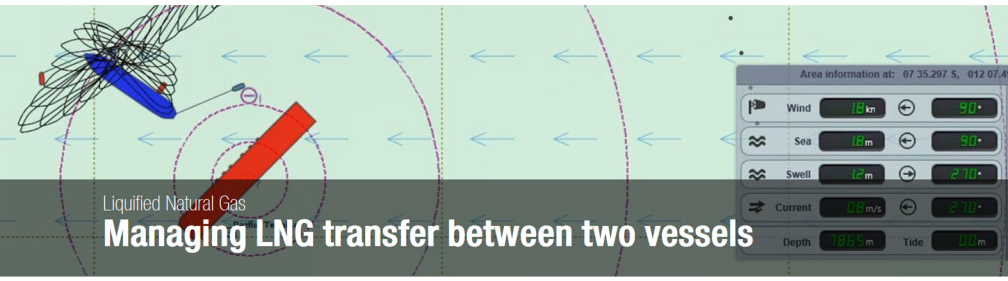

Liquified Natural Gas

Managing LNG transfer between two vessels

By having the liquefaction plant right on the platform, floating liquefaction (FLNG) is a key innovation to enhance the gas sector's operational performance. Continuous LNG production and its transfer to tankers under all metocean conditions is now a major focus to cut offshore gas project costs and cement our strategic position as the second-biggest operator in the LNG market.

Aroquiaradj Gervais
LNG
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Benoît Grovel
Oil facilities
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Geoffrey Mark Jones
LNG
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AN FLNG UNIT TO **PRODUCE HARD-TO-ACCESS GAS FIELDS MORE AFFORDABLY**

Until recently, offshore gas production consisted of extracting the gas and then piping it to an onshore processing plant. At the plant, the natural gas is usually treated so that it can be fed into a gas pipeline network and/or liquefied for export via LNG carrier. But building pipelines between the point of extraction and the shore makes it expensive — and sometimes impossible — to develop offshore fields that are far from land and/or hard to access.

To avoid building such complex installations and costly infrastructure, the Floating Liquefied Natural Gas (FLNG) facility was invented and developed to combine an extraction unit with a natural gas liquefaction plant. The pay-off is steep savings and the protection of coastal areas that can be environmentally sensitive.

Because LNG is produced around the clock and storage capacity is limited, the gas must be regularly transferred to LNG carriers — every five to six days — using cryogenic loading arms that can tolerate a temperature of -163°C. A lack of weather windows may disrupt this schedule. If bad conditions persist for days, the FLNG's production has to be halted, triggering a series of measures to protect the subsea production system and the liquefaction trains. The latter must be kept cold to minimize the amount of time needed to start back up again.

LNG TRANSFER TECHNIQUES FOR **ALL METOCEAN CONDITIONS**

The gas industry has known for years how to transfer LNG from ship to ship. But STS transfers are done in calm seas, at a time chosen by the crews based on meticulously analyzed factors such as significant wave height (Hs) and current and wind velocities. That is because wave and wind directions, wave troughs, repulsive forces and engine power limitations can combine to make it impossible for the tugs towing the LNG carrier to operate.

Potential problems during mooring or LNG transfer include too much rolling of the LNG carrier, high mooring-cable tension, compression of the buoys buffering the ships, and forces that cause the articulated loading arms to stretch, damaging the hoses. Such incidents can be fatal for personnel and damage installations. The only way to control the risks is a preventive shutdown of the transfer to separate the two ships before something happens. The inherent complexity of ship-to-ship LNG transfer is thus a major obstacle to ramping up FLNG use.

There are currently three STS transfer methods:

- **Side by side**: The two vessels are brought alongside one another so that the LNG carrier can moor itself to the FLNG and offload the cargo.
- **Tandem**: The FLNG unit and LNG carrier are lined up one behind the other. This requires an LNG carrier that can work with the loading system, including a reliable propulsion and dynamic positioning system to maintain the correct distance.
- **Parallel positioning**: Similar to the tandem system, but the FLNG and the LNG carrier are positioned parallel to one another. This system is suitable for standard LNG carriers.

Right now, the only solution used to transfer LNG at sea is the side-by-side method.

Mastering offshore LNG transfer between two vessels - Exploration & Production - Total

ABANDONING TURRET MOORING TO **CUT THE COSTS OF STS LNG TRANSFER**

At end-2019, four FLNG facilities were operating worldwide: two in the Indian Ocean, one in the Gulf of Guinea and one offshore Argentina. The last two are moored to a jetty in calm seas. An external turret mooring system enables the Indian Ocean FLNG to weathervane through 360 degrees, to adapt to ocean conditions and face the best direction for LNG transfer.

However, a turret is a fragile FLNG structural component and adds a hefty $100 million-plus to the price tag, especially since it's not needed in waters with strong directional waves that don't vary much (± 15° from the median direction). It can be replaced by conventional spread mooring at the FLNG's four corners. This much cheaper option keeps the FLNG in the desired direction and position.

Using tests conducted on a real-time simulator, Total has acquired know-how that lets us pinpoint metocean conditions, to transfer LNG from a non-turret FLNG moored offshore to a combined LNG carrier. This new technique seems especially well adapted to the Gulf of Guinea, where Total is now working on several offshore projects.

These studies also zeroed in on marine logistics issues and defined operability criteria essential to proposing a competitive FLNG unit that can operate offshore, until tandem STS transfer systems are available.