Accurate Fuel Consumption Metering on Vessels

Nautisch Technischer Inspektorenkreis 04.04.2017 in Hamburg

Our structure

Klaus Endress, President of the Supervisory Board of the Endress+Hauser Group

The shareholder family

- Business in sole ownership of the Endress family since 1975
- Founded in 1953 by Georg H Endress and Ludwig Hauser
- A charter settles the relationship between family and company

Our offering

We provide sensors, instruments, components and systems for tasks in the field of

- Level measurement
- Flow measurement
- Pressure measurement
- Temperature measurement
- Analytics and sampling
- Data management
- Device communication and integration

Our offering

Our range of services increase availability of our customers' plants and
improve process and product quality

- Commissioning
- Operation
- Maintenance
- Calibration
- Repair

Our structure

- Holding company in Reinach, Switzerland
- 26 production facilities in 12 countries
- Sales centers and representatives in more than 125 countries
- Regional sales support centers

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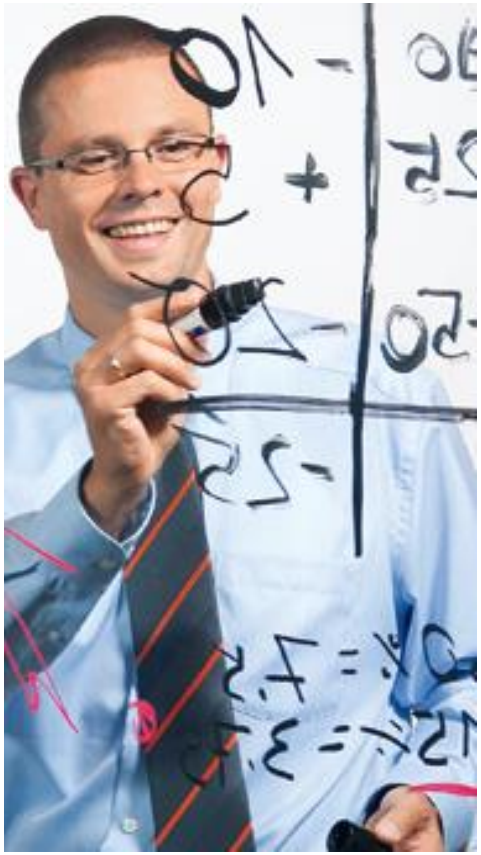
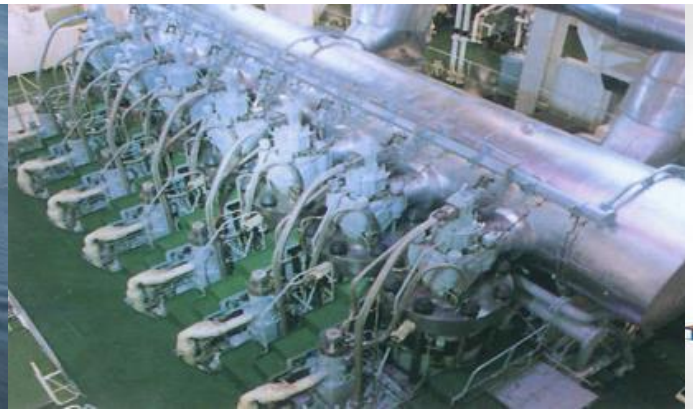
Our figures 2015

- Net sales of 2.1 billion euros
  ...a strong partner
- 12,952 employees worldwide
  ...a reliable employer
- Net income of 165 million euros
  ...economically successful
- Equity ratio of 73%
  ...solidly financed
- Investments of 166 million euros
  ...future-oriented
- 6,500 patents and patent applications
  ...innovative and creative



Marine Fuel Solutions

Accurate and long-term reliable
Fuel Consumption Metering



Why fuel consumption metering?

The need of todays Fuel Metering Systems are driven by:

- Rising fuel prices
- Rising environmental requirements
- Rising demand of efficiency improvements
- CO2 footprint

