**White Paper**
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# The Benefits of Fully Certified Measurement Solutions in LNG Bunkering Applications

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# LNG Bunkering Solution


## Abstract

**With stricter regulations coming into force, aimed at reducing the amount of sulfur oxides (SOx) emitted by ships, an increasing number of operators are using liquefied natural gas (LNG) as a cleaner marine fuel option. This in turn has increased the need for LNG bunkering. Measurement accuracy and reliability are essential in all custody transfer operations, but LNG bunkering presents some particular challenges that must be overcome. These include the cryogenic temperature of LNG and how it impacts the accuracy of measurement instrumentation; the need to calculate the energy content of the transferred fuel; and having the ability to accurately measure the amount of vapour returned to the bunker barge, when required. This paper explains how Coriolis mass flow meters and the latest gas chromatography technology can meet these challenges, and describes the benefits that can be achieved by installing them as part of a complete, fully certified measurement solution for LNG bunkering applications.**


## Emissions Regulations

Heavy fuel oil (HFO), the most widely used marine fuel, produces emissions containing high levels of SOx, which can impact both human health and the environment. Consequently, the International Maritime Organization (IMO) has introduced regulations to limit SOx emissions by ships. From 1st January 2020, under the terms of the new IMO 2020 regulation, the sulfur limit in fuel oil used on board ships operating outside designated emission control areas will be reduced from 3.5% m/m (mass by mass) to just 0.5% m/m. This will significantly reduce the amount of SOx emitted by ships around the world and should result in tangible health and environmental benefits.

Ship owners, managers and operators can comply with the new IMO regulations by using exhaust gas cleaning systems, known as scrubbers. These systems remove SOx from exhaust gases, enabling ships fitted with scrubbers to burn HFO and remain within the required sulfur limit. However, most ships do not have scrubbers as they are extremely expensive to fit, with material and installation costs of around $2 million to $6 million per ship. One of the most popular scrubber applications is the open loop scrubber system, however, concerns have been raised by port authorities about the environmental impact caused by the contaminated water from open loop scrubber systems being discharged at sea. This has led some ports to ban open loop scrubbers.

*LNG Bunkering Solution on a sailing vessel*

## LNG as a Marine Fuel

An approach that is gaining momentum as a means of ensuring compliance with IMO 2020, is to use LNG as a marine fuel, rather than HFO. LNG is one of the cleanest burning fossil fuels, emitting almost zero sulfur oxides (SOx) and producing lower emissions of carbon dioxide ($CO_2$) and nitrogen oxides (NOx) than HFO. A further advantage of using LNG rather than HFO is that the cleaner fuel will result in ship engines and associated equipment requiring less maintenance and achieving greater longevity. These benefits have led to more vessels being fueled by LNG, which in turn has resulted in an increasing need for LNG bunkering.

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## Accuracy, Traceability and Transparency

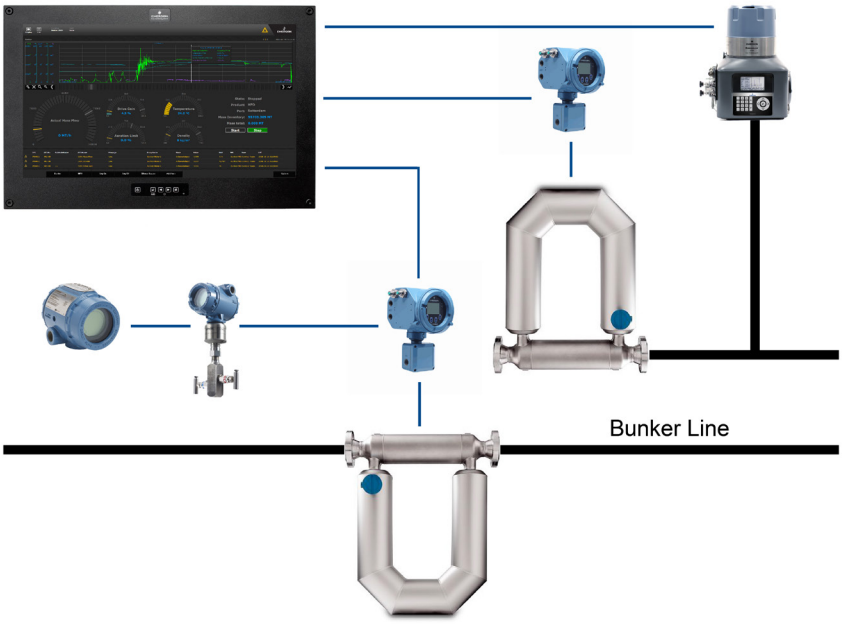
In bunkering operations, reliable measurement capabilities are essential for both sellers and buyers during custody transfer to ensure accurate fuel billing. This avoids disputes and creates trust between stakeholders in the fuel supply chain. Traceability and transparency in LNG bunkering is addressed by two custody transfer regulations – Singapore's TR56 and the European Union's Measuring Instruments Directive (MID) – both of which will be applicable in respective regions.

