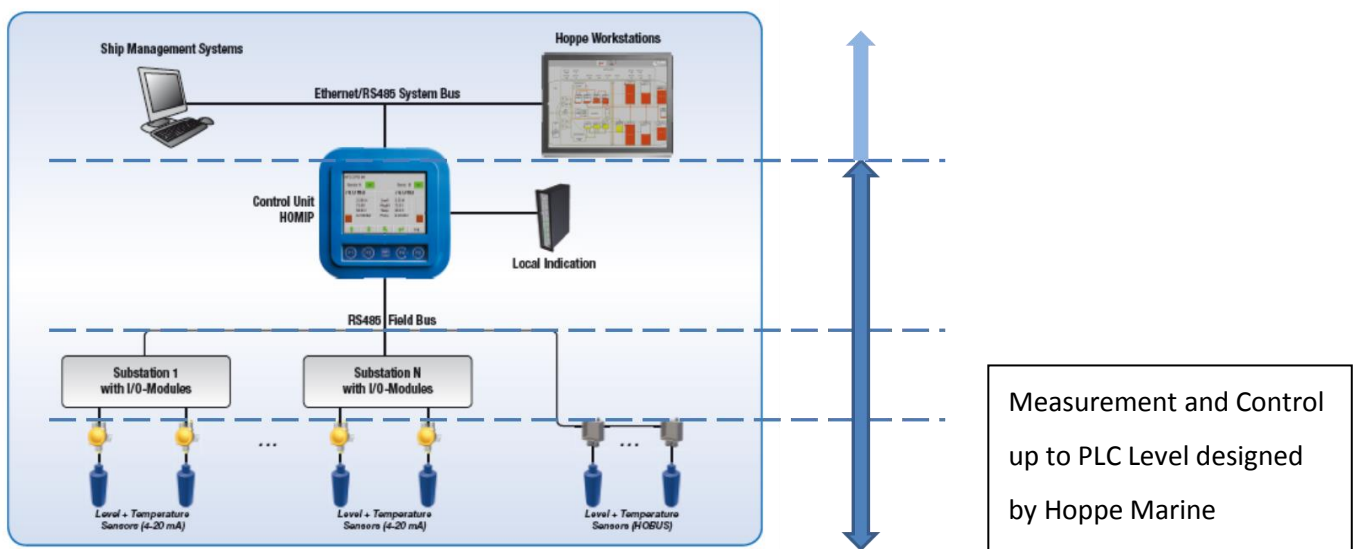


**SYSTEM OVERVIEW**

The Hoppe Marine Tank Content and Draught Measuring System with electric pressure type sensors type HCG (Hoppe electric pressure type TCDM system) is the state of the art solution for continuous monitoring the content and temperature of ballast, fuel, liquid cargo and other tanks on board of all types of ships and offshore installations. The same sensors are used for precise measuring of the vessels draught. The Hoppe electric pressure type TCDM system combines high precision and operation reliability with a unique sensor and tank data tracing approach, which allows on board and remote diagnostics and trouble shooting and is thus minimizing spare parts and ownership cost (OPEX).

