FSRU/FSU market standards and growing small-scale compatibility

ANDREW STAFFORD, Trelleborg Marine Systems

When managing floating storage regasification unit (FSRU) operations, the ship-to-shore interfaces for gas output, and the interfaces between an LNG carrier (LNGC) and an FSRU for liquid transfer, are mission critical. The ship-shore link (SSL) is part of the emergency shutdown (ESD) and safety chain across this interface, carrying communications and data between ship and shore or between floating assets (FIG. 1).

A backward-compatible, high-speed digital design was developed in 2005–2007 to overcome the limited functionality of legacy SSL systems. With the implementation of FSRs and floating storage units (FSUs) in 2007–2008, which required transfer support for multiple processes, this digital design proved to be an ideal solution. However, regulatory standards took a while to catch up. In 2011, an ISO standard was released covering key compatibility aspects of the traditional large-scale LNGC ship-shore interface, but no standard emerged to cover the FSRU/FSRU interface.

FSRUs/FSUs: Considering compatibility. In the absence of relevant standards, new FSRU/FSU projects are being designed in isolation. Arbitrary, bespoke interfaces have been developed without thought for wider compatibility. Requirements for ultra-fast Ethernet links via legacy fiber-optic infrastructure, as well as via standard instrument cable, have been seen without regard for feasibility of implementation or compatibility with other applications.

The further development of mooring arrangements for double bunc and direct ship-to-ship transfers have introduced the installation of quick release hooks (QRHs) with integrated load monitoring onboard vessels. These require more complex interfacing between FSRU/FSU and the LNGC, in effect turning an FSRU/FSU ship into a shore, while always retaining the flexibility for the FSRU/FSU ship to return to trade as an LNG carrier (FIG. 2). Meanwhile, the emergence of small-scale and LNG banking is only adding to the debate.

Looking back at large-scale transfer. The large-scale LNG marine transfer industry has used linked shutdown systems since the mid-1970s. The primary function of the link is to mutually shut down the connected counter-part system in the case of an ESD condition being raised on the local system. A number of the connectors began to offer additional functionality, beginning with telecon and followed by mooring load with environmental data, and more recently, Ethernet and process data. Although the actual connectors used ended up being quite standard, the pin configurations within the connectors were open to interpretation by the original system integrators, resulting in the majority of pre-2000 terminal installations using bespoke configurations.

Work on standardization of ship/shore links was undertaken in 2009, with the publication of the Society of International Gas Tanker and Terminal Operators (SIGTTO) document, “ESD arrangements and linked ship/shore systems for liquefied gas carriers.” This was followed by the publication of ISO 28460:2010, which defined standard pin-outs for the 37 pin and Miyaki-type systems.

These have had a positive influence on newbuild facilities. However, existing terminals have not moved to the standard pin-out, meaning that vessels are required to configure per terminal. Additionally, both of these publications are limited to the transfer of LNG in bulk, and do not directly cover the new application of FSRUs, FSUs and small-scale LNG fueling. Therefore, these new applications are subject to interpretation of existing guidance with project-by-project developments being made.

FSRU compatibility. The first FSRU vessels were delivered in 2005 and, at that time, were installed with traditional SSL equipment. This was more than adequate for the initial applications of FSRU compressed natural gas (CNG) discharge at a jetty, or for offshore buoy with LNG reloading taking place via ship-ship transfer while removed from the jetty.

Increasingly complex operations soon required concurrent, and independent, discharge of CNG and reloading of LNG. This required introducing the concept of dual-ESD, which was not possible using existing SSL systems. Additionally, with FSRU terminals being built by and for domestic utility companies, a requirement existed for gas volumes and qualities to be shared by the FSRU to the terminal.

