Floating LNG

Lessons learned from three of the industry’s first FLNG contracts position TechnipFMC as the pioneer developer for the next generation of FLNG facilities
Floating LNG facilities

As one of the pioneers in the provision of services and technologies to the LNG industry, we have a long record of innovation in developing offshore liquefied natural gas.

**Expertise in liquefaction**
A leader in LNG for 50 years, TechnipFMC has experience spanning all sizes of plants, from peak shavers to mega-trains in Qatar. We have contributed significantly to defining the state of the art in LNG and maintain a broad portfolio of technologies.

**The world’s largest FPSOs**
TechnipFMC has delivered some of the world’s largest FPSOs, with integrated topside facilities of up to 37,000 tons.

**Advanced technologies in cryogenic transfer**
We offer fully qualified LNG transfer systems with marinized mechanical loading arms as its central component.

**World leader in subsea field development**
TechnipFMC is the world leader in design, manufacture, and installation of subsea wellheads, production systems, flowlines, umbilicals, and risers.

**Leadership in oil and gas naval architecture**
We design and build complete offshore facilities in-house or with partner companies.

**Leadership in project execution**
The depth of our experience ensures project success from conceptual and pre-FEED studies through delivery and commissioning. We have solid references in working with major shipyards under all types of contractual arrangements.

TechnipFMC offers an organization whose combined resources, experience, technology, skills, and financial stability are second to none.

For an FLNG project development, TechnipFMC has demonstrated its ability to act as main contractor for the entire project from conception to start-up.
Complete design flexibility

Building on the execution of the world’s largest LNG facilities, Shell Prelude FLNG, Petronas Satu FLNG, and ENI Coral South FLNG, TechnipFMC can manage the design and delivery of the most complex FLNG projects.

We provide a wide range of design options at the conceptual stage:

- Large production capacity: 1 to 8 Mtpa
- Overall storage up to 400,000 m³
- Mixed refrigerant or gas expansion liquefaction processes
- Modularized, safe, compact facilities
- Spread mooring or turret mooring for weathervaning
- Permanent or disconnectable mooring in case storm alert
- Standard membrane type LNG tanks or self-supporting tanks such as SPB
- Side-by-side or tandem LNG offloading configurations
Major FLNG contracts signed since 2009

TechnipFMC integrates all core activities: LNG process, offshore facilities, and subsea infrastructure.

FLNG solutions can place gas liquefaction facilities directly over offshore gas fields, precluding the need for long-distance pipelines and extensive onshore infrastructure. This innovative alternative to traditional onshore LNG plants is a commercially attractive and environmentally friendly approach to monetization of offshore gas fields.

Recent awards that confirm TechnipFMC’s position as the leading FLNG engineering contractor:

**Shell**
- July 2009: the TechnipFMC-led consortium with Samsung Heavy Industries is awarded a master agreement for multiple FLNG facilities over up to 15 years and a FEED contract for Shell’s 3.6 Mtpa FLNG unit
- December 2012: the consortium signs an agreement for future innovative FLNG solutions

**Petronas Satu**
Client: Petronas
Contractor: TechnipFMC, in consortium with DSME
Capacity: 1.2 Mtpa
- February 2011: FEED contract for an FLNG unit offshore Malaysia
- June 2012: EPC contract
- April 2014: hull launch
- March 2015: topside integration
- December 2016: first LNG drop ever produced offshore
- March 2017: world’s first offloading of LNG at sea in side-by-side configuration

**Shell Prelude**
- March 2010: FEED contract for Prelude FLNG (consortium)
- May 2011: Notice to proceed with Prelude FLNG’s EPC (consortium)
- June 2012: TechnipFMC awarded a large subsea installation contract for Prelude FLNG
- June 2017: Sail away
- July 2017: Safe mooring offshore Australia

**ENI Coral South**
Client: ENI
Contractor: TechnipFMC, in consortium with JGC and Samsung Heavy Industries
Capacity: 3.4 Mtpa
- June 2017: Major integrated contract including associated risers and subsea flowlines as well as installation of the umbilicals and subsea equipment
Addressing FLNG challenges

TechnipFMC has developed new tools and solutions and adapted existing methods to meet the needs of FLNG vessels operating in harsh environments.

**Process improvement**
Enhanced processes meet the requirements of the new context of floating LNG, including:

- High efficiency offshore “reverse Brayton” liquefaction process
- Gas condensate stabilization producing rich gas for direct liquefaction without LPG production
- Production of high-purity N₂ from natural gas

**Managing risks from cryogenic and hazardous fluids**

A major challenge in the layout of FLNG facilities is the large process area required in a reduced footprint, which necessitates tall and highly congested topside modules. FLNG flare radiation at deck level is potentially much higher than for conventional FPSOs, requiring the use of state-of-the-art modeling tools.

TechnipFMC’s risk-based approach assesses potential consequences of accidental events and associated frequencies of occurrences to demonstrate that risks have been reduced to the greatest reasonably practicable extent. This is achieved by incorporating safety principles in engineering development to eliminate or reduce hazards and implementing safeguards and mitigation measures derived from safety studies.

Among process risks (such as fire and explosion) and non-process risks (ship collision, dropped object, etc.), personnel protection and asset integrity to cryogenic fluids are FLNGs’ specific safety drivers.

As a prime example, the potential consequences of cryogenic spillage on deck and hull structures are studied to define the best counter measures.

The top objectives are to minimize the potential for escalation, ensure personnel safety, and maintain asset integrity.
Hull motions
Design of topside equipment requires collaboration across an entire team of naval architects; piping, process, structure and equipment engineers; critical-equipment suppliers; installation specialists; and engineers skilled in advanced numerical modeling.

Accelerations are quantified and loads on mechanical equipment validated with vendors.

The effects of hull motions on gas/liquid separation in process equipment are evaluated, when necessary, with process licensors and suppliers to confirm plant availability.

Interface management
FLNG projects have an increased number of design and construction interfaces. To mitigate the risk from poor management, TechnipFMC developed an interface management tool (IMT) that allows full technical and commercial alignment among multiple parties at each interface.

Naval architecture
Naval architects had to address several new challenges:

- **Size** – larger than any existing FPSO
- Harsh environmental conditions
- Weathervaning systems able to withstand a 10,000-year storm
- LNG cryogenic transfer between floating units in the open sea
- Accommodating a wide range of LNG and LPG carriers

TechnipFMC joined with Metocean Services International, Shell, SBM, and Samsung Heavy Industries to develop the turret mooring system for Shell Prelude. In this regard, we developed methodologies to ensure LNG offshore offloading in any conditions including 3D berthing simulations coupled with wind tunnel tests to derive wind and current loads on an FLNG:

- Mooring in Category 5 cyclone conditions
- Decay and sea-keeping tests
- Berthing and mooring and the equipment required between the two vessels