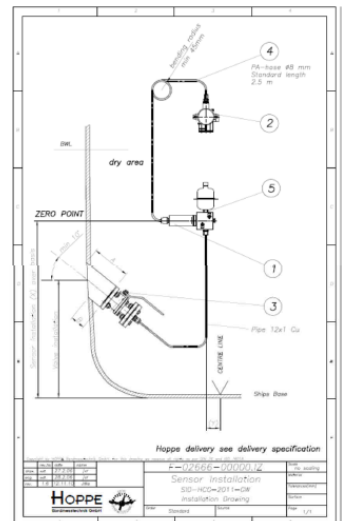
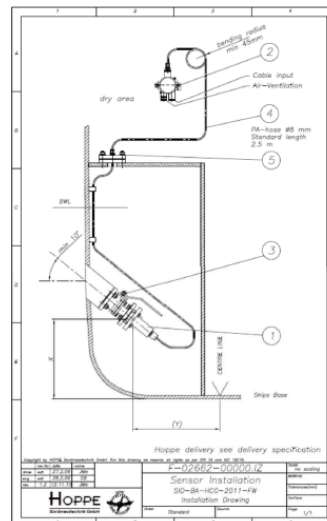
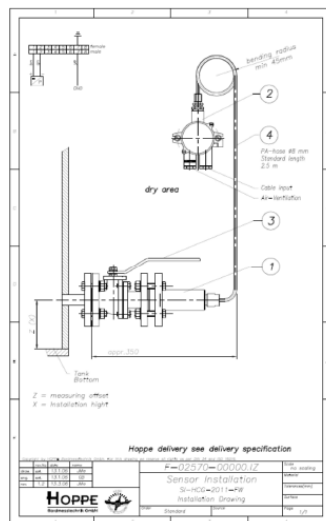
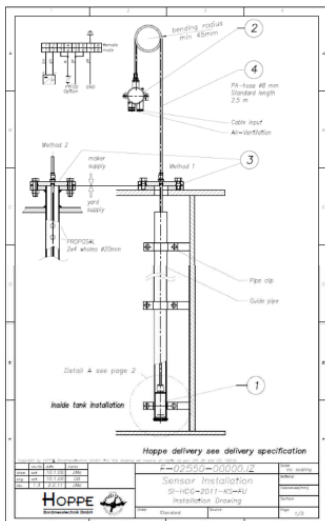
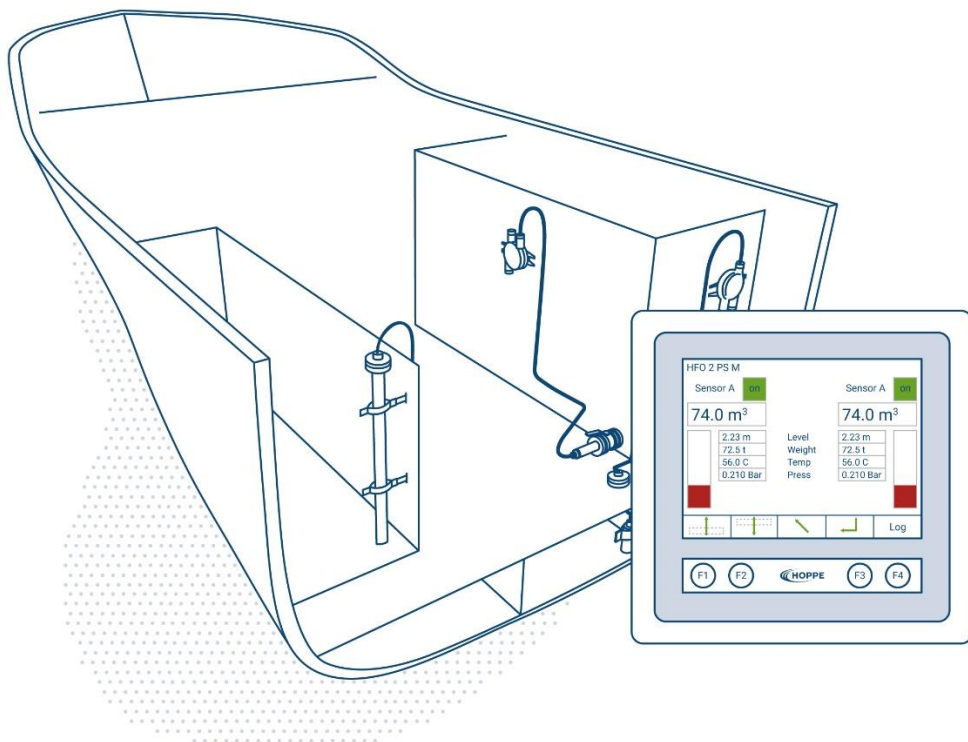


