

Case study

At a glance

Problem

Accurate measurement of flow during LNG transport, backflow of boil-off gas (BOG), and flare at an LNG facility

Solution

Panametrics' Sentinel LNG, gas, and flare gas flowmeters

Outcome

- Successful tracking of flow in a suboptimal environment using 26 Sentinel flowmeters
- Accuracy to $\pm 0.25\%$
- Ensured against pressure drops in backflow of BOG
- Certification for all hazardous area standards

Sentinel LNG flowmeter in extreme conditions

Background

With an increased need for gas as the energy transition gathers momentum and we progress toward a lower carbon future, operators have to increase the amount of produced gas before liquefying it. Some of this gas is located in extremely cold areas, for example toward the North Pole. These locations contain some of the largest untapped sources of natural gas and dozens of liquefied natural gas (LNG) processing facilities.

In 2000, the US Geological Survey (USGS) stated that nearly 1/3 of the earth's undiscovered oil and gas resources were in the Arctic. These are wild, remote locations where temperatures regularly drop as low as -50°C . The extreme ambient conditions also compound a significant challenge associated with LNG production—flow measurement.

It's no secret that natural gas is compressed 600 times in volume to facilitate easier transport as LNG. Under the best conditions, measurement is a challenge since volume is a function of pressure and temperature—factors that can create havoc in metrology. Panametrics technology is widely deployed on liquefaction trains, including ones located in extreme conditions like the Arctic.

Application challenges

Before natural gas can be supplied to national distribution networks, it needs to be liquefied for transport. LNG terminals are faced with receiving the gas for processing and moving it within their facility, storing, and ultimately transferring the now liquid product to vessels that will bring it to market. Natural gas changes physical form within the infrastructure that handles these operations as temperature and pressure conditions vary. For instance, LNG is stored at pressures very close to its boiling point within cryogenic double-walled tanks. Within these tanks, it is mostly stable. However, once LNG starts moving through a pipeline, there is a risk of it changing to a two-phase flow if there are hot spots along the path or if the pressure drop transforms some of the liquid into gas with a much higher volume. Accurate measurement is essential to minimize lost and unaccounted-for product.

Within the LNG facility, Panametrics engineers worked with the customer to identify situations with the greatest potential for product loss and the greatest need for flow measurement. Needs centered around the transport of LNG, backflow of boil-off gas (BOG), and flare.

The LNG facility was built to withstand the harsh environment using a modular design. This approach saved nearly 30% in construction costs but created a compact infrastructure devoid of sufficiently long straight runs, a requirement for accurately measuring flow with ultrasonic meters. Getting accurate measurements was one of the top priorities for the customer to export LNG efficiently.

The temperamental nature of LNG demands that it be handled at a very low temperature (around -150°C or lower). Every time LNG moves from a vessel

to the processing facility, some BOG needs to be flown in the opposite direction to maintain the delicate pressure equilibrium to prevent the rapid release of LNG vapors, known as “rollover.” Here again, there was a need for precise measurement.

The third area requiring careful measurement is the handling of excess gas. Due to the liquefaction process, excess gas (mainly methane) is vented through a flare stack where, as a safety protocol, it is combusted. Depending on where it is released, the excess gas going to the flare can have a vast flow rate range—from 0.03 m/s up to $100+\text{ m/s}$ —and temperature—from -160°C up to $+300^{\circ}\text{C}$ —making the measurement a big challenge.



Solving the challenges



With the challenges identified, Panametrics' experience with similar LNG projects took over. We immediately set to work on a technical analysis that included a review of isometric engineering drawings and computational fluid dynamics to model the environment mathematically.

This work resulted in a plan that was custom-tailored to the needs of this particular LNG facility and relied heavily on Panametrics' Sentinel LNG flowmeter. The BOG and flare measurements both used the legacy gas and flare meters, of which there are several thousand in operation worldwide. The plan, and Panametrics' industry-leading expertise in LNG, created a trustful environment with the engineering, procurement, construction firm, and the customer.

Valves, elbows, control valves, and other piping components limit the number of straight runs in an LNG facility and can cause flow disturbances. The tight configuration of this facility had

more than the usual amount of these to fit within the available footprint.

To address the woefully insufficient straight runs, which create measurement errors due to non-fully developed flow profiles, Panametrics selected our 4-path meter Sentinel LNG flowmeter, which reacts to changes in flow rate with incredible speed and accuracy. The flowmeter extends the use of ultrasonic technology into cryogenic applications for measuring LNG with unbeatable performance, reliability, and safety and can be calibrated down to $\pm 0.25\%$ of reading. In all, 26 Sentinel units were installed.

Panametrics has a proven track record for BOG measurement

in similar LNG projects. For this project, we recommended our XGM868i, which handles low pressure and cryogenic conditions exceptionally well using ultrasonic technology. Choosing this meter ensured against pressure drops and the maintenance of necessary equilibrium pressure.

The harsh environment of the region also demanded special consideration for handling flare. To ensure that our product was up for the task, in addition to using our XGF868i flare electronics, Panametrics conducted extensive testing of our transducers to expose them to extreme temperature cycles. Creating artificial environments using liquid nitrogen and specialized ovens, we tested the units at -190°C and then at $+300^{\circ}\text{C}$. The transducers performed at both extremes, enabling certification for all hazardous area standards while ensuring reliable operations.



Panametrics provides solutions in the toughest applications and environments for moisture, oxygen, liquid, and gas flow measurement. Experts in flare management, our technology also reduces flare emissions and optimizes performance. With a reach that extends across the globe, Panametrics' critical measurement solutions and flare emissions management are enabling customers to drive efficiency and achieve carbon reduction targets across critical industries, including oil and gas, energy, health care, water and wastewater, chemical processing, food and beverage, and many others.

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