# Accurately Measuring LNG Tanker Boil-Off Gas for Process Efficiency & Environmental Compliance

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**With the recent growth in demand and production of liquefied natural gas (LNG), there has been an increase in trade and the need to transport it globally via LNG tanker ships. This increase in LNG transport has driven the need for expansion of the tanker fleets with increased capacity, wherein the LNG ships are typically carrying up to 266,000 m³ around the world. The LNG tanker fleets are unique because LNG cargo generates waste gas, commonly known as boil-off gas (BOG). This waste gas can be used as fuel for the ships boilers and must be accounted for in order to comply with current marine propulsion regulations for energy efficiency. Accurate flow measurement of the BOG to the ships boilers is essential to tanker operators.**

## Ship handling of LNG cargo and boil-off gas (BOG)

*Fig 1. LNG Tanker*

In order to transport natural gas, it is economical to convert it to LNG. The conversion process involves cryogenically cooling the natural gas to -163°C at atmospheric pressure, at which point the gas condenses to a liquid and is ready for transport. The refrigerated tanks on board the ship ensure the liquid gas remains cryogenic during storage. BOG results when the LNG within the ships storage tanks vapourises due to subsequent ambient heat input to the tanks during transport. In the past LNG tanker ships used an onboard re-liquefaction plant to recycle the LNG vapor back to liquid and into the storage tanks.

## BOG problems

On January 1, 2013 the International Maritime Organisation (IMO) implemented an amendment to the International Convention for the Prevention of Pollution from Ships whereby they added a new regulation to increase the energy efficiency for ships in order to reduce the $CO_2$ emissions. Though many ships have already implemented energy efficiency measures, it's now mandatory that they meet the new IMO regulation. LNG tanker ships are powered by steam turbines with boilers that are fueled by either methane, oil, or a combination of both. In recent years the ships are now using the LNG BOG that is produced during transport as fuel for the ships boilers.

The BOG is collected, heated to ambient temperature, odourised, compressed and then distributed to the boilers which power the steam turbines used for the ships propulsion. The flow measurement of the BOG to the ships boilers is a critical component because the IMO regulation requires low $CO_2$ emissions, which means they must accurately measure the amount of BOG they are using in their boilers for energy efficiency.

## BOG measurement solution

The ST110 Series Flow Meter from Fluid Components International (FCI) meets the accuracy requirements for measuring BOG aboard tankers, at land terminals, storage facilities and points of distribution. This advanced air/gas flow meter combines powerful electronic features and an advanced flow sensor design to provide precision measurement, reliability and economy.

The ST110 Flow Meter (Fig 2) is designed with FCI's unique VeriCal In-Situ Calibration Verification System. Flow meters equipped with the VeriCal System (Fig 3) can perform periodic field functional testing and calibration verification of the flow meter's measurement performance without extracting the flow meter from the pipe or process to avoid shutting down the process for a lengthy period.

*Fig 2. ST110 Air/Gas Flow Meter*

For BOG measurement, the ST110 Flow Meter with VeriCal features an internal purge tube that runs the length of the probe to the sensor and allows the operator to generate a known flow across the sensor element. The resultant signal output can then be compared to the factory baseline test certificate.

The ST110 Series' electronics can meet both current and future need for BOG measurement outputs, process information and communications. Whether the need is for 4-20 mA analog, frequency/pulse, alarm relays or digital bus communications such as HART, Fieldbus, Profibus or Modbus, it provides a solution.

For LNG operators, the ST110 Flow Meter features a graphical, multivariable, backlit LCD display/readout. It provides local information with a continuous display of all process measurements and alarm status, as well as service diagnostics.

Designed for complex gas measurements such as LNG and methane, the ST110 Flow Meter stores up to five calibration groups to support a broad flow range, differing gas mixtures, multiple gases, and obtains up over a 500:1 turndown. An on-board data logger with a removable 2-GB micro-SD memory card that stores 21 million readings is also included.

The ST110 can be calibrated to measure LNG, methane and other process gases. The insertion style ST110 Flow Meter features a thermal flow sensing element that measures flow from 0.25 to 1000 SFPS (0.07 NMPS to 305 NMPS) with accuracy of ±0.75 percent of reading, ±0.5 percent of full scale.

Designed for demanding oil/gas industry applications, the ST110 Flow Meter operates at up to 850ºF (454ºC) and is available with both integral and remote (up to 1000 feet [300 meters]) electronics versions. The ST110 includes system wide agency approvals for hazardous environments, and a rugged, NEMA 4X/IP67 rated 316 stainless steel enclosure. Approvals include SIL-1, ATEX, IECEx, FM and FMc.