The Hoppe electric pressure type TCDM system has been developed according to the Hoppe “Vertical Responsibility Concept”. All relevant system components, from PLC unit to sensors, are designed by Hoppe and supplied by “one hand”, which is a substantial advantage for the ship operator. The interfaces between the components are standardized and adapted for a wide range of different configurations. Hoppe Marine takes the full responsibility for delivering trim corrected real tank content data (masses, based on shipyard’s tank data), not fluid level information only. No further data processing of sensor output is necessary. Also, the HCG pressure type sensors is not influenced by “cappuccino effects” and can determine the tank content mass without measuring fluid density in all prismatic or almost rectangular tank shapes.

The Hoppe electric pressure type TCDM system can be arranged in several substations which are linked by field bus to minimize cabling, depending on the sensor positions. All data handing and processing is performed by Hoppe’s in-house developed PLC unit HOMIP. The HOMIP has an integrated touch screen display, which offers a clearly structured interface for system configuration, parameter settings and back-up operation. The HOMIP provides online bus data connections (Ethernet or RS485 interfaces) to main ship automation and control system (AMS), loading computer as well as to Hoppe’s computer

workstations for visualization and optional software features. For local / console indication bar-graph indicators to display the real tank contents are available.

The Hoppe electric pressure type TCDM system bases on Hoppe Marine's electric pressure type sensors type HCG, especially designed for robust and long term operation in challenging marine environments. They are well suited for both, tank content and draught measuring. The sensors can be arranged in different configurations, e.g. mounted outside the tank in the side wall (designs "FW" and "GW") or inside the tank e.g. in a guide pipe from the tank top (design "KS"). For draught measurement the sensor is mounted inside the ship, on an outer shell penetration together with a welding block / ball valve unit (designs "FW" and "GW").

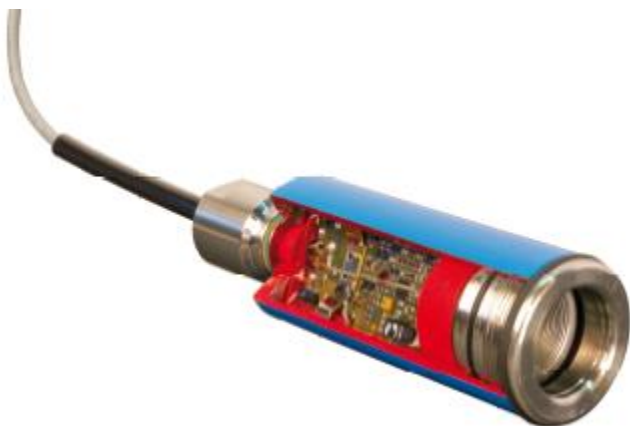


## HOPPE MARINE'S ELECTRIC PRESSURE TYPE SENSORS TYPE HCG

Hoppe Marine's electric pressure type sensors type HCG are especially designed for robust and long term operation in challenging marine environments.

The sensors measure the hydrostatic pressure in the tank or in the surrounding water at the draught measuring point using the piezo resistive sensor principle. All sensors include a microprocessor chip for very high resolution and accuracy, by eliminating the individual temperature and other individual error curves of the sensor allowing a measuring accuracy better than 0.3% of the measuring range.

The sensors are properly designed to protect the electronics against medium ingress, incrustation, fouling and overpressure. A titanium membrane and a powder coated stainless steel (optional titanium) casing prevent the sensor from corrosion. Hoppe therefore performs continuous failure product improvement based on operation experiences and failure analysis.



The HCG 2011-MO4 sensor provides a standard 4-20 mA analogue signal and allows customized measuring ranges from 0-2500 mbar as standard version. For special applications a 0-4000mbar version is also available. The HCG 4011 sensor series provides a digital serial bus connection to the Hoppe PLC unit HOMIP.

