



## K-GAUGE GAS

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### LNG / LPG / NH<sub>3</sub> FUEL TANK MONITORING SYSTEM

The K-Gauge GAS LNG/LPG/NH<sub>3</sub> fuel tank monitoring system is designed to meet the classification rules and guidelines concerning instrumentation and monitoring of storage tanks for ships using liquefied gases as fuel. The accuracy, reliability, integrity and safety of shipboard containment and operations are key elements embedded into the system design.

#### System description

The implementation of dual fuel engines and growing interest in using liquefied gases as a marine fuel, raise many practical challenges regarding bunkering, storing and processing. The K-Gauge GAS fuel tank monitoring system is designed to fulfil the requirements set in the IGF Code and the challenging demands concerning safe monitoring and storage of liquefied gas on board ships.

KONGSBERG extensive knowhow from 20 years in production, design and servicing LNG automation and tank monitoring systems, is embedded into complete solutions for main engine control, Fuel Gas Supply and tank instrumentation for monitoring of fuel tanks for liquefied gases (LNG / LPG / NH<sub>3</sub>).

#### Functional description

K-Gauge GAS fuel tank monitoring system measure the level by use of KONGSBERG well proven Radar Tank Gauge. Extensive surface movements, combined with the low dielec-

tric properties of LNG and LPGs, require quality instrumentation and signal processing to provide reliable measurements. KONGSBERG unique Radar Tank Gauge design, with its high signal-to-noise ratio and powerful signal processing, offers accurate measurement regardless of the tank atmospheric conditions.

The system also implement quality temperature- and pressure transmitters, safety barriers, processing units and display panel for local monitoring through dedicated mimics. Flexible hardware and software modules ensure easy adaptation to all IMO type tank designs, and all kind of liquefied gases.

All field equipment is designed and certified for marine use, manufactured in AISI 316L stainless steel and type approved by the major classification societies. The intrinsically safe apparatus is certified Ex ia according to ATEX and IECEx.

# BUILDING BLOCKS

## Radar Tank Gauge (RTG)

The KONGSBERG Radar Tank Gauge (RTG), GLA-310/5-FUEL, is designed to measure level in tanks containing liquefied gases. Accurate measurement is possible regardless of the tank atmospheric conditions. Flexible hardware and software modules ensure easy adaptation to all tank designs.

The RTG consists of a microwave antenna and an electronic unit. The electronic unit includes a sophisticated signal detection method that ensures optimum performance, which combined with its superb signal-to-noise ratio offers the highest measurement reliability and accuracy.

The horn antenna is designed to guide a frequency sweeping microwave signal through a 50 mm standpipe. The distance is derived from the time delay of the reflected signal.

The standpipe has ventilation holes allowing the vapour pressure inside and outside the pipe to stabilize, thus allowing the liquid to rise or fall in the pipe. The standpipe is considered an integrated part of the level gauge, and is delivered to match the total tank height.

The RTG is specially designed to withstand the severe mechanical and physical conditions in a maritime environment. Only AISI 316L acid-resistant steel and PTFE/PEEK materials are used.

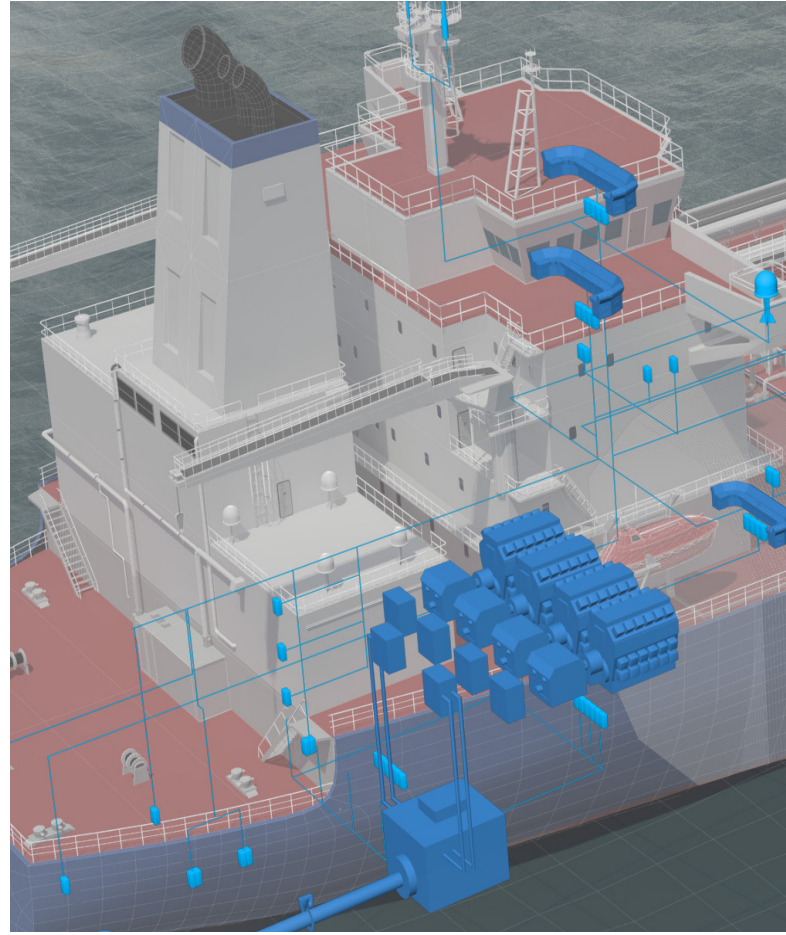
## Signal Processing Unit (SPU)

