A new STANDARD

Andrew Stafford, Trelleborg’s marine systems operation, UK, discusses the need for industry standards to facilitate compatibility across FSRU interfaces.

From traditional terminals to bunker barges and everything in between, LNG interfaces can vary substantially. There are many and varied needs of multiple stakeholders for suppliers to meet. Nowhere is this truer than in the case of floating storage and regasification units (FSRUs).

When there are three parties required to interact, communications and asset requirements become more complex. Compatibility and consistency between all three becomes critical to ensure effective data sharing, quick decision making and shared judgement across all parties.

This article discusses the need for industry standards for FSRU applications to facilitate compatibility across interfaces.

With an increasing LNG capacity on stream y/y, there is rising demand for large-scale transportation of cargo, and small-scale bunkering, as well as for more FSRU applications.

As with any other LNG application, FSRUs require the safe, efficient and timely transfer of LNG from one tank system to another. As FSRU applications develop, systems integration becomes more complex due to the combination of conventional jetty mooring and docking, and offshore ship-to-ship (STS) systems. It is essential that integration is made simple, cost-effective, safe and efficient. Compatibility empowers this.

The safe, efficient transportation and transfer of LNG as a cargo has had an enviable track record over its 40-year history. To continue this, ports, terminals and vessels alike must take a smarter approach to interfaces between units in LNG transfer, which can have a significant impact on overall efficiency.
Bringing together all of the key stakeholders in the LNG transportation supply chain, including vessel owners/operators, ports, LNG project developers, energy majors, charterers and equipment/service suppliers, is a critical element in achieving this much needed compatibility (as is the introduction of standards to guide all parties).

**Smarter ways to simplify complexity**

When managing FSRU operations, the ship-to-shore interfaces for gas output, and interfaces between the LNG carrier and 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.

A backward compatible high speed digital design was developed in 2005 – 2007 to overcome the limited functionality of legacy SSL systems, and with the implementation of FSUs and floating storage units (FSUs) in 2007 – 2008 requiring transfer support for multiple processes, this digital design proved an ideal solution. Regulatory standards, however, took a while to catch up. 2011 saw an ISO standard released that covered key compatibility aspects of the traditional large scale LNG carrier ship-shore interface, but still nothing to cover the FSU/FSRU interface.

**Desperately seeking standards**

In the absence of relevant standards, new FSRU 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 fibre-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 bank and direct STS transfers have introduced the installation of quick-release hooks (QRHs) with integrated load monitoring on board vessels. These require more complex interfacing between the FSRU/FSU and the LNG carrier, in effect turning an FSRU/FSU ship into a shore, whilst always retaining the flexibility for the FSRU/FSU ship to return to trade as an LNG carrier. Meanwhile, the emergence of small scale and LNG bunkering 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 counterpart system in the case of an ESD condition being raised on the local system. A number of the connectors started to offer additional functionality, beginning with telecom 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 terminal installations pre-2000 using bespoke configurations.

Work on standardisation of ship-shore links was undertaken around 2009, with the publication of the Sichtig document ‘ESD Arrangements & Linked Ship/Shore Systems for Liquefied Gas Carriers’. This was followed by the publication of ISO 28460:2010, which defined standard pinouts 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 vessels are still required to configure per terminal. Furthermore, both of these specifications are limited to the transfer of LNG in bulk and do not directly cover the newer application of FSRU, FSU and small scale/LNG fuelling. Therefore, these newer markets are subject to interpretation of existing guidance with project-by-project bespoke developments being made.

**FSRU compatibility**

The first FSRU vessels were delivered around 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 offshore buoy with LNG reloading taking place via STS transfer while removed from the jetty. At this time, a commercially available wireless data link or even V-SAT was implemented to transfer data between the terminal and FSRU.

As the popularity of FSRU deployments increased, so too did the complexity of the operational requirements. Applications were soon requiring concurrent discharge of CNG and reloading of LNG. These processes had to be kept independent as the gas send-out could not be interrupted by the loading of LNG. This requirement introduced the concept of dual ESD, which was not possible when using existing SSL systems. Additionally, with FSRU terminals being built by and for domestic utility companies, there was a requirement for gas volumes and qualities to be shared by the FSRU to the terminal. The Trelleborg digital SSL, originally developed as an expansion of the existing LNG link utilising the pre-existing fibre-optic infrastructure, was able to provide both the additional ESD functionality and the required data channels. This new link allowed the number of ESDs to be increased, as well as offering additional telecom channels and a dedicated ethernet link via the transmission payload.
Although the digital SSL offers 100 Mbps ethernet, how the data is transferred in both medium and protocol is currently fully open to interpretation. To date, the ethernet has been used for directly linking ship and shore via object linking and embedding for process control (OPC) server arrangements, which send over Modbus from the vessel’s integrated automation system (IAS), Modbus transmission control protocol (TCP), either directly connected or via a remote terminal unit (RTU) to TCP converters has also been used. Typical data transferred includes tank data for volumes and temperature, regasification process output including pressure and temperature, real-time gas chromatography, a time value is typically also included for reference. Although the data is common for all FSRU applications, as there is no standard, various data sets are being proliferated, which limits the compatibility of interchanging FSRUs around the world. This has occurred on a number of occasions.

To complement the ethernet data link provided by the fibre-optic system, electrical network backups have also been implemented. As the link is physically based on instrumentation, cabling and distances between FSRU and shore SSL enclosures can be many hundreds of meters. Ethernet extender devices have been used to attain the best possible link speed based on the installation infrastructure. These devices do not currently work to any defined standard as they are intended for point-to-point use. Manufacturers can also make them obsolete in short time periods: they do not necessarily need to concern themselves with ongoing compatibility as they are typically supplied as a matching pair.

Although the ship-to-shore link should only ever be connected via a single cable to protect against damage to the backup, some operators insist on always connecting both cables. It was found that doing this had the potential to introduce an ethernet broadcast storm: as two paths are available for the data, network requests are looped, which causes ethernet switches to shut down. To mitigate this, and as the ethernet extenders do not work to any fixed standards, additional network protection is required as some standard data switch redundancy modes are not compatible with the extenders. After testing in many applications, the preferred network protection interface is Link Aggregation Control Protocol (LACP), further complicating the link.

As the market becomes more familiar with the arrangements of FSRU installations, newer implementations are being conceived with the ultimate aim of streamlining the terminal to a simple tie-in location with the entire process being managed by the FSRU. This started with sending a few shore data values for temperature and pressure at a national grid tie-in point, which may be 10 km or more away from the FSRU, being fed back to the FSRU via the data channel to allow the FSRU send-out to be compensated, ensuring the correct tie-in specification is being met. More recent discussions have been 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).

**Conclusion**

The piecemeal evolution of the large scale LNG market has led to a proliferation of standards that the industry is still addressing today. Although ISO standards are now in place, there has to date been no proactive modification 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 vessels are constructed, there is no common standard to build to. Although there has been much attention paid to ensuring links are physically compatible in terms of connectors and signal transmission format, application data is being implemented at a local level that does not lead to standardisation. 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 to reduce project timesframes and simplify integration between systems.

**Note**

1. LACP as defined in IEEE 802.3ad
Figure 1. As the popularity of floating storage and regasification unit (FSRU) deployments increased, so did the complexity of the operational requirements.