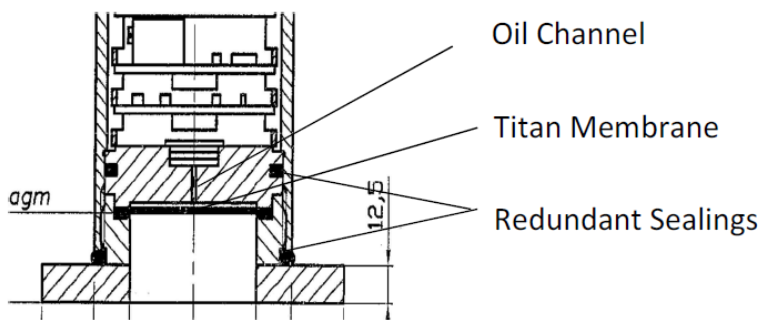
All HCG sensor types can be easily dismantled for inspection by disconnecting the cable screw plug interface, which is a unique Hoppe feature. For easy installation special sets of fitting parts are provided.

## COMPARISON OF DIFFERENT SENSOR TYPES FOR TANK CONTENT AND DRAUGHT MEASUREMENT

### Pressure type sensors:

Commonly used electric hydrostatic pressure type sensors are of a ceramic cell type. A major disadvantage of the ceramic cell concept is the direct connection of the measuring cell with the fluid environment. Thus limestone sediments can occur which will harm the measuring results of the ceramic cell sensors. Furthermore only one sealing level is possible for the ceramic cell sensor type, which also increases the failure risk.

Hoppe Marine's HCG sensors use the piezo resistive element concept. This concept allows a separation of the measuring cell and the membrane that is in contact with the fluid. The hydrostatic pressure is transferred to the measuring cell via an internal oil channel. Therefore Hoppe can provide a redundant radial sealing in- and outside of the membrane.



Section view of a Hoppe Marine HCG pressure type sensor

### Pneumatic type sensors:

Pneumatic ("air bubbling") sensors can be installed in a cabinet outside the tank, to which it must have a pipe connection. Therefore pneumatic sensors do not need as much protection as pressure type sensors. This makes an air bubbling system usually cheaper compared to an electric pressure type system. However, due to the higher installation costs for the air piping system the electric pressure type system cost are more advantageous. Compared to pneumatic sensors a major advantage of electric pressure type system is the much higher accuracy. Please note that Hoppe Marine is also supplying Tank Content and Draught measuring systems based on pneumatic (air bubbling) sensors.

### Other sensor types:

Radar or ultrasonic sensors are further an alternative solution for accurate tank level reading ("ullage"). However, they only provide a level indication (no content) and are much more complex and expensive than hydrostatic sensors. For this reason both sensor types are not commonly used for tank content and draught measuring, except radar for oil and dry cargo level measuring from the tank top.

## CONTINUOUS PRODUCT IMPROVEMENT: HOPPE MARINE'S SENSOR & TANK LIFECYCLE TRACING APPROACH

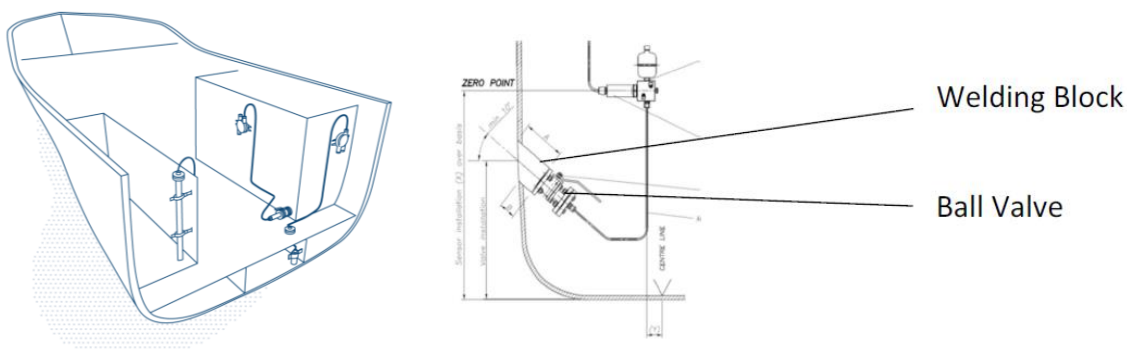
An important factor in Hoppe's leading position in the field of Tank Content and Draught Measuring is the Sensor & Tank Lifecycle Tracing. Hoppe's data base includes all sensor and tank data for all vessels equipped with Hoppe's electric pressure type TCDM system and is an important element of continuous product improvement and customer support.