Each RTG is connected to a dedicated signal processing unit, where the specific tank design data is stored.

The GLK-300 Signal Processing Unit (SPU) is located in safe area and provides necessary communication and power barriers to the instrumentation located in hazardous area. The SPU employs powerful processing of the data from the Radar Tank Gauge and temperature transmitter.

## AutroCAL®

Gas vapour density and mixture of gases influence the propagation speed of the radar signal, thus the accuracy of the measurement. AutroCAL® utilizes multiple reference markers to measure the speed of the signal down the tank and continuously compensates level readings for a varying propagation speed. Each pipe section is delivered with reference markers in the flange joints. The liquid level and the markers are measured simultaneously, and the system automatically verifies itself at every measurement.



## Temperature transmitter

The K-Gauge GAS system offers two alternative temperature monitoring configurations:

### Alt. 1: Up to three temperature sensors

KONGSBERG Cargo Temperature Unit (CTU), GC-300, is a marine approved intrinsically safe signal converter and connection box designed for installation on tank top for connection of up to three temperature sensors through one tank penetration.

### Alt. 2: Up to six temperature sensors

KONGSBERG Cargo Temperature Unit (CTU), GC-306, is a marine approved intrinsically safe signal converter for connection of up to six temperature sensors. The transmitter is designed to be installed in a local cabinet. A connection box for connection of the temperature sensors on tank top is included and provide gas sealing toward the tank atmosphere.



