Leading edge performance in LNG

The Performance People

Trelleborg Marine Systems offers much more than a high quality product portfolio. We work with you on a case by case basis to develop bespoke solutions that work in the best interests of your project.

More than that, we support our offer with the knowledge and experience of an unrivalled team of industry experts. The Performance People support and enhance your project, from innovative conceptual design through to installation assistance and beyond, to guarantee performance over the lifetime of your solution.

The use of liquefied natural gas (LNG) is now a mainstream, commercial reality, as the demand for energy continues to rise. With natural gas being a reliable, clean burning fossil fuel and one that is in plentiful supply, it has become a truly viable, global resource.

But given the myriad applications within the LNG arena, infrastructure must evolve to accommodate varied and specific requirements. As such, some key components such as fenders, docking and mooring equipment and transfer systems must be reconsidered.

In the following pages, the Performance People at Trelleborg Marine Systems will discuss some of the key issues per application, how infrastructure is evolving with the needs of the market and the importance of ensuring you have the right product for the right application.

Pick a project type, scroll to the relevant chapter and see if there's a better solution for your specification.

FSRUs, FSUs and fLNG

To maximize the opportunities offered by natural gas, floating LNG projects are increasingly being considered as the optimal configuration, for liquefaction storage and regasification.

However, with these complex projects comes the need to re-examine docking, mooring, fendering and transfer solutions in order to meet the requirements of all stakeholders and provide the most safe and efficient operation.

Floating Storage and Regasification Units (FSRUs) in some cases with Floating Storage Units (FSUs) represent the majority of projects currently being executed or in the FEED stage, as they can provide an attractive "fast track" solution for small markets and emerging economies.

DOCKING AND MOORING

Peter Pickering, Managing Director, Docking and Mooring

In the complex case of FLNG mooring configurations, a comprehensive overview should be undertaken and the design requirements of all stakeholders aligned and coordinated. However, because of the timelines and execution methodologies typical to these projects, the jetty requirements and FSRU docking and mooring requirements often suffer from splitting the scope, resulting in system fragmentation and compromising safety and operational efficiency.

The docking and mooring system for FSRUs consists of mechanical, instrumentation and control and monitoring elements – all of which must function together to assure safe and efficient operation across the three constituents: jetty, FSRU and LNGC. Compatibility at each interface ensures improved operational control, data sharing and flexibility for the FSRU.

So, what are the requirements of these diverse stakeholders?

- **The jetty:** may require plant operations and process oversight, as well as load monitoring data, MetOcean data and berthing data. Alternatively, the jetty control room may be unmanned with all jetty operations such as loading, ESD, Mooring Tension & Emergency Release being transferred to the FSRU control room.
- **The FSRU:** requires plant operations and process oversight, as well as load monitoring data, MetOcean data and berthing data. In many cases, the FSRU may be used as the primary control centre for the monitoring of mooring line tensions from the jetty and those to the LNGC (in the case of STS mooring). The instigation of emergency mooring release of jetty and / or LNGC mooring lines will also be required from the primary control centre.
- **The LNGC:** needs to monitor and maintain the mooring system during cargo operations, so access to mooring line data is essential.

All of the above rely on a compatible SSL for Emergency Shutdown control, Emergency Mooring Release and load monitoring data transfer, hot line communications and, increasingly for FSRU operations, a common data link between the three platforms.

Terminal operations during berthing, un-berthing and cargo operations will also require berthing aid data, MetOcean monitoring and mooring system load monitoring. In some cases, a passive workstation may be required at a remote location to allow asset owners access to the combined operation. The system architecture should be designed to allow for such a situation.

MOORING CAPACITY

Quick Release Hooks (QRHs) are an essential part of the docking and mooring system. However, we've seen some disconnect between the civil engineering EPC and the ship designers in the specification of Safe Working Load (SWL). This can potentially mean that the hooks selected for the Ship-to-Ship mooring arrangement have a different rating than the jetty based hook – a good example of the need to align the requirements of the different statutory bodies involved in jetty design and ship design, because this can become problematic when the jetty mooring equipment is shared by both the FSRU and the LNGC.

Physically, a compact footprint for the mooring equipment on the FSRU is necessary, to save valuable deck space and simplify the under-deck reinforcement requirements. High salt-spray ingress protection is also required for mechanisms, load cells, capstan motors and electrical control boxes.

The semi-permanent nature of the FSRU to jetty mooring typically means that the Quick Release Hooks are not operated as frequently as they would be at a conventional terminal, so special attention needs to be paid to using a low maintenance hook design to ensure that the release function operates properly when required.

With the introduction of FSRU technologies, and the long term nature of their mooring alongside the jetty, there is a need for lower maintenance Quick release Hooks (QRHs).