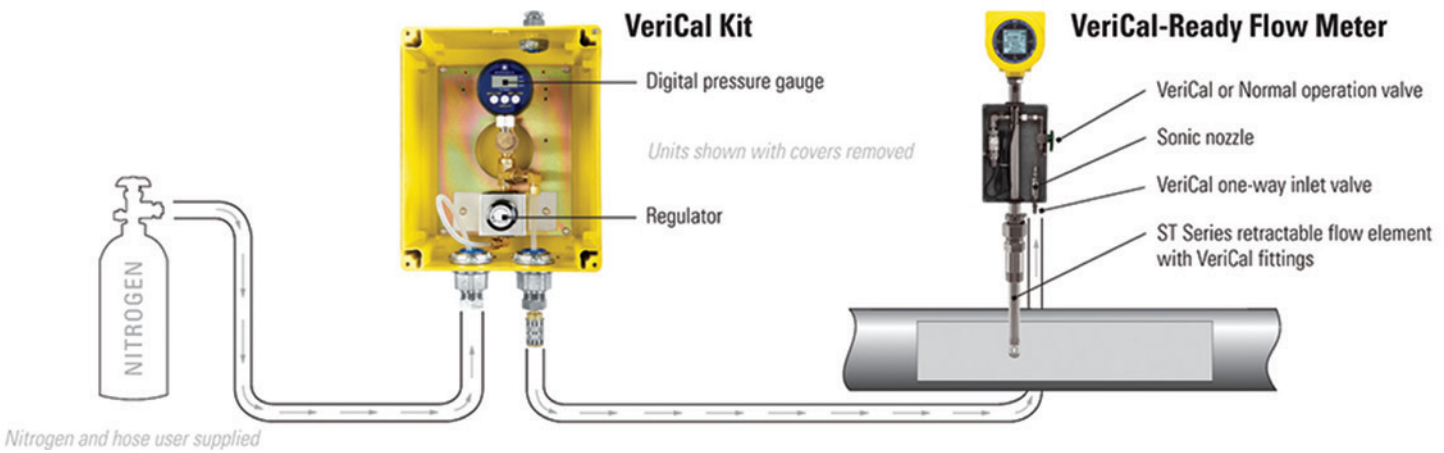
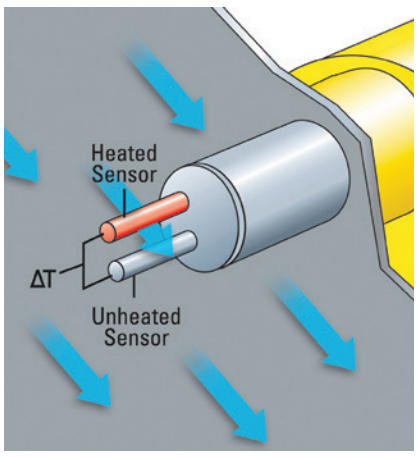



*Fig 3. VeriCal In-Situ Calibration System*




## Thermal dispersion technology

The ST110 Flow Meter's precision flow sensors are designed with thermal dispersion constant current technology, which places two thermowell protected platinum RTD temperature sensors in the process stream (Fig. 4). One RTD is heated while the other senses the actual process temperature. The difference in temperature between the two sensors is measured and is directly proportional to the mass flow rate of the fluid. This technique supports direct mass flow measurement and does not require the addition of temperature and pressure sensors for mass flow computations.

*Fig 4. Thermal Dispersion Technology Principle of Operation*

## Conclusions

At this time, FCI flow meters are operating successfully in LNG BOG applications aboard tankers and at land terminals. The ST110 Flow Meter's accuracy, reliability, rugged design and certification to global industry standards makes it ideal for the LNG industry. In addition, thermal mass flow meters feature a unique no moving parts design that requires virtually no maintenance with low operating and lifecycle cost over a long life.

The combination of accurate performance, low maintenance and long life offers distinct advantages over other flow measurement technology solutions. With 50 years' of experience in the oil/gas industry, FCI's thermal flow maters are designed with this industry in mind and are especially well suited for its rugged operational environment.

With the demand and production growing for natural gas worldwide, FCI's thermal mass flow meters are helping the oil/gas industry and the shipping industry provide cleaner energy solutions by helping to reduce the greenhouse gasses that are a cause of global warming. FCI is committed to helping industry protect the environment through more reliable monitoring of air/gas quality for sustainable best industrial process practices.

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# Flexible Flow Meter Platform Introduced


**Titan Enterprises** (UK) announces the Hedgehog, an electronic development platform for OEM applications based upon the company's innovative Atrato ultrasonic flow meter.