Figure 1: Radar Tank Gauge GLA-310/5-FUEL



Figure 2: Signal Processing Unit GLK-300



Figure 4: Temperature transmitter GC-300



Figure 5: Temperature sensor

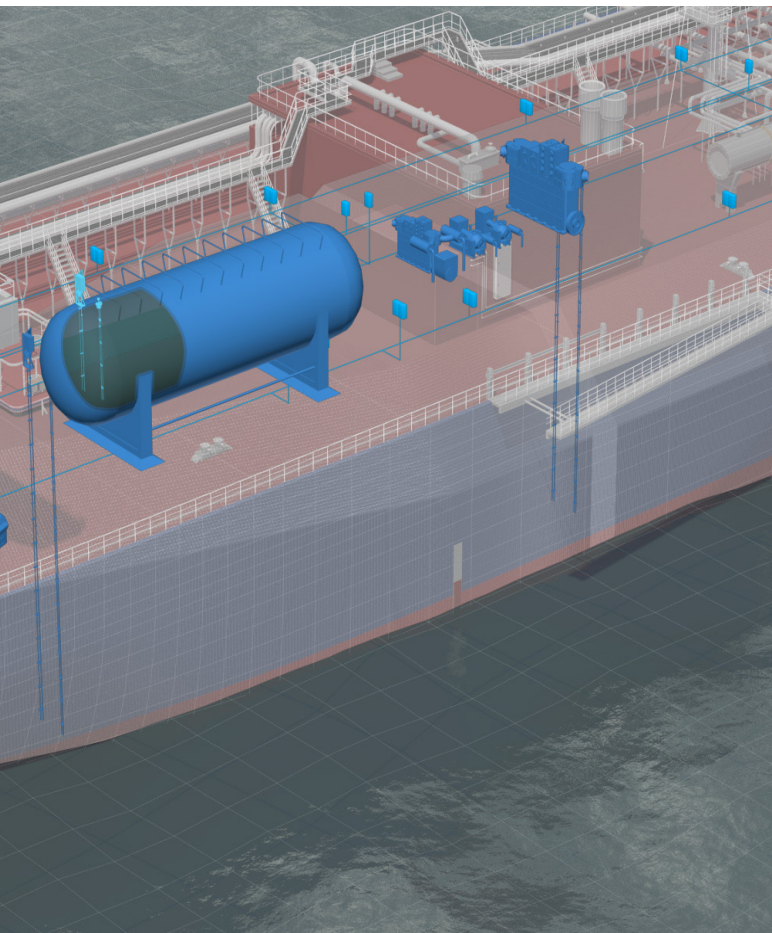


Figure 8: RTG and standpipe installation in Type C tank (example)

### Operator Panel

An Operator Panel mounted in the cabinet door is included in the stand-alone system configuration. The panel is a marine approved 12" touch screen computer with a set of user friendly mimics for presentation of:

- Liquid levels
- Tank volumes (liquid, vapour, total, individual tank)
- Tank temperatures (average liquid, average vapour, individual)
- Tank vapour pressures
- Trim and List readings (if applicable)
- Level alarms (HiHi, Hi, Lo, LoLo)

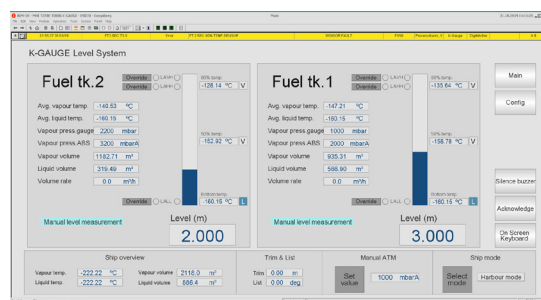


Figure 9: LNG fuel tank overview mimic (2 tanks example)

The temperature converter accurately transforms and transmits temperature measurements from sensors installed inside tanks to the Signal Processing Unit (SPU).

### Temperature sensors

High quality sensors with reliable accuracy are an important factor when monitoring cryogenic liquids. KONGSBERG temperature sensors are designed for submerged installation inside tanks, and are made entirely of AISI 316L acid resistant stainless steel. This also includes the mineral insulated, metal sheathed cable. A compression fitting with conical threads ensures gas-tight penetration of the tank top.

### Vapour pressure transmitter

The pressure transmitter is used for accurate measurement of vapour pressure. The pressure transmitter is available in different pressure ranges, and comes with a local display and a 3-way control valve for easy maintenance.

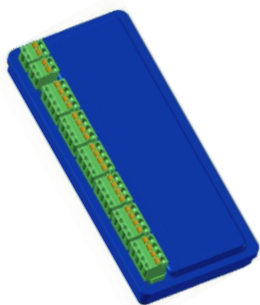


Figure 6: Temperature transmitter GC-306



Figure 7: Temperature- and pressure transmitter cabinet installation



Figure 10: Pressure transmitter with display



Figure 11: Control Panel 12" touch screen computer

### Dual level gauge (2-in-1)

When redundancy and system integrity are considered important, and physical size and limitations of tank penetrations are a challenge, KONGSBERG offers a dual level gauge, where one sensor head provides two independent level gauges through one tank penetration. The two independent level gauges are connected to dedicated signal processing units through separate cables from the control room cabinet.

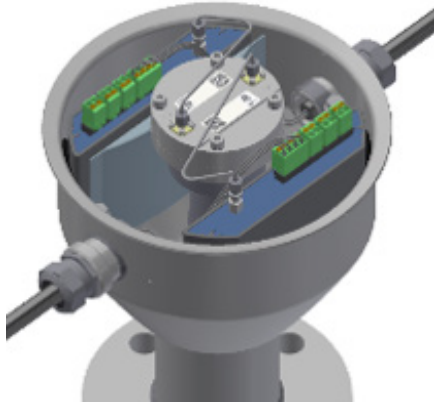


Figure 13: Dual radar level gauge (2-in-1)

### Independent Tank Overfill Protection (TOP)

KONGSBERG offers a separate radar level gauge for independent level alarm detection. The independent level gauge is delivered with a short pipe assembled of two segments. In the flange between the two pipe segments is a reference marker (AutoCAL®), providing a fixed reference for the radar under all tank conditions. The reference is also used to allow the operator to do a function test of the alarm circuit from the Control Panel.