Consequently the Fuel Metering System has to detect precisely

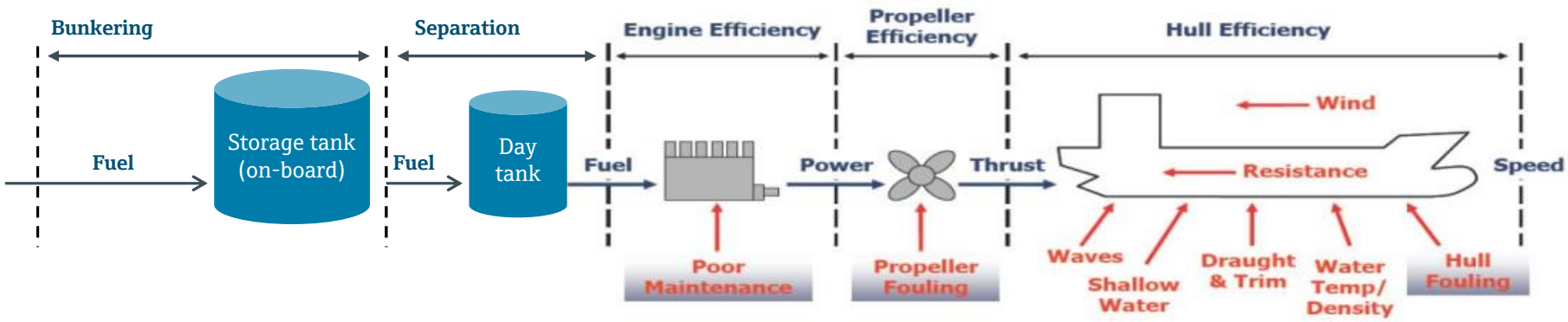
- How much fuel is actual consumed
- How much fuel was used in the past

Why fuel consumption metering?

- To fulfill the different regulations:
- EEDI (Energy Efficiency Design Index) - CO2 Emission pro Transport Work - IMO regulation
- EEOI (Energy Efficiency Operational Indicator) - Fuel Efficiency Monitoring – optional, possible reduction of harbor costs
- SEEMP (Ship Energy Efficiency Management Plan) – IMO Regulation – conteniously improvment is mandatory
- MRV (Monitor Report Verify) - EU regulation

Bunker and Fuel Consumption Metering on vessels

- Bunker Metering
  - How much will be purchased and paid? How much came onboard?
  - Saving potential: up to 3% due to inaccurate sounding and calculation on barges as well as the supply of aerated fuels
- Fuel Consumption Metering
  - How much is consumed onboard by different consumers?
  - Saving potential: up to several % due to efficiency improvments for engine operation and hull performance



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Today - Difficulties in Fuel Consumption Metering

- Bunkering in mass (mT) but consumption metered in volume (ltr)
- Manual data collection and manual calculation to mass
- All shipyards use simple mechanical meters
  - for them the flow meter is a “piece of pipe”
  - The fuel meters are not placed and installed for high accuracy
- High drift in accuracy through wear
  - Abrasive wear through CAT fines and dirt → strainer required
  - High flow pulsation will increase the wear → pulsation damper required
  - Corrosion through low quality fuels
- With the same meter we have to measure different fuels
- Different type of fuel concepts means added errors of flow meters (volumetric)

Optimization potentials – Simple rules

- Optimization of fuel consumption → monitor all parameters which have an impact on fuel consumption and make them transparent
- Transparent monitoring → all fuel related parameters have to be measured
- Measurement → most accurate sensors must be used
  - Direct mass metering
  - In differential metering high-accuracy meter (0.1%)
  - Check quality parameters like density

Today - Typical fuel consumption meter installation

- For this type of installation a bypass is always required
- In some case a blocking of the flowmeter causes a black out of the engine
- By using Corriolis Massmeters no Filter and Bypass is required

Today – Typical shipyard installations

Volumetric flow meters

Life time of bearings are dependent of speed and temperature

High wear of vanes/inner parts

- Break often
- High inaccuracy after a while

280 mesh strainers required

- Much higher pressure loss
- cleaning intervals!