Historically, maintenance of mooring hooks required greasing of multiple points on the QRH, at least every three months – in order to effectively distribute grease during maintenance, all moving parts of the hook must be exercised, ideally through their full range of motion.

Where vessels are permanently moored, of course, maintenance cannot be performed adequately. Without this maintenance the safety, operation and lifespan of the equiment is compromised. The result may be restricted movement or seizure of components. Rectification can be time consuming, costly and affect facility production.

The Low Maintenance Hook from Trelleborg represents a virtually maintenance free option, which eliminates reliance on manual greasing as the primary means of protection. The design uses a combination of custom self-lubricating bushes and stainless steel sleeves to provide a low friction bearing surface for all moving parts. These components offer excellent corrosion resistance and are capable of providing years of greatly reduced or maintenance free operation.

FENDERS

Mishra Kumar, Global Technical & Market Support Manager

On the jetty side, with the FSRU moored semi-permanently, the jetty's fenders, fender panels and associated chain and hardware are subjected to constant stress. Fender loads will also be magnified when the LNGC berths alongside the FSRU.

Other considerations, for example, low ambient temperatures and fender response from the effect of passing vessels must also be examined. Selection of the correct fender is therefore not limited to Energy and Reaction performance requirements.

The characteristics of the fender and as such, both Velocity Factor (VF) and Temperature Factor (TF) are greatly affected by the type of rubber used, be it natural or synthetic – and within that, virgin or recycled – and further still by the compound composition of the rubber.

VF and TF must be calculated and reported on a case by case basis. Each is dependent on the make-up of the rubber compound, and as such, to accommodate the increased demands of semi-permanent mooring, it's even more critical that suppliers calculate and report performance under the specific temperatures expected at the berth.

Other factors such as aging, UV exposure, temperature and immersion must also be considered if longevity of the fender and its hardware is to be guaranteed.

Likewise, reducing abrasion between the fender facing and ship's hull, and easy change out of damaged facing sections are also relevant considerations for semi-permanent FSRU mooring.

Super Cone (SCN) or SCK Cell fenders represent rugged, high performance fender types that can cope with the increased stress brought about by the semi-permanent nature of the FSRU's mooring against the jetty.

Super Cones are the latest generation of 'cell' fender, with optimal performance and efficiency, renowned for their remarkable energy capacity and low reaction force. The conical body shape makes the SCN very stable even at large compression angles, and provides excellent shear strength. With overload stops the Super Cone is even more resistant to over-compression.

On the FSRU, the fender system must also be considered as part of the mooring system, along with their associated deployment and retrieval systems. Here, the smaller footprint that's essential for Ship-to-Ship operations needs to be considered.

Pneumatic fenders with chain tyre nets have been the traditional choice for Ship-to-Ship operations. However, foam fenders can be manufactured without chain tyre nets and provide lower frictional resistance since the fender skin can be of a low friction polyurethane material rather than rubber.

Foam fenders are virtually unsinkable, and could be considered a heavy duty alternative to pneumatic fenders and better suited for some FLNG projects. Foam-filled fenders can offer similar reaction and energy performance to pneumatic fenders and can be engineered to offer low hull pressure. Importantly, in the event of an LNG spill, foam fenders have been shown to be much more resistant to damage from low temperatures.

TRANSFER

David Pendleton, Business Development Director, Oil and Gas Transfer Technology

Ship Shore Link (SSL) systems have been around since 1975, and in use almost universally in the LNG industry since the introduction of the Society of International Gas Tanker and Terminal Operators' (SIGTTO), Recommendations and Guidelines for Linked Ship/Shore Emergency Shut-Down of Liquefied Gas Cargo Transfer in 1987.

The primary role of the SSL-ESD is to ensure secure Emergency Shut-Down (ESD) signalling to mutually shut-down ship and shore pumping and transfer systems in the event of an abnormal condition or emergency. The SSL-ESD avoids damaging surge pressures that could lead to spillages of cryogenic liquid, which could in turn, compromise the hull integrity through 'cold-cracking'. The SSL, which is ATEX, IECEx and SIL 2 certified handles the ESD, telephony, process information and mooring load monitor data.

While a variety of different solutions were used up to the late nineties, the SeaTechnik™ integrated SSL assured full compatibility between the ship and any of the main systems installed at terminals around the world. This cost-effective flexibility was a significant factor in facilitating the LNG trade to change from the liner to the spot market in a decade when the world fleet expanded three-fold.

An FSRU SSL system handles ESD, communications and other data for the control of the liquid transfer from an LNGC to replenish the FSRU while simultaneously controlling the ESD, communications, MLM and all process plant data for the high pressure gas output from the FSRU to the shore. It is vital that the system is designed with the highest integrity to ensure that an ESD from either process does not trip the other.