## Measurement Challenges

Accurate and reliable measurement are required for the above custody transfer standards to be met, however LNG applications present challenges for measurement technologies. For example, the cryogenic temperature of LNG (-160° C) creates mechanical stresses that can cause mechanical flow metering equipment to become less accurate.

cryogenic temperatures close to its boiling point, it can easily become a two-phase liquid if there are hot spots in the pipeline or if there is an excessive pressure drop anywhere in the system. These challenges can make volumetric and more traditional technologies unsuitable for measuring LNG.

For this type of application, mass flow measurement presents a much better option. Volumetric measurement methods involve density and temperature correction, and the readings are subsequently converted to mass before energy content is calculated. Converting the volume into mass can involve significant errors due to the number of steps involved and the effects of changes in temperature and density. Coriolis mass flow meters provide greater accuracy, flexibility and already have well-established industry track record in measuring LNG. Measuring the mass directly – as Coriolis meters do – both eliminates the tedious conversion process and ensures accuracy in LNG bunkering. In addition, Coriolis technology addresses many of the limitations of the traditional technologies.




Also, because

*Emerson's LNG fuel bunkering solution provides certified energy and mass measurement, as well as boil-off gas measurement.*

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## Benefits of Coriolis Technology

Coriolis technology presents several distinct benefits over other measurement options. These include:

● Coriolis quantity measurements are unaffected by changing fluid properties such as viscosity, density, temperature, or pressure. Traditional volumetric meters require either pure single-phase fluids or density-compensation correction systems to adjust the actual measured volume flows to reference conditions – a conversion that increases the uncertainty of the measurements. By measuring mass directly, Coriolis meters eliminate the extra complication and save costs as there is no need for density compensation. Reducing the conversions and compensations for flow measurement reduces the risk of errors and variabilities. The direct mass flow measurement of the Coriolis meter is a more straightforward way to calculate total mass delivered and ultimately ensure measurement accuracy and reliability.

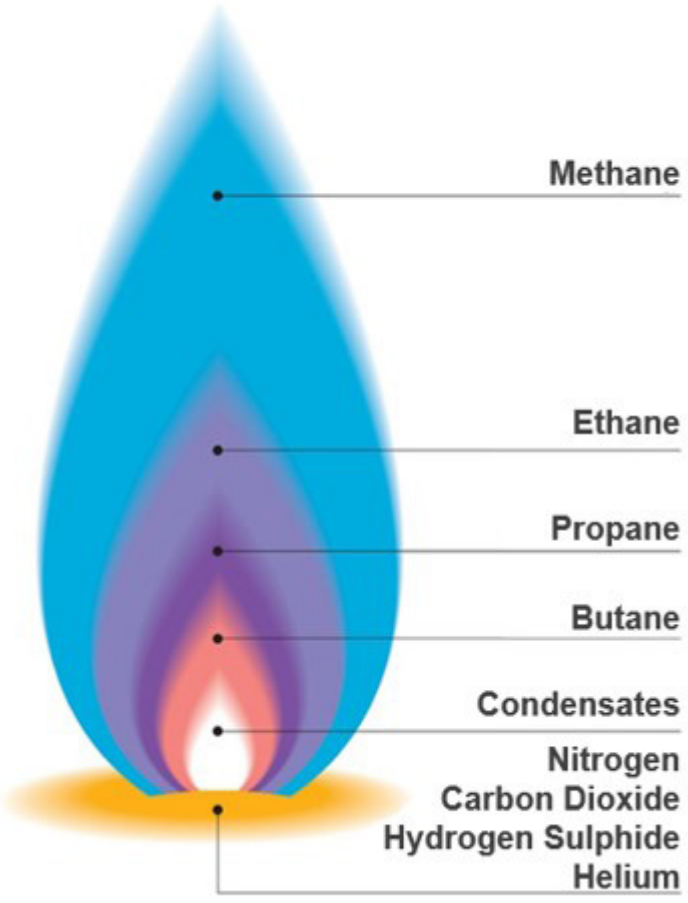
● Coriolis meters do not require special installation procedures, flow straighteners or specific lengths of straight pipe for correcting the fluid flow profile. These typical installation requirements are used to overcome the limitations of turbine, ultrasonic and differential pressure systems are costly and cumbersome. By eliminating the external piping requirements, the costs and size of skid-based measurement systems are reduced.