Each TOP radar is connected to its dedicated signal processing unit, and further to an independent Controller Unit holding the system software.

Level alarms are interfaced to Fuel Gas Supply System for high level alarm warning and activation of Filling Valve Shut.

## TOPOLOGY DRAWING

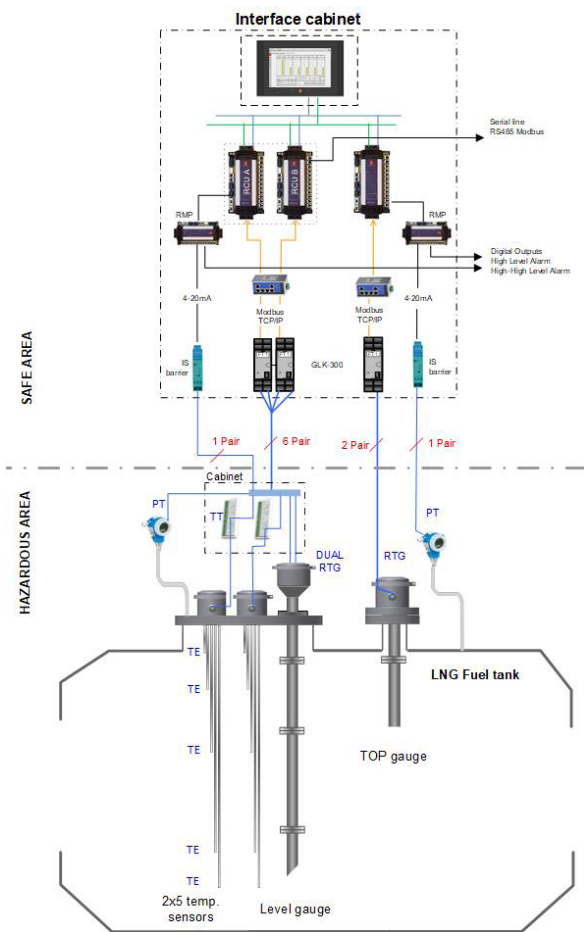


Figure 14: Stand-alone system topology (example)

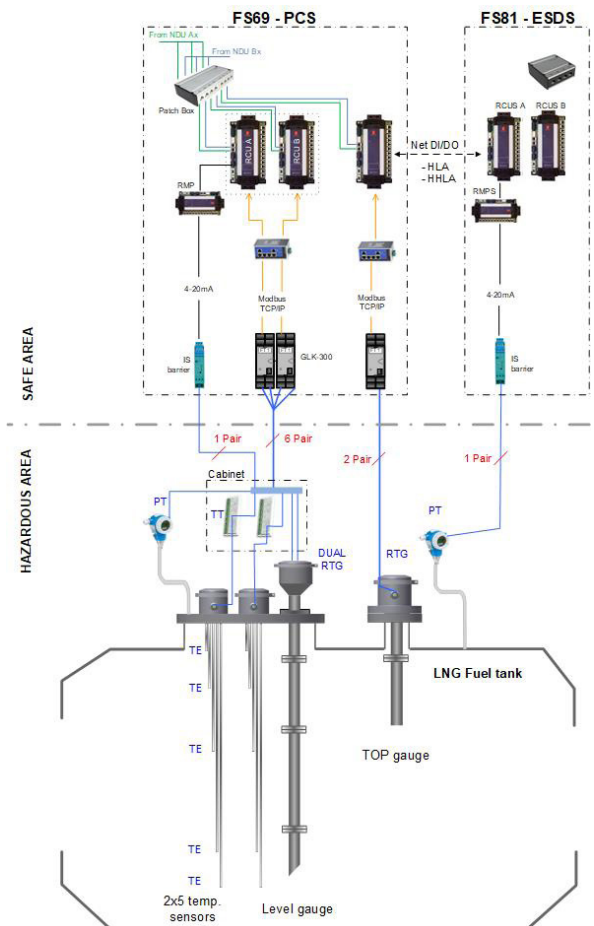


Figure 15: KM integrated FGSS system topology (example)

Specifications subject to change without any further notice.