Trelleborg Marine Systems specifically designed their SeaTechnik™ digital SSL for FSRU applications, to safeguard the FSRU during the transfer process, as it sends high pressure gas onshore, and when periodically, visiting LNGCs replenish the FSRU. That 20 hour batch operation must not interfere with the high pressure gas send out. The process is managed from a single location and the operators must be able to access and control the shore and FSRU as one process. The SeaTechnik™ digital SSL supports this.

With multiple operating locations, additional flexible SSL telecom channels can be configured to support the extra telephones and hot-line phones needed. For the increasingly popular side-moored case, mooring lines from the visiting LNGC are secured to quick release hooks or bollards on the seaward side of the FSRU, as well as the jetty dolphins and tensioning a single line on one vessel can affect the tensions on the other lines.

Transfer of mooring load data from jetty hooks to the FSRU, along with data from the FSRU hooks to the LNGC, ensures that the full mooring plan can be displayed, with quantified data helping both ship's' first officers to maintain a safe moor.

Offshore side-by-side transfer

DOCKING AND MOORING

Peter Pickering, Managing Director, Docking and Mooring

Similar to onshore mooring, ship-to-ship FLNG will have between eight to 10 sets of mooring hooks, with a safe working load capacity of 100-150 tonnes, configured as double and triple hooks. Physically though, a compact footprint for the mooring equipment is necessary, as deck space is at a premium.

Under deck reinforcement requirements must be simplified as much as possible and high salt-spray ingress protection is also essential for mechanisms such as load cells and capstans.

Quick Release Hooks (QRHs) for ship to ship mooring will need to comply with designated vessel Class Rules and certification requirements, representing a significant difference when compared to QRH installed on jetties and docks. They should comply with the recommendations of OCIMF MEG3, whereby the Safe Working Load will be equal to the Minimum Breaking Load (MBL) of the mooring line.

In the case of offshore applications – and of particular importance as conditions become more extreme – fixed lasers are no longer an appropriate solution in measuring and recording berthing speed and the angle of approach. Alternative solutions are required to allow the flexibility needed for open sea berthing and allow for pitch and roll.

The use of real time kinetic (RTK) GPS will allow the operator more reliable management of the LNGCs speed of approach, angle and distance, whilst providing a similar level of accuracy to traditional fixed lasers.

Additional environmental monitoring and the use of predictive software in a GPS docking tool will further assist the pilot during this critical stage and optimise the operational window.

FENDERS

Mishra Kumar, Global Technical & Market Support Manager

Again, traditional fixed fenders are not an option. Pneumatic fenders with chain tyre nets have been the traditional choice for ship-to-ship mooring, but foam fenders can provide an attractive alternative for this application too. They can be manufactured without tyre nets, and provide lower frictional resistance since the fender skin can be manufactured from a low polyurethane material, rather than rubber.

Pneumatic or foam, the fenders will need to be retrieved when no LNGC berths alongside the FLNG unit. Contrary to a small margin of opinion, fenders should not be left in the water once the LNGC has departed.

Fenders left deployed will take the full force of the waves and as FLNG terminals move further offshore and experience more extreme conditions, this will become more of a problem.

It's essential then that operators have the deployment and retrieval systems necessary to bring fenders back on deck for storage when they're not in use. Given that deck space is at a premium, this scenario necessitates good forward planning at the earliest stages of LNGC to FLNG unit conversion.

Small-scale LNG

The burgeoning small-scale LNG market in its many guises still brings with it a fair amount of uncertainty. Depending on the specific sector, be it lightering, where large cargoes of 100,000 m3 are offloaded to smaller LNGCs for transhipment, break/bulk or fuelling, the market for each is evolving in different ways in different places.

What is clear is that small-scale LNG in one form or another presents an effective solution in the drive to make the most environmentally friendly fossil fuel available to markets which are not deemed big enough to merit a pipeline network, and lack the infrastructure to support large scale LNG import.

FENDERS

Scott Smith, Regional Director, Asia Pacific

Ensuring fender efficiency for large vessels as well as small.

Across the industry, vessel sizes have been steadily increasing – and of course, port infrastructure has had to evolve to keep pace. But now, there is an increasing need for large-scale expertise to adapt and become applicable at something of a micro level: keeping the same mission critical capabilities with a more compact footprint.

Off the shelf solutions are not an option in the LNG arena, where downtime is at a premium and safety is paramount. In the wider, relatively mature LNG sector, fender systems have grown with the size of the vessels they're required to accommodate. However, as the small-scale LNG market evolves, terminals will be required to berth smaller vessels as well as their larger counterparts.

This introduction of small-scale LNG facilities at existing terminals will, at the very least, require a full review of the fender systems utilised.

