FLNG Offloading for Real Verdict from the Field

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TechnipFMC at a glance

Broadest portfolio of solutions for the oil & gas industry

37,000+ Employees

20 Vessels

48 Countries in which we operate

$14.3B (*)

Total company backlog

(*) at December 31st, 2018
Offshore LNG offloading systems

Context

- A wide range of offloading concepts developed by the industry for both side-by-side and tandem offloading over the last 40 years
- However the viability of FLNG projects was severely challenged by the number of novelties; any significant downtime of the offloading system would completely stop LNG production
Offshore LNG offloading systems
How to enable a first application?

• The Targeting System has been developed to allow the connection and disconnection of the Marine Loading Arms (MLA) under dynamic offshore conditions.

• The first MLA equipped with the Targeting System were installed on the GBS of Adriatic LNG, Italy, in operation since 2009.
Offshore LNG offloading systems

Challenges for FLNG application

Compared to onshore MLA, several design criteria were changed:

- Floating base
  - More design criteria, sometimes governing

- Design conditions (Hs<2,5m)
  - New stress analysis & fatigue calculation methods

- Standard LNGC manifolds
  - Challenge on length & weight of MLA

- Offshore standards
  - Specific safety margin & design methods

- High safety and integrity
  - Enhanced control systems capabilities

- Limited access offshore
  - Adapted maintenance philosophy
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FLNG application – Qualification plan

• Comprehensive engineering studies
• Extensive qualification:
  – Key components testing
  – Instrumented ¼ scale model
  – Full scale MLA testing with dynamic test bench

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FLNG application – Installation phase

Installation sequences:
1. MLA shipped from factory in 5 main parts for transportation
2. MLA reassembled on a dedicated area in shipyards
3. MLA lifted and installed sequentially on the FLNG deck
4. In parallel, auxiliaries (HPU, Control Panel, etc…) installed onboard the FLNG
5. Electric and hydraulic lines routed for packages interconnection
6. Startup and pre-commissioning activities carried out onboard the FLNG

= high coactivity / reduced efficiency

Main improvement identified:
Duration of the installation and pre-commissioning phases
Offshore LNG offloading systems

FLNG application – Installation phase

TechnipFMC has developed an enhanced execution plan:

• Assembly and pre-commission of the MLA in a skidded submodule
• Complete package delivered to the shipyard and installed through a single lift operation onboard the FLNG
• Activities onboard the FLNG limited to pure commissioning activities

Time spent onboard the FLNG significantly reduced

= drastic costs reduction
= better risks management
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FLNG application – First LNG transfer!

• The world first offshore LNG ship-to-ship transfer happened in March 2017 from Petronas FLNG Satu,

• First offloading from Golar Hilli Episeyo in May 2018

• These first offshore operations highlighted the importance of:
  – The preparation of the equipment first, through a solid commissioning program
  – The preparation of the crew, through a comprehensive training program
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FLNG application – Operations monitoring

- The positions and accelerations are constantly monitored during LNG transfer, thanks to the Constant Position Monitoring System (CPMS).
- Positions records of the first offloading have been downloaded from the CPMS, converted in time traces and ran in FEA to assess real loads.
- The theoretical correlation between accelerations and loads seen by the MLA has been successfully validated with field data.
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FLNG application – The story continues

• Both Petronas and ENI confirmed their trust in TechnipFMC Loading Systems for the supply of the offloading system for their FLNG in construction (respectively Rotan and South Coral Field)

• TechnipFMC pursue its offshore success story with 100% market share on offshore side-by-side loading systems.
Offshore LNG offloading systems
FLNG application – Extended capabilities

- FLNG will continue to be a prime option for LNG export, extending to areas with more severe sea states
- ATOL (Articulated Tandem Offshore Loader) technology has been developed to address harsh environmental conditions
- ATOL is an integrated solution with an articulated piping assembly. The solution is supported by proven technology, tests, components qualifications, and conceptual certification
Offshore LNG offloading systems
FLNG application – Extended capabilities

ATOL at a glance:
• 3x20” articulated rigid product lines
• Fitted with a Targeting System to ensure safe dynamic connection
• Offloading capabilities up to Hs = 5.5m
• Separation distance between vessels: 70 to 115m
• Typical offloading rate: Up to 16 000 m3/h
• Proof tested with a 1/5 scale model
• Detailed execution plan developed
Offshore LNG offloading systems
FLNG application – Extended capabilities

• The flexible pipe based solution ALLS (Amplitude LNG Loading System) has been developed, tested and fully qualified in the 2000’s

• ALLS offers an alternative solution when the separation distance between the FLNG and the LNGC is larger or when the LNGC fishtailing is wide.
Offshore LNG offloading systems
FLNG application – Extended capabilities

• The Parallel Loading System (PLS) combines the LNG HiLoad with ATOL or ALLS to allow using unmodified LNGCs:
  – High operability (up to at least Hs = 4 m).
  – Large separation of units for protection against risk of collision & process upsets.
  – Minimum length of LNG transfer lines (minimize pressure drop / Boil off gas).
  – Use of proven or qualified technologies
Offshore LNG offloading systems

Conclusions

• First ever made offshore FLNG/LNGC side-by-side transfers concretize years of development and confirm safe and reliable operations
• An intelligent control system made capable the recording of loading arms position and loads during operations, to provide health monitoring capabilities in real time
• TechnipFMC optimized the execution plan by pre-installing the loading arms on a skidded submodule, reducing installation costs
• TechnipFMC developed and qualified several systems (PLS, ATOL, ALLS) to open the door to operations in harsher environments
• And a lot more to come for your success!
Thank you for your attention