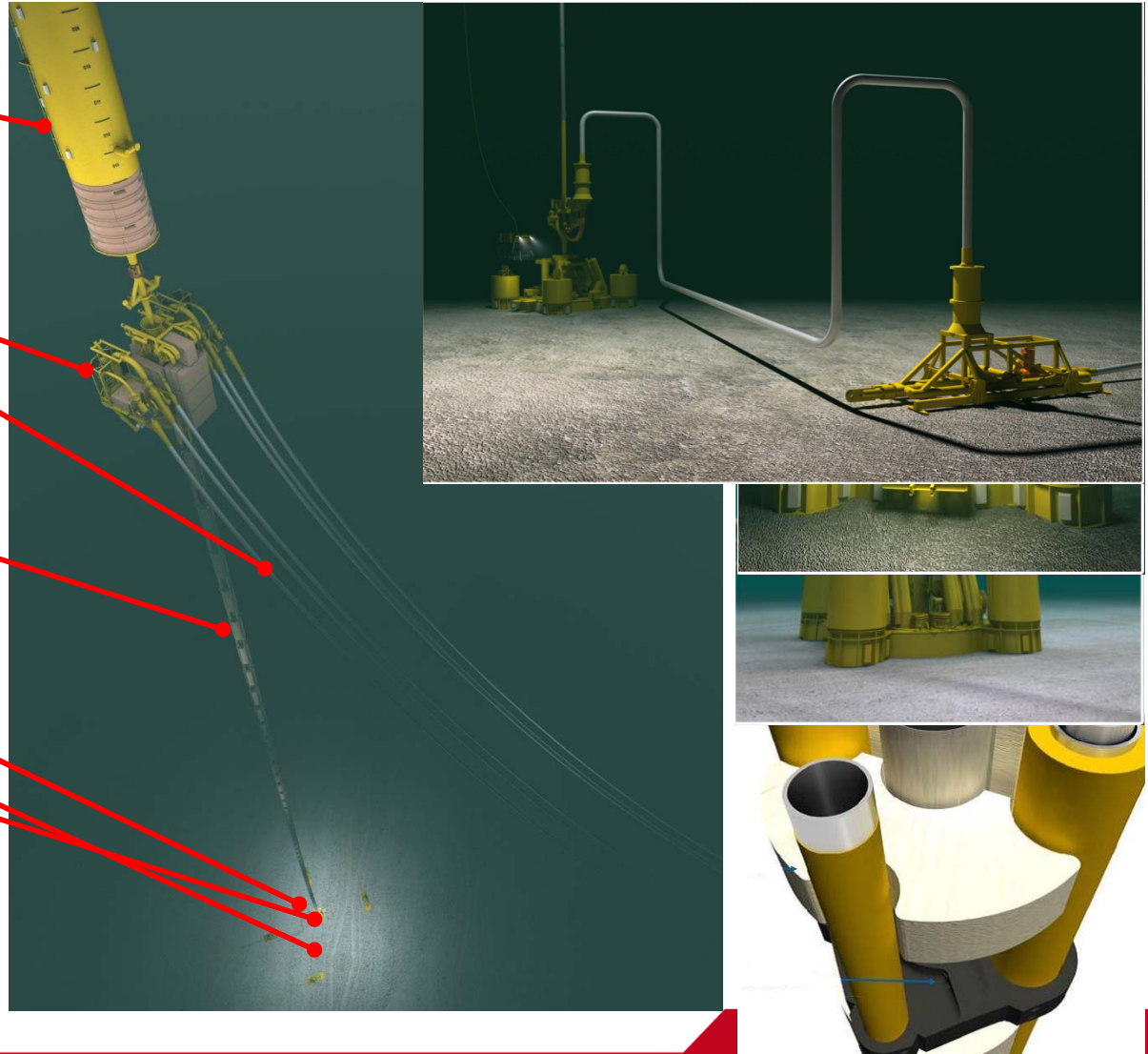
Flexible jumpers

Bundle

LRTA

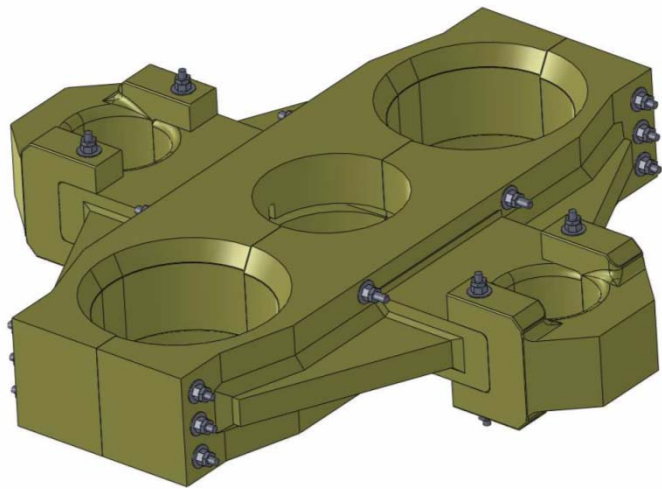
Rigid spools

Suction pile foundation



Key Design Highlights

Innovative guide frames design using polyurethane instead of steel.



Key Design Highlights

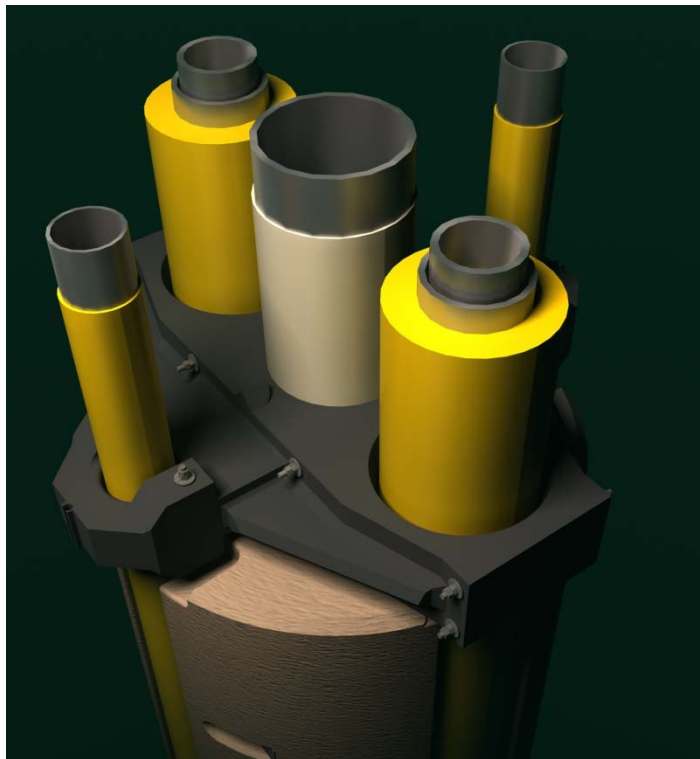
Hybrid design for buoyancy tank with buoyancy from both foam blocks and steel compartments:

- Safer installation methodology: BT is deployed with steel compartments flooded and valves open.
- Simplified deballasting sequence for BT steel compartments.



Key Design Highlights

Pipe-in-pipe design for production risers with gas lift through the annulus.



Key Fabrication Highlights

Both HRT were fully fabricated on Sonamet yard in Lobito (Angola).



Key Fabrication Highlights

Bundle assembly process:

- For each riser type & core pipe, SJ are used to produce 220m-long strings.
- 220m-long bundle sections are successively assembled on a launchway on the HRT assembly area.