This unique data base allows comprehensive operation and failure analysis as well as performance optimization measurements. For a vessel's lifetime it can be traced which sensors were programmed to measure in which tanks and did operate for which period of time. If received via return of defect sensors (or via e-mail by using the onboard analysis tool kit HOSET 2.0, see options below) failure codes can be traced as well. By such an analysis, certain operational or installation issues on board a vessel can be identified and improved, in order to reduce sensor exchange / spare part costs (OPEX).

Regular careful failure analysis based on returned, damaged sensors (or failure codes submitted using HOSET 2.0) with consideration of their operation environment widens Hoppe Marine's experience base and supports our continuous research and product improvement for all kinds of marine applications. With this continuous improvement program Hoppe Marine drastically reduced the sensor failure return rate from ships in operation in the last years (below 5% of all delivered sensors).

## HOPPE MARINE'S SPECIAL EXPERTISE IN DRAUGHT MEASURING

The draught measuring function is usually provided as a part of the tank content measuring system. The draught sensors and their signals are the same as of those for tank content, but the installation solutions and the signal data processing (further computation steps) are different.



Hoppe Marine has developed a smart solution for draught sensor installation: The safe and robust Hoppe welding block / ball valve unit at the hull penetration allows a very cost efficient installation and service. It enables reliable measuring results during operation by minimizing unwanted effects as for example air trapping, sediments sticking as well as avoiding mechanical damages.

Draught indication is sensitive, dependent on the determination of the correct sensor coordinates and influenced by external factors such as ship hull accuracy and speed (pressure type sensors as such are

usable for static draught / at very low or zero speed). The Hoppe draught measuring (TCDM) results can be processed in combination with data provided by other Hoppe systems such as Electronic Inclinometer and Dynamic Floating Monitoring System (measurement and recording of dynamic trim, squat + motion).

## SUMMARY OF ADVANTAGES OF THE HOPPE ELECTRIC PRESSURE TYPE TCDM SYSTEM

- **For the shipyard:**
  - Ship Price / CAPEX: Hoppe electric pressure TCDM system is a very competitive system for tank content and draught measuring, even against the cheaper pneumatic air bubbling systems, if all related system and installation costs are taken into account.
  - Ship Price / CAPEX: low installation costs at the yard by using the smart substation concept for HCG 2011/4 type or by using HCG 4011 serial bus type (minimization of cables / installation).
  - Engineering / Project Management: Complete package provided by Hoppe Marine, no interface problems between makers of sensor and automation system (and no discussion between them in case of malfunction), since overall responsibility for signal measuring, transfer, processing and content / draught indication is taken by Hoppe Marine.
- **For the ship owner / operator:**
  - OPEX / Cost of ownership: low costs of ownership due to sensor reliability (piezo resistive principle, double sealing, titanium membrane and (optional) casing, etc.), low failure rate of improved product generations, comprehensive data analyzing support for improvement during vessel life time (service partnership can be even formalized) and easy dismantling / mounting of sensors without the need to touch cables (screw plug at sensor casing). The On Board Sensor Analysis and Calibration Toolbox HOSET 2.0 opens even more savings (see upgrade options below).
  - Operation / Reliability: Hoppe HCG sensors as well as Hoppe HOMIP data processing features can be combined to provide leading edge measuring reliability and accuracy in marine business. Hoppe Marine provides real tank content data (trim corrected), not only level gauging. This in particular becomes more and more important with upcoming performance monitoring tasks.