The large vessels that berth at traditional LNG terminals are relatively easy to design for once the berthing parameters are known: they are usually very large and have large, flat hulls, and it's relatively straightforward to design fender systems for a terminal that's expecting a similar standard of vessels to berth.

However, add the small, feeder type vessels of small-scale LNG in to the mix, and fender design and spacing will both need something of an overhaul to ensure that both can berth safely and efficiently.

At the least, there would need to be a review of fender spacing, which is particularly affected by a vessel's geometry and must allow the smallest design vessel to lie alongside at any location.

Potential low blow contact scenarios, under different tidal conditions – as well as varying hull geometries, and the presence of beltings on smaller vessels, could potentially cause issues with existing fender systems.

An updated design will need to ensure fender spacing is sufficient, so that smaller vessels will not contact the wharf structure between fenders, or get caught up under fender frames. The design of the frontal frame must also have sufficient strength to handle low blow or belting contact, as opposed to standard designs which are based on full face contact.

To optimize fender design and guarantee performance, it is essential that the rubber compound composition of marine fenders is duly considered for LNG terminals – the selection of the rubber material is of paramount importance. In fact, by far the
most important factor affecting fender performance is rubber type and rubber
compound composition.

Research by Trelleborg reveals that the incorrect rubber selection will have a major impact on the energy absorption and corresponding reaction force that the LNG terminal has to distribute.

However, the behaviour of rubber under stress is unique, so it's essential that precisely the right formulation is specified and – critically, finds its way to the final product – to ensure a long and robust service life.

Three key factors – velocity factor, temperature factor and longevity are affected by rubber grade and compound formulation in marine fenders.

The properties of fenders vary dramatically depending on their composition, as such; rubber compound composition should be built into specifications in order to guarantee performance and lifecycle.

Trelleborg has recently launched a model specification which is intended to guide specifiers in ensuring the correct rubber compound composition, and ensure that suppliers provide the compound composition and physical properties required to optimise performance and guarantee longevity.

TRANSFER

David Pendleton, Business Development Director, Oil and Gas Transfer Technology

Assuring compatibility in oil and gas transfer technology.

Across international markets LNG is being traded as a commodity. Across the international shipping community it is being used as a fuel. Each has different business models but require the same thing.

“The safe, efficient, timely and cost effective transfer of LNG from a discharge tank to a receiving tank and compatible systems that allow this”

One of the key issues for both markets is compatibility. Compatibility guarantees flexibility. Flexibility of vessels and terminals to trade with any other facility and ensure they can transfer LNG safely, efficiently and economically. This is a lesson that the large scale LNG industry has learned over the last twenty years and helped revolutionise the trading patterns of that industry. A revolution that has seen Trelleborg Marine Systems SeaTechnik™ Ship Shore Link (SSL) products positioned right at the centre.

Small Scale LNG transfer and the use of LNG as a marine fuel on the face of it look identical to the large scale industry. However, this is a much more cost sensitive market and there is a need to strike a balance between the implementation of the compatible systems and safe practices of the large scale industry and the need to make this new market economically viable.

With the new Trelleborg SeaTechnik™ Universal Safety Link (USL), Trelleborg Marine Systems believe they have struck this balance perfectly.

The USL is an integrated fiber optic and electrical safety system, that is both IECEx and ATEX approved, it uses industry standard connection systems, and distils the company’s vast large-scale Terminal, LNGC, FSRU and FSU expertise into an optimized product for small-scale LNG transfer or bunkering. The system can also interface with pneumatic systems to allow vessels to load from road tankers with pneumatic ESD control only.

The Trelleborg SeaTechnik™ Digital SSL, that has underpinned most FSU and FSRU operations, exchanges any number of process signals between the ships and shore terminal to safely operate the gas or LNG transfer as a whole. In these large scale operations, jetty Mooring Load Monitor signals can be exchanged with FSRU or FSUs.

With small scale LNG transfers, which are undertaken at much higher pressures, careful control of the process conditions of both the offloading and the receiving tanks is crucial to avoid nuisance ESD trips or discharges from safety valves. The Trelleborg SeaTechnik™ USL system uses the same digital technology to allow a single operator to safely manage the entire transfer process from the bunkering LNGC.

The USL is designed as a rugged, compact and cost-effective solution that, when connected to a remote counterpart USL, automatically configures itself to display to the operator the process conditions on board the remote receiving tank system.

Onshore, offshore and onboard, have a look at our track record in the LNG sector.

View our “Track Record Tool” at http://trackrecord.trelleborg.com

TRELLEBORG

Trelleborg is a world leader in engineered polymer solutions that seal, damp and protect critical applications in demanding environments. Its innovative solutions accelerate performance for customers in a sustainable way.

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