No temperature compensation

- Easy errors of up to 2% only on the thermal expansion factor

Expensive signal conversion

- Pulse multiplier
- Pulse to 4-20mA converter

Promass 100 = Full Performance on smallest footprint

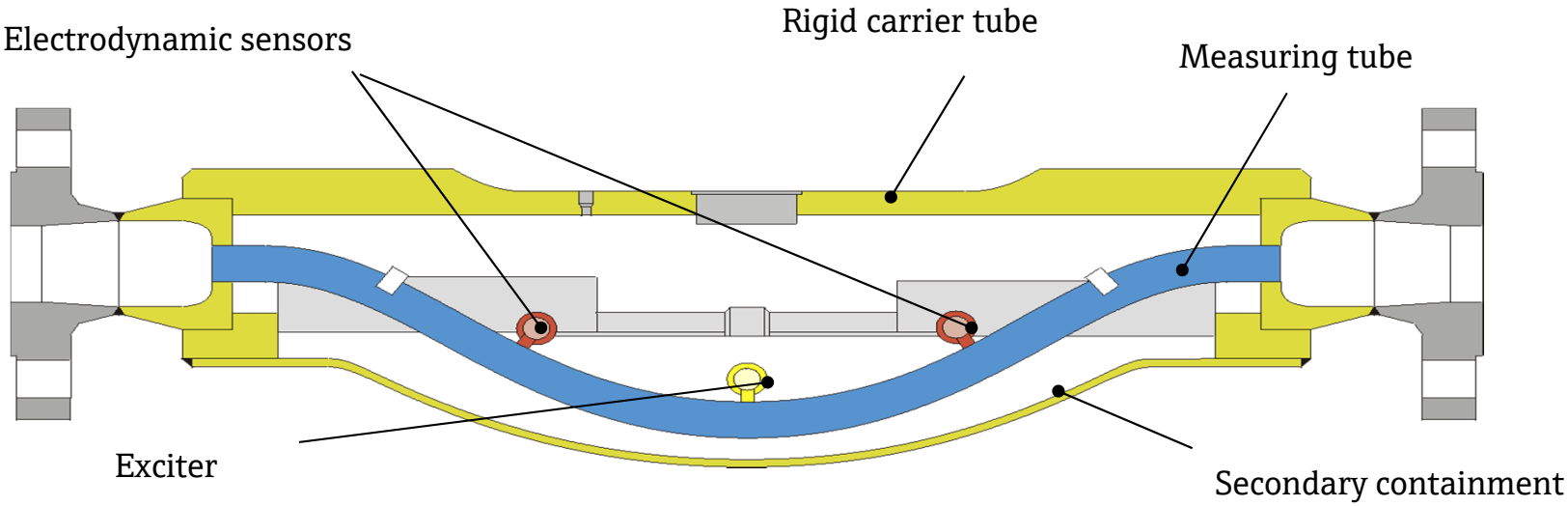
NOTE:
The Promass 100 transmitters are available on all sensors

Benefits

- **Ultra compact design**
  - Easy skids integration with IP69K rating
- **Full functionality and performance**
  - Multi variable / Advanced feature packages / Diagnostics
- **Seamless system integration**
  - Reduced complexity

Housing	Coated aluminum, stainless steel, stainless steel ultra-compact
Size	(Aluminum housing) 135 mm × 140 mm, (stainless steel ultra compact) 110 mm × 140mm
Accuracy	Massflow 0.1% (0.05% PremiumCal)
Outputs/System integration	Modbus RS485, EtherNet/IP, 4 to 20 mA HART, pulse/freq./stat., PROFIBUS DP
Display	No display (commissioning via web server or digital bus)
Hazardous area approvals	Zone 2; Cl. 1 Div. 2 / Zone 1; Cl. 1 Div. 1 (Modbus only)

PROMASS features....sensor design



The rigid carrier tube withstands all loads in a piping system, allowing for true “Fit and Forget”.

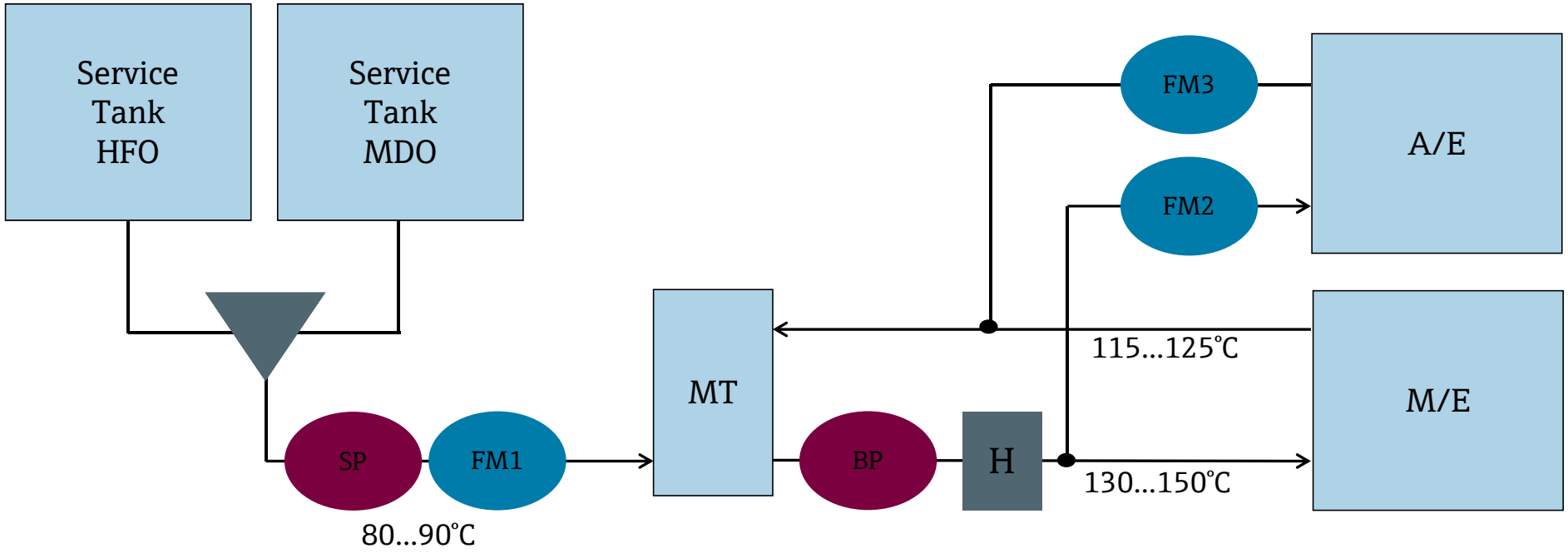
No extra measures like pipe line support needed.