Key Fabrication Highlights

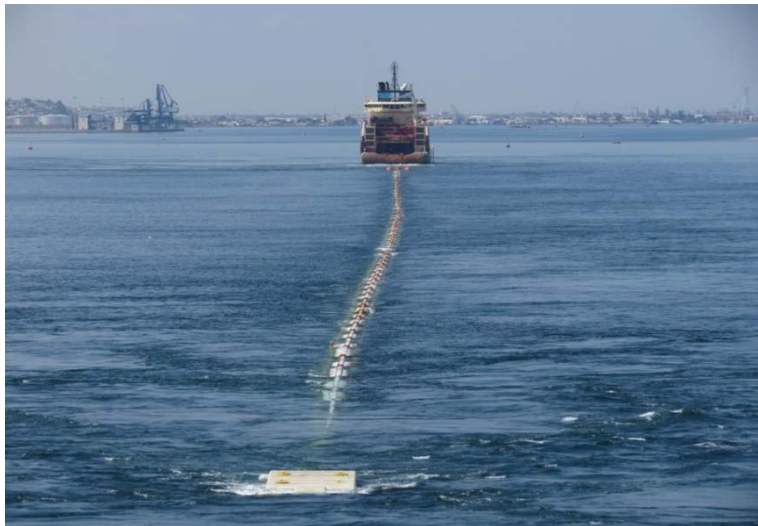
Final HRT assembly:

- URTA placed on the launched way and tied in to the first bundle section.
- Subsequent bundle sections are assembled and tied in to the URTA / previous bundle section.
- LRTA is finally placed on the launchway and tied in to the last bundle section.
- Storage in Lobito bay.



Key Installation Highlights

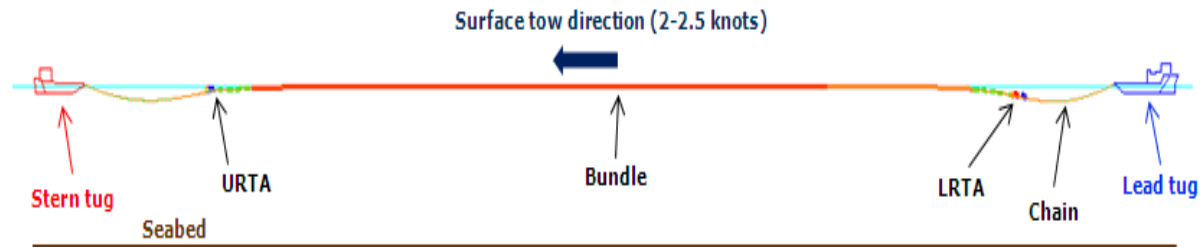
Up to 6 vessels involved in the HRT installation campaign.



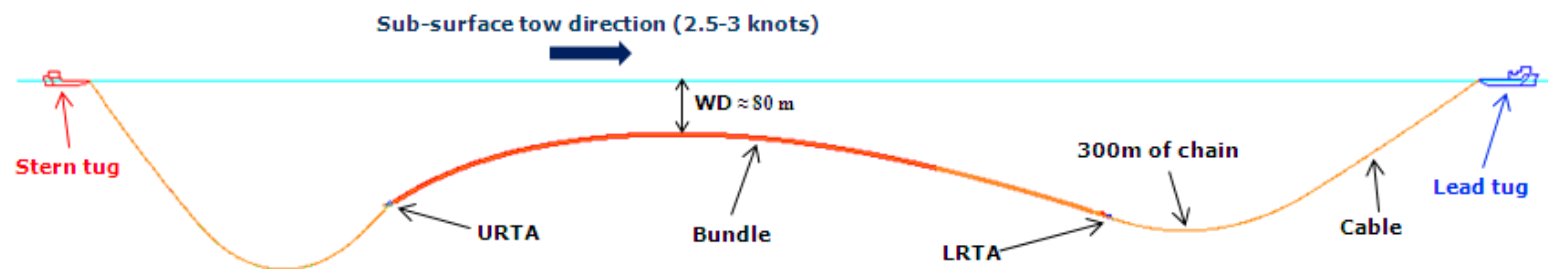
Key Installation Highlights

HRT tow in 2 phases:

- Surface tow from departure from Lobito bay.