Newer implementations are now being conceived to simplify the terminal to a simple tie-in location, with the entire process being managed by the FSRU (FIG. 3). This started with sending a few shore data values for temperature and pressure at a national grid tie-in point. More recent discussions center around the level of control the FSRU should have at the jetty, and specifications are being written and implemented to allow the FSRU to release both the shore QRHs and the shore-side loading arm powered emergency release couplings (PERCs).

FSU compatibility. FSU applications typically originate from conversions of existing LNG carriers. During conversion, it is preferable to reuse as much of the pre-existing installation as possible. In terms of ship-shore links, there will be an existing SSL “ship” system onboard, but techniques used in the original fiber-optic links mean that an LNG carrier link can only ever connect fully to a “terminal” system.

Historically, the optical fiber has never offered a ship-ship mode for both ESD and telephony due to these compatibility issues. Since an FSU is effectively the storage extension of an onshore facility, increased integration between the FSU and terminal is critical. Existing fiber-optic cabling performance must be addressed, as the original SSL fiber-optic specification is for a 50/125μm OM2 offering limited bandwidth over distance. User expectations for high speed and long distances must be managed, as it may not be possible to implement this link using existing infrastructure.

Depending on the facility, an enhanced input/output (I/O) signaling between terminal and ship vessel may be required. If the signal is required to have high integrity, such as an additional level of shutdown, then a hardware-based I/O channel within the core SONET packet structure can be implemented. However, for process control I/O, if serial data is not an option, then third-party distributed I/O hardware modules can be implemented with the SONET Ethernet.

Small-scale compatibility. Emerging small-scale LNG applications have presented the industry with a crossroads in terms of ship-shore link compatibilities and functionality. The first option is retaining the bespoke links and allowing the small-scale market to inherit existing large-scale system types with their limited functionalities. Alternatively, the opportunity to globally standardize and simplify new vessels by using up-to-date and international standards technologies both.
future-proofs the industry and creates flexible trading assets.

Building on the SONET technology, now well-proven in the FSRU market, small-scale shutdown links have the opportunity to integrate the ESD, telecoms and process control functions together within a simple link. The Trelleborg Universal Safety Link is installed on some of the leading projects in the sector, and offers operators a level of oversight and control not previously seen in the LNG transfer market. Process data for the remotely connected system can be displayed and made available to the local operator, and the network link has enabled full control DCS interlink between vessels and terminals.

Special case considerations for intermediate vessels could load from an existing large-scale facility and then distribute to a number of smaller customers. In this case, the asset would need to be equipped for connection to the legacy system, as well as for the new small-scale systems. As the small-scale technology is based on that contained in FSRU applications, cost-effective solutions allowing connection to all applications exist.

**Need for a standard interface.**

The piecemeal evolution of the large-scale LNG market has led to the proliferation of standards that the industry is still addressing today. Although ISO standards are now in place, no proactive modifications have been made to the configuration of existing terminals, which do not conform to the standard pin-out. This is forcing LNG carriers to continue to install complicated configurable systems that could lead to delayed connections.

As newer fleets of FSRU and FSU vessels are constructed, they are not being built to a common standard. Although much attention has been paid to ensure that links are physically compatible in terms of connectors and signal transmission format, application data is being implemented at a local level, which does not lead to standardization. In an industry that requires worldwide compatibility, this represents a major challenge.

Consideration should be given to forming an industry working group that looks at the requirements of standard data and interfacing to generate a core specification. This core specification could then be adopted as standard practice into future guidelines, helping reduce project timeframe and simplify integration between systems.

Andrew Stafford, Technical Director at Trelleborg’s marine systems operation, will be presenting a paper titled, “Interface standards for FSRU, FSU and small-scale sectors,” on Thursday, April 6 at 4 p.m. at the Main Conference Center. Trelleborg’s marine systems operation and Teekay Marine Solutions will launch a new, premium pneumatic fender offering. Representatives from both companies will be available at exhibit 16-320 to discuss the new HALO Fender offering for the ship-to-ship (STS) transfer market and the wider marine industry.

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