No restrictions on pipe mismatch.

Conclusion – PROMASS offers...

- Direct mass measurement
- Density measurement
- Two totalizers – one for HFO, one for MDO/MGO
- between 3...5 times higher accuracy than volume meters
- No wear guarantees long-term stability
- Diagnostic features show drift and re-calibration
- Insensitive to pulsation/vibration
- No strainer or filter required
- No PRV in by-pass required
- Open interfaces for seamless ship monitoring integration

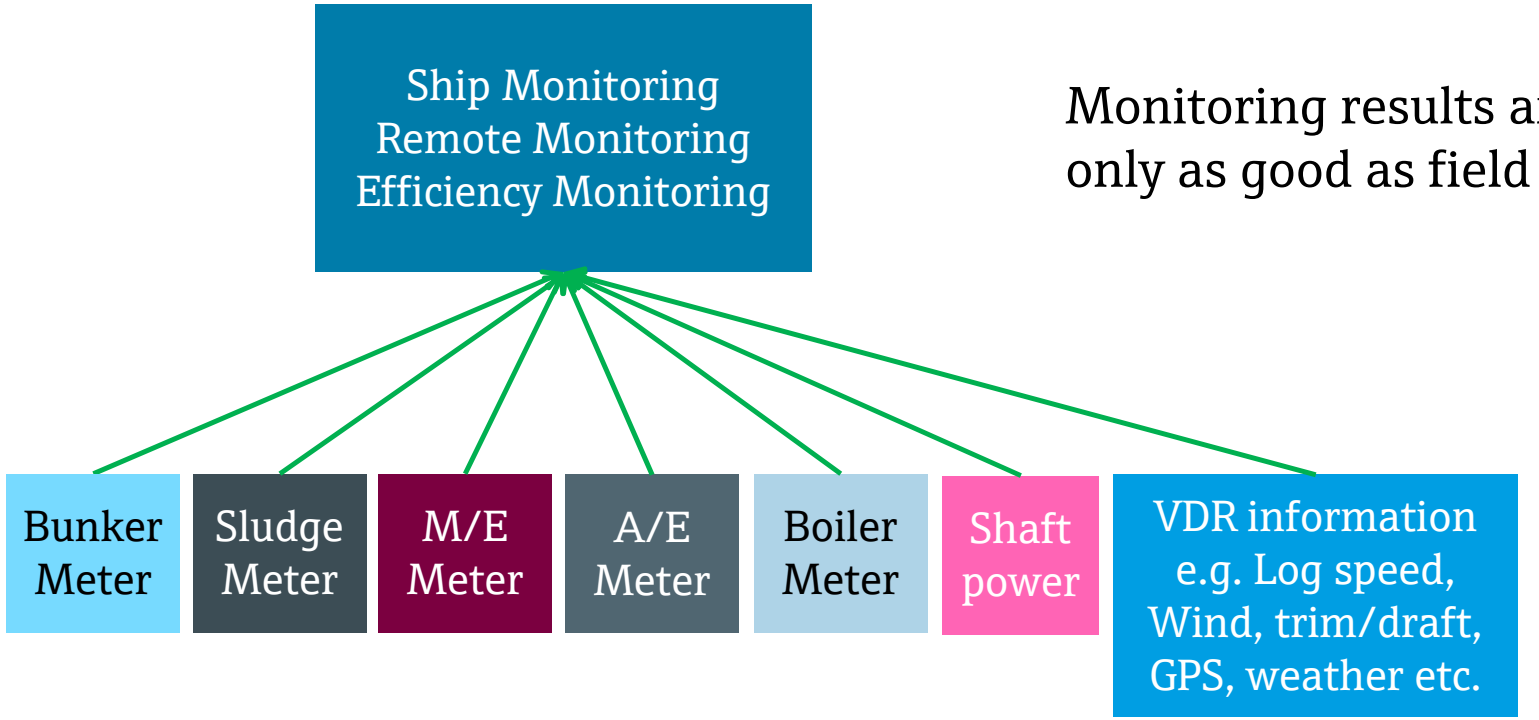
Shipyard installations – typical system



M/E = FM1 – (FM2-FM3)

A/E = FM2-FM3

Optimization potentials – Simple rules