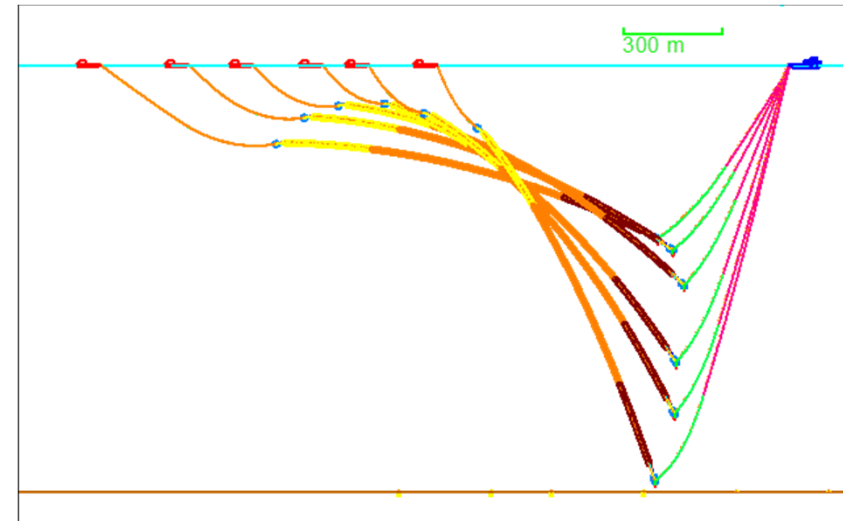
- Sub-surface tow to shelter the HRT from the wave dynamic motions as soon as water depth allows.



Key Installation Highlights

HRT upending in 2 phases:

- Perform upending phase 1.
- Shift, connect & transfer HRT to foundation.
- Complete upending phase 2.
- Connect HRT to pulling slings, pull down and dock the HRT to the foundation.



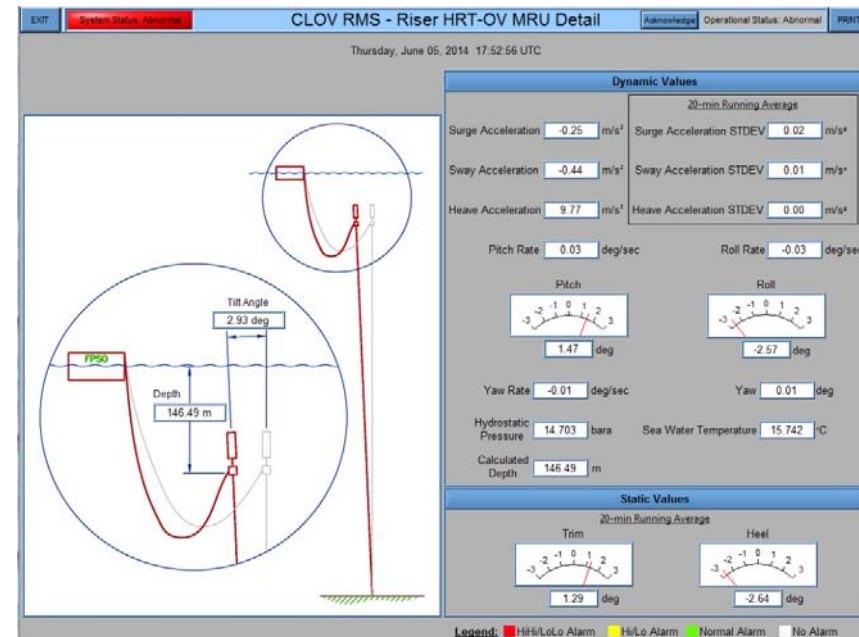
Similar process for BT upending and docking.



Key Installation Highlights

Remaining activities:

- Flooding, cleaning, gauging and hydrotest.
- Thermal performance test.
- Commissioning of the RMS.



Conclusion

The HRTs were a key contributor to the success of the CLOV project story.

- Fit tight project schedule:
 - First HRT delivered 3 years after project award.
 - Second HRT delivered 4 months later.
 - In line with first oil schedule.
- Thermal performances better than requested.
- Strong contribution to the local content requirements.

Acknowledgments / Thank You / Questions?

This presentation was done at the OTC 2015
(OTC-25771-MS)

The authors would like to thank:

Sociedade Nacional de Combustiveis de Angola
(SONANGOL), Total E&P Angola, Esso Exploration Angola
(Block 17) Ltd., BP Exploration (Angola) Ltd., Statoil and
Total for permission to present the information contained in
this paper.



seabed-to-surface

www.subsea7.com