

Dynamic measurement solutions in LNG custody transfer

Emerson's Rossella Mimmi* highlights the merits of dynamic metering for accurate and reliable measuring of LNG volumes in future projects

Current levels of uncertainty in LNG tanker custody transfer operations, combined with the increasing volumes being transferred, still represent a significant fiscal risk.

Long-term LNG sale and purchase contracts restrict custody transfer operations to tank measurement technology that depends on minimising various physical and operating variables in order to achieve acceptable discrepancies in the quantity of LNG transferred. In addition efforts to utilise proven ultrasonic flow meter technology as a dynamic alternative have limited its use to a general check meter, primarily because of the inability to validate its in-situ performance against industry standards and guidelines.

Finding viable options to reducing the current levels of fiscal risk by decreasing uncertainty is a challenging problem with a huge economic impact. The application of best practices for ultrasonic meter flow measurement systems to reduce overall uncertainty in LNG transfer quantities, combined with the latest LNG proving technology to ensure ongoing sustainable and reliable measurements, sets the foundation for acceptable check metering to manage and validate transfer discrepancies.

The bright future for clean-burning natural gas is driving the LNG industry forward. As the volume of LNG traded increases in the years ahead, and the LNG fleet and terminal network grows to meet demand, there will be a commensurate increase in the number of LNG metering points.

In international trading of LNG the quantity invoiced is the transferred LNG energy, given by the product of three quantities: volume, density and gross calorific value. The complex scheme used to calculate the energy value involves LNG sampling, the direct measurement of quantities and the calculation of derived quantities. The direct measurement of quantities, in turn, relies on the LNG tank level, composition and temperature while the calculation of derived quantities depends on the LNG volume inferred through the method known as 'tank strapping' as well as on



Daniel LNG provers provide LNG measurements in compliance with the current standards

LNG density and gross calorific value.

The implementation of these measurement methods and the derived quantity uncertainty are a major metrological challenge. The measurements need to take into account many different scenarios and parameters. These include variable tank shape, possibly involving deformation under the weight of LNG, errors in tank tables, surface conditions, cargo boil-off gas (BOG) rates and a cargo's equilibrium state.

The method of quality determination also plays a very important role. The sample must be homogeneous and give an accurate composition of the LNG, as this has a direct influence on the calculated value of the density, calorific value and, therefore, transferred energy. Many differing gauge technologies are available for level measurement, each with specific advantages and disadvantages. It is therefore important to make the right selection based on the real operating conditions.

All these issues currently lead to a total energy measurement uncertainty for LNG that is higher than in typical oil or gas transactions. While the estimated best uncertainty value under ideal measurement conditions is 0.5 per cent, in normal operations this value can increase to 0.9-1.0 per cent or more. The impact is huge, considering that a 1 per cent uncertainty on the total value of the global LNG trade in 2010 (approximately

200 million tonnes) represents US\$607 million.

Measurement techniques are being enhanced at a rapid pace. An alternative technology for LNG custody transfer applications exists today and is being employed as a volumetric check meter. Dynamic measurement of LNG with ultrasonic meters has already been accepted by the industry as a reliable solution that can provide improved accuracy.

The latest ultrasonic meter technology can overcome most of the LNG dynamic measurement problems, such as large drops in pressure and hot spots that could cause the liquid to gasify. These problems relate to the unstable nature of LNG, which is stored and transported at cryogenic temperatures close to its boiling point.

Ultrasonic meters allow mitigation of the sources of pressure drop in a metering system, as they are full-bore devices and do not generate any incremental pressure drop beyond normal pipe friction. They are also generally sized to operate at relatively low velocities to keep the meter size the same as the pipe size. The electronics are remotely mounted to avoid a heat source close to the pipe and, consequently, reduce the hot spots. In addition meters are designed with integral insulation that facilitates installation of a user's primary insulation.

Even if this technology proved to be suitable for higher-accuracy volume measurement at cryogenic conditions, its adoption as a custody transfer measurement is impeded. The main reason is that LNG trade has generally been based on long-term, 20-year contracts. Within this context the industry has mainly used and accepted the measurement of tank volume as an established procedure that both parties understand and allow.

To overcome this problem, traditional measurement techniques can be supplemented by adding flowmetering points, which will improve operational efficiency and reduce lost-and-unaccounted-for quantities. The addition of flowmetering points also means having more data inputs available to better control the plant systems.

The growing LNG industry is welcoming new facilities and embracing more and more short-term contracts. Therefore opportunities exist to consider a change to dynamic methods. The same applies to future LNG projects where long-term contracts are not in place.

An additional challenge to the utilisation of dynamic



The Daniel 3818 LNG ultrasonic meter is designed to reduce flow measurement uncertainty across the LNG value chain

measurement was the lack of an in-situ proving system for the meter calibration. This requirement is critical in meeting industry standards or guidelines such as API Chapter 4.

With Emerson's Daniel LNG prover, it is now possible to provide an effective solution for a complete LNG measurement system in compliance with the current standards. It is a concept that has evolved from field-proven bi-directional piston provers. Special design details for all main components like proximity detectors,

piston, seals and pipe walls have been applied to operate with LNG at approximately -162°C . Anticipated uncertainty for LNG custody transfer measurement in the field with in-situ proving is ± 0.3 per cent.

A complete LNG flow measurement system incorporates a wide range of flow and fluid property technologies for LNG custody transfer measurement to provide a dynamic measurement solution and ensure API compliance. The incorporation of a creditable check metering technology helps manage and mitigate fiscal risk due to transfer discrepancies.

A complete measurement system also solves other issues linked to current methods, such as sampling complexity and high maintenance costs, and takes advantage of new technologies, such as advanced diagnostics, wireless solutions, and new-generation control systems. Reducing vendor complexity and applying best practices can result in increased operational efficiency and effectiveness, reduced reactive maintenance and increased capital efficiency and measurement system reliability.

Future LNG project contracts can consider a change to dynamic methods per the API custody transfer standard for liquid transfer. Dynamic metering allows measuring LNG with increased accuracy and reliability with reduced fiscal risk. [LNG](#)

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