● Coriolis meters do not require re-calibration over time when operating on LNG, unlike other technologies. Coriolis meters hold their calibration for years at a time without requiring maintenance and as there are no intrusive moving parts there is nothing that can be worn out or be sensitive to changing fluid composition.

In conclusion, Coriolis mass flow measurement are proven to be the technology of choice for LNG bunkering applications.

## Energy Content Measurement

The composition of LNG is mainly comprising of Methane, Ethane, Propane, Butane, Nitrogen. Because of this differing energy content level, and the fact the current LNG bunker standards are defined as mass transfer, an additional calculation must be made. In an LNG bunkering operation, buyers and/or suppliers measure the energy content which has been transferred. This involves measuring the quantity in mass (or converted to mass if volume is measured) and measuring the gross calorific value (GCV) of the fuel. Highly accurate gas chromatography technology takes continuous samples of the fuel being bunkered and analyses these in real time to determine the GCV, which can then be used to calculate the total energy transferred. As the gas chromatograph is measuring the complete composition of the gas (C6+), the vessel operator can determine the methane number which will help optimize engine parameters for reduced engine knocking, lower emissions and better efficiency.



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The latest gas chromatograph technology eliminates the complexity often associated with process gas chromatographs and provides the users a simple solution for LNG analysis. With the ability to validate or calibrate utilising a reference gas mixture, operators can validate their measurement easily reducing the risk of disputes or mismeasurement

## Vapour Return

Some ships will have a reliquefaction skid, while some will have a compressor on board and a compressed natural gas tank below deck, enabling the compressed natural gas to be burned as fuel. There are also occasions where the vapour returned to the bunker barge via a separate line, to avoid being wasted. In these occasions, it is necessary to measure the amount of vapour return, so that the total mass of delivered LNG can be accurately calculated. For example, if a bunker barge can accurately measure 100 tons of LNG being delivered and five tons vapour returned, the receiving vessel can reliably be billed for 95 tons of LNG. Measurement of the vapour return can be performed by Coriolis mass flow meters as part of a fully certified LNG bunkering system.

## Complete, Fully Certified Solutions

When implementing an LNG fuel bunkering solution, ship operators have the option of separately buying the individual components – including Coriolis flow meters, a gas chromatograph, pressure and temperature transmitters – and installing these themselves. However, this would not only involve significant complexity and therefore be prone to errors, it would also not result in a fully certified solution. A better alternative is to approach a trusted automation supplier that is proven in installing complete, fully certified systems.

A fully certified system ensures accredited, independent accurate and certified bunker delivery notes (BDN). Provided both bunker operators and receiving vessels / customers the complete confidence in the transaction.

MID-approved bunkering systems not only provide an insight into the bunker process, but also monitor real time bunkering operations, presenting instant visibility of alarms and parameters such as mass total, flow rate, actual density and temperature. This gives the advantage of early action before any critical incidents happen and provides an overview of all bunker-related data through an integrated control and monitoring interface. All relevant parameters of the bunker process are logged and stored in the system. The log files provide all necessary information, if a dispute between seller and buyer occurs.

Emerson's LNG fuel bunkering solution holds the MID type approval T11158 providing a fully certified solution. The system has a unique and patented design and geometry that enables the highest measurement accuracy of LNG in mass and density. With this system, Emerson provides a solution for all LNG bunkering needs. Choosing Emerson as your LNG bunkering solution provider ensures you are working with a partner with vast experience in cryogenic applications, mass flow meters and gas chromatography.

To learn more about Emerson's marine fuel management solutions,
please visit www.emerson.com/marinefuel

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