PFLNG1 Project – A Massive Gas Plant Complex That Sails

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Petronas is a Global FORTUNE 500 oil and gas major in integrated petroleum operations with over 50,000 employees comprising more than 100 nationalities. Backed by 42 years of solid reputation as owner, operator and regulator in domestic operations as well as partnerships and operatorships on the international front, Petronas now runs the world's first Floating Liquefied Natural Gas (LNG) facility and is a technology leader and leading LNG player.

As one of the world's largest LNG producers, it operates one of the largest LNG facilities in a single location in Bintulu, and owns the largest LNG fleet in the world, with an unblemished delivery record of close to 10,000 LNG cargoes to 75 LNG terminals in more than 26 countries. With more than 100 Production Sharing Contracts under its belt, Petronas is experienced in exploration, development and production of crude oil and natural gas in Malaysia and abroad. Other scopes include.

- liquefaction, sale and transportation of LNG.
- processing and transmission of natural gas and the sale of natural gas products.
- refining and marketing of petroleum products.
- manufacture and sale of petrochemical products, trading of crude oil, petroleum products. and petrochemical products and
- shipping and logistics relating to LNG, crude oil and petroleum products.

BACKGROUND

The Petronas Floating LNG concept was envisaged to monetise stranded gas resources. FLNG is a facility custom-built as a vessel to liquefy, produce, store and offload LNG. It plays a significant role in efforts to unlock gas reserves in remote and stranded fields deemed uneconomical to develop and evacuate. The two floaters, PFLNG1 and PFLNG2, for offshore Sarawak and Sabah respectively will increase the country's LNG production capacity by approximately 8% (2.5 metric tonnes per annum).

Figure 1: PFLNG1 Construction Aerial View

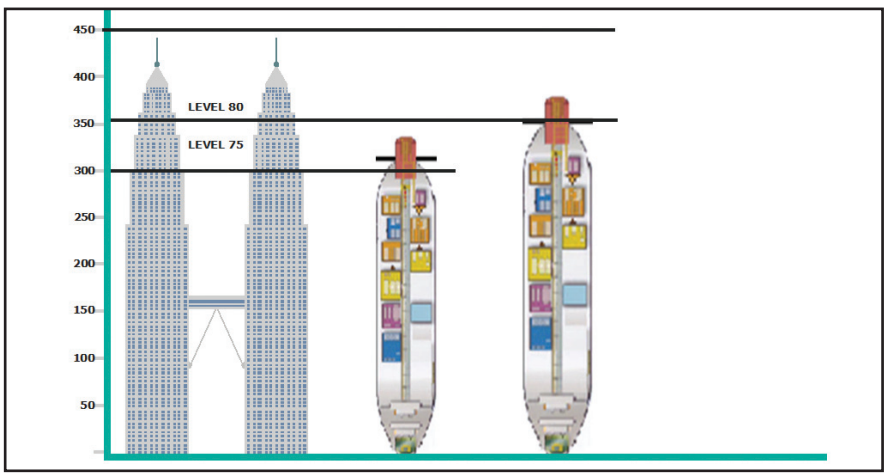

Figure 2: Physical Dimension of PFLNG1 & PFLNG2

The fast track nature of the project presents a challenge to the upstream gas business in meeting the target date, especially in building a mega high technological structure like the FLNG (see Figure 2 for physical dimension comparison). Extensive technology selection exercises were conducted in finalising the turret mooring, gas treating, liquefaction, LNG cargo containment and LNG offloading systems.

Designers and licensors have done rigorous design optimisation and marinisation studies on impact of floater motion and evaluated these against an extensive list of criteria. Marinisation is a process of design, redesign or testing of products specifically for use and long-term survival in a harsh marine environment. The design optimisation focused on the following:

- Proven and established onshore and offshore track records as well as experience or involvement in the delivery of LNG plants.
- Design robustness and acceptable efficiency.
- Operating envelop and flexibility.
- Inherent safe design.

Figure 3: Lifting of the last pipe rack module

In addition to the design optimisation, lessons learnt from PFLNG1 were captured to ensure necessary improvement in the PFLNG2 design and operability aspects.

LIFTING OPERATION

PFLNG1 Constructability Review (CR) was performed prior to the lifting operation of each topside module onto the hull section. Like a giant jigsaw puzzle, various pieces of the topside modules were preassembled and construction of the super-structure involved the installation of the large and heavy equipment such as process columns, flare, turret, gas-turbine package, electrical and instrumentation building. Topside modules integration was controlled and checked by the construction engineering and quality management team.

The hull stability, weight control report and stresses of both structures (hull and topside modules) and their sub-components, including the temporary support, lifting lugs and the erection aids, were analysed to ensure accuracy.

For pipe rack erection and topside module lifting, centre of gravity (COG) and hull stability analysis were carried out while for safety lifting operation, job safety analysis (JSA) was approved and carried out in accordance with shipyard floating crane operation and lifting safety procedure.

STRUCTURAL HOOK-UP AND INTEGRATION

All topside modules were erected and lifted to the hull main deck and were positioned at the location of support stools. A laminated elastomeric bearing system was attached to the underside of the modules during load-out and welded down to the support stools after topside module set-down.

PIPING HOOK-UP AND INTEGRATION

Pipe spools were routed between topside modules or between the piperack. When all topside modules were installed and erected on the hull, the hook-up spools acted as tie-in spools between topside modules and piperack. The hook-up spools were welded or bolted after the piping stringing and alignment arrangement were checked and, where necessary, an adjustable spools piece would be considered. After the hook-up spools were completed and installed, the piping hydrotest commenced as part of the integration phase activities on board (floater).

LESSONS LEARNT

From a mega project such as this, lessons learnt are of the utmost importance. More importantly, these lessons would be crucial to the success and efficiency of PFLNG2. Shipyard selection and work allocation inside or outside of the shipyard need be "locked" or finalised with no changes allowed during the execution phase. Any change request can only be considered after risk assessment and change management approvals are obtained.

Piperack modules detailed engineering deliverables versus shipyard shop drawing (construction engineering) need to be aligned for early completion in order to meet the lifting sequence. Topside modules on ground erection and completion need to be determined by shipyard floating crane capability and availability. Preservation quality on the critical equipment and material needs to be continuously inspected and protected. The topside modules lifting sequence has to be established during the Constructability Review (CR) at the detailed engineering phase and the System Mechanical Completion (SMC) needs to be integrated between hull completion and topside modules completion.

Figure 4: PFLNG1 Topside Modules Construction

Simultaneous Activities (SIMA) Matrix needs to be established to ensure adequate controls are in place. SIMA is used when there is a conflict of interest in executing project activities at the same place, which may cause an adverse impact on Personnel, Environment, Asset and Reputation. This is to manage and execute the conflicting activities in a safe and effective manner by evaluating and identifying appropriate control measure in place to as low as reasonably practicable.

WORLD'S FIRST

The success of the PFLNG1 Project was a remarkable accomplishment in marine construction technology and engineering advancement. It was not just an achievement for the local and international engineering industry but also an accomplishment for Malaysia as a country on its way to become a developed nation in 2020. On 5 December, 2016, Petronas achieved a world's first, successfully producing the first LNG drop from the PFLNG1 and delivering its first cargo a few months later. It is a megastructure of unconventional proportions, a technological marvel that has changed the landscape of LNG production forever. ■

SOURCES

- https://www.petronasofficial.com/floating-lng/index).
- IEM Talk, 11 November, 2017, "Construction of First Floating LNG in the world: PFLNG SATU Lessons Learnt" by Ir. Roslin Ramli.

Author's Biodata

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