The instrument has the capability of running up to 4 flow sensors simultaneously with real time analysis. The software interface permits a wide operating envelope allowing OEM products to be developed for 0.5 to 20mm pipes including in-line and clamp-on devices. The structure is such that software changes can be simply "dragged and dropped" into a box in the interface permitting remote on-board logic updating and system re-programming. A full array of inlets and outlets are available including both analogue and high speed logic signals for fast response system requirements. Smaller single channel versions `Hoglets` have also been produced to enable testing of single pre-production meters where space may be at a premium.

Using patented technology that enables it to operate with excellent accuracy over very wide flow ranges, the Atrato range of inline flow meters is a genuine breakthrough in flow meter technology. Its rugged, clean bore construction makes the Atrato ideal for a wide range of low flow applications and its USB port allows software connectivity at literally the touch of a button. The advanced Atrato signal processing system permits flow measurement across the whole Reynolds number range allowing both viscous and non-viscous products to be metered anywhere.

With over 40 years' experience in flow meter innovation and manufacture, Titan's company philosophy of "pushing the envelope by trying to do things a little different and better" has resulted in sales of over 250,000 products into 40 countries worldwide and a repeat purchase rate of 95%. Today Titan supplies innovative flow measurement solutions to a broad range of market sectors, including medical, chemical, petrochemical, food and drink, laboratory and pharmaceutical.

**For More Info, email:** 31185pr@reply-direct.com

# Level Transmitter without Troublesome Lines and Tubes

**Endress+Hauser** (Switzerland) introduces the Deltabar FMD71 level transmitter, which uses two pressure sensor modules, each connected electronically to a single transmitter. Using a Ceraphire ceramic sensor in the pressure sensor modules, the transmitter calculates the differential pressure from both sensors and transmits the level, volume or mass via 4-20 mA with HART as a standard two-wire loop-powered device.

One sensor module measures the hydrostatic pressure (HP) and the other one the head pressure (LP). Each sensor sends a digital signal corresponding to temperature compensated measured pressure to the transmitter. This electronic system eliminates issues of traditional differential pressure measurements by doing away with impulse lines or capillaries and their related issues of icing, clogging, leaks, condensation and changing ambient temperatures.

The sensors connect to the transmitter module via industry standard, color-coded twisted pair cable and have NEMA 4X/6P (IP66/IP68) watertight housings and connections. The transmitter can be located away from the sensors in areas safe and convenient for personnel. The system meets ATEX, IEC Ex, CSA and FM specifications for use in hazardous areas including Zones 0, 1 and 2; and Division 1 and 2.

The Ceraphire ceramic cell is vacuum, corrosion and abrasion resistant, eliminating traditional mechanical issues with corrosive and abrasive media. The Ceraphire ceramic cell can be used in absolute vacuum and has excellent chemical resistance properties, similar to Alloy C.

For applications where heavy environmental wash-down is a concern, the FMD71 automatically incorporates Endress+Hauser's dehydration module when a hygienic process connection is utilized. The dehydration module draws moisture from the ambient air inside the cell before it affects the sensor.

The FMD71 offers a standard 4-20mA HART capable output. The dP level measurement is the default 4-20mA signal while dP level, head pressure and sensor temperature can all be assigned as HART variables. Each sensor in the FMD71 system has 0.075% reference accuracy, maximum nominal pressure measurement of -15 to 600 psig, and a -40°F to 302°F process temperature capability.

The system has built-in diagnostics for continuous health indication via HART. Operators can access HART data via Endress+Hauser's FieldCare software or Field Xpert PDA.

For more detailed information about the Deltabar FMD71 Electronic Differential Pressure measurement system, go directly to the product page at: http://www.us.endress.com/electronic-dp.

**For More Info, email:** 30254pr@reply-direct.com

# New Single and Multi Channel Readout/Control Units

**Bronkhorst High-Tech B.V.** (Netherlands), manufacturers of advanced mass flow metering and control systems, designed a new series of Power Supply / Readout and Control Units for use with digital Mass Flow Meters/Controllers, Pressure Meters/Controllers and other transmitters and transducers with RS232 communication. The E-8000 series have one or two colour TFT displays per module (3HE/14TE) for indication of measured/totalised values and a push button menu to easily enable the user to change the setpoint, reset the counter value, select other fluids and many functions more. Based on the modular technique of the E-8000 series, it is easy to assemble price efficient multi-channel configurations in ½ 19" and 19" housings, either for rack mount or table top. For Bronkhorst vapour delivery systems (CEM-systems) a single channel module for temperature control can be integrated with optional display and various fieldbus options.

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