## REFERENCES

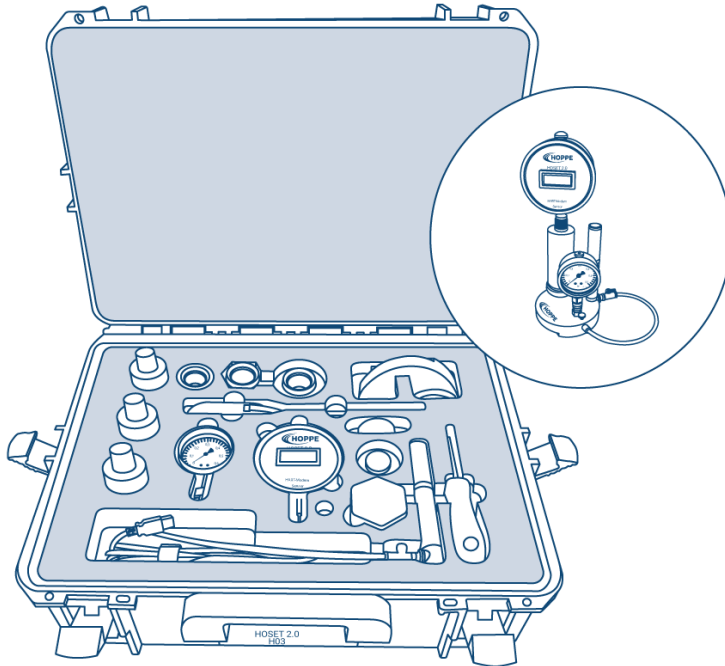
Hoppe is supplying the maritime market with HCG sensor series since more than 20 years. More than 150.000 sensors are in operation on board of more than 2.000 vessels. The Hoppe electric pressure type TCDM system has been supplied to most of the major shipbuilders around the world.

Major ships owners and operators using HCG sensors, including Hapag-Lloyd, Maersk Line, CMA CGM, Hamburg Süd, UASC, Hyundai Merchant, Hanjin Shipping, Peter Döhle, NSB, E.R. Schifffahrt, Rickmers, Leonhardt + Blumberg and many more.

## UPGRADE OPTIONS FOR HOPPE ELECTRIC TCDM SYSTEM

- **On Board Sensor Analysis and Calibration Toolbox HOSET 2.0**

In pursuit of its sensor lifecycle tracing approach Hoppe Marine has developed the Sensor Toolbox HOSET 2.0 for smart on board sensor handling.



The Sensor Toolbox HOSET 2.0 contains tank data and Levelcom software, a HART modem with USB connector, a battery pack and a connection cable, sensor / HART adapters and adapter tools and also 3 spare sensors.

The Sensor Toolbox HOSET 2.0 enables easy on board zero point and parameter settings as well as sensor failure checks to support the decision for necessity of spare sensors. We have noted from analyzing returned sensors that 20-30% of the sensors, which were considered as damaged by the crew, are in fact still usable after check and possible re-tuning. The sensor toolbox allows the crew on board doing these checks and eventual re-settings easily and thus enables substantial savings in spare parts costs.

The Levelcom software is equipped with all relevant tank data information of the vessel. This information is used to automatically parametrize new sensors for the defined installation point. No manual data input is necessary, thus avoiding individual failures. The analysis and setting results shall be sent via e-mail to Hoppe Marine and will be imported into Hoppe's sensor database, where each delivered sensor including its actual location and lifecycle data is listed.

- **Bunker Safety System**

A valuable extension to Hoppe's Tank Content Measuring System is a Bunker Safety System according to class requirements.



The system provides “High” and “High-High” alarms with visual and acoustic warnings for bunker and storage tanks, the alarms are provided on an indication panel in the ECR as well as locally in robust cabinets to be installed at bunker stations. The advantage of combining with Hoppe electric TCDM system is the usage of sensor signal for one level alarm. The other alarm is provided by separate level switch to ensure class requirements of redundancy.

- **Temperature Monitoring and Control System**

A continuous temperature monitoring function for each tank including high + low alarms can be provided as well as temperature control signals and temperature signal controlled valves (in connection with Hoppe VRC), applicable e.g. for heating control of HFO storage tanks or ice alarm / heating of ballast water tanks.

- **Floating Dock Monitoring**

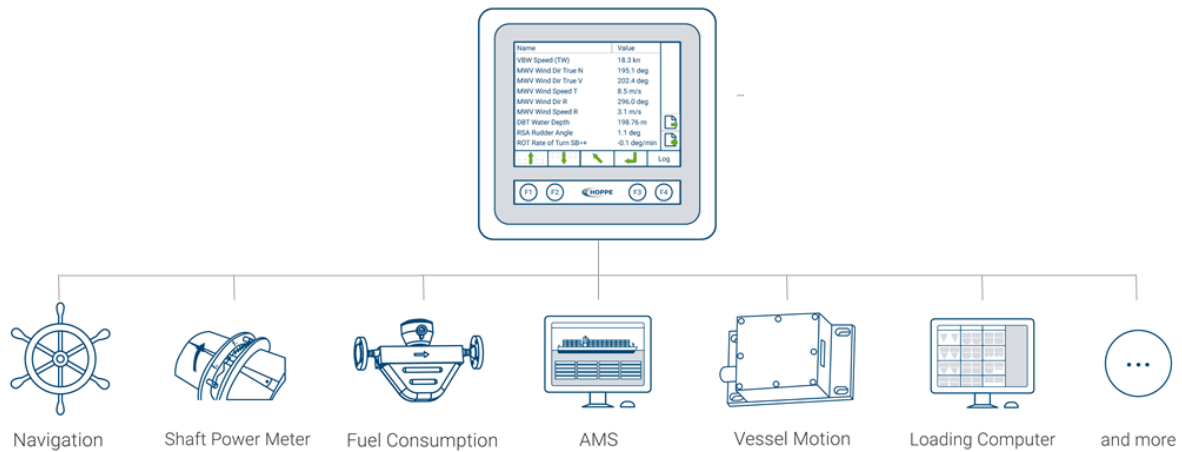
The Hoppe electric pressure type TCDM system is also used for monitoring and control of actual floating (trim, heeling), bending and torsion condition of floating docks, ensuring safe floating dock operation by the dock master. The sensors are used in a special installation arrangement working similar to the water level. The accuracy of sensors and the system allows detection of bending effects below 1 cm. The precise information can be furthermore used in connection with the Hoppe Marine Dock Control System allowing automated dock control in various steps.



**Bunker Management System**

Hoppe Marine has developed a sophisticated Bunker Management System which continuously monitors the actual Tank Content System information for all tanks of the fuel system and thus enables a detailed recording of all bunker intake and transfer processes. Hoppe’s HCG pressure type sensors are not subject to misleading readings influenced by “cappuccino effects”, they can determine the real fluid mass content in the tank without measuring fluid density, in all prismatic / almost rectangular tanks (for curved-shaped tanks respective correction factors are applied).

The Bunker Management System further allows fuel flow and energy balance studies if linked with Hoppe mass flow meters and the MAIHAK Performance Monitoring System.



**Bunker Management reporting example:**

**Bunker Tank Content Summary**

	Content	Intake	Content
HFO 1	1.184 t	0 t	1.184 t
HFO 2	13 t	1.493 t	1.506 t
HFO 3	14 t	0 t	14 t
HFO 4	11 t	0 t	11 t
HFO 5	3 t	1.549 t	1.552 t
LS HFO 1	283 t	0 t	283 t
<b>Summary</b>	<b>1.508 t</b>	<b>3.042 t</b>	<b>4.550 t</b>

**First Bunkering**

Tank 2	13 t	1.493 t	1.506 t
Tank 5	3 t	1.549 t	1.552 t

**Tank Content**

Settling Tank	190 t
Service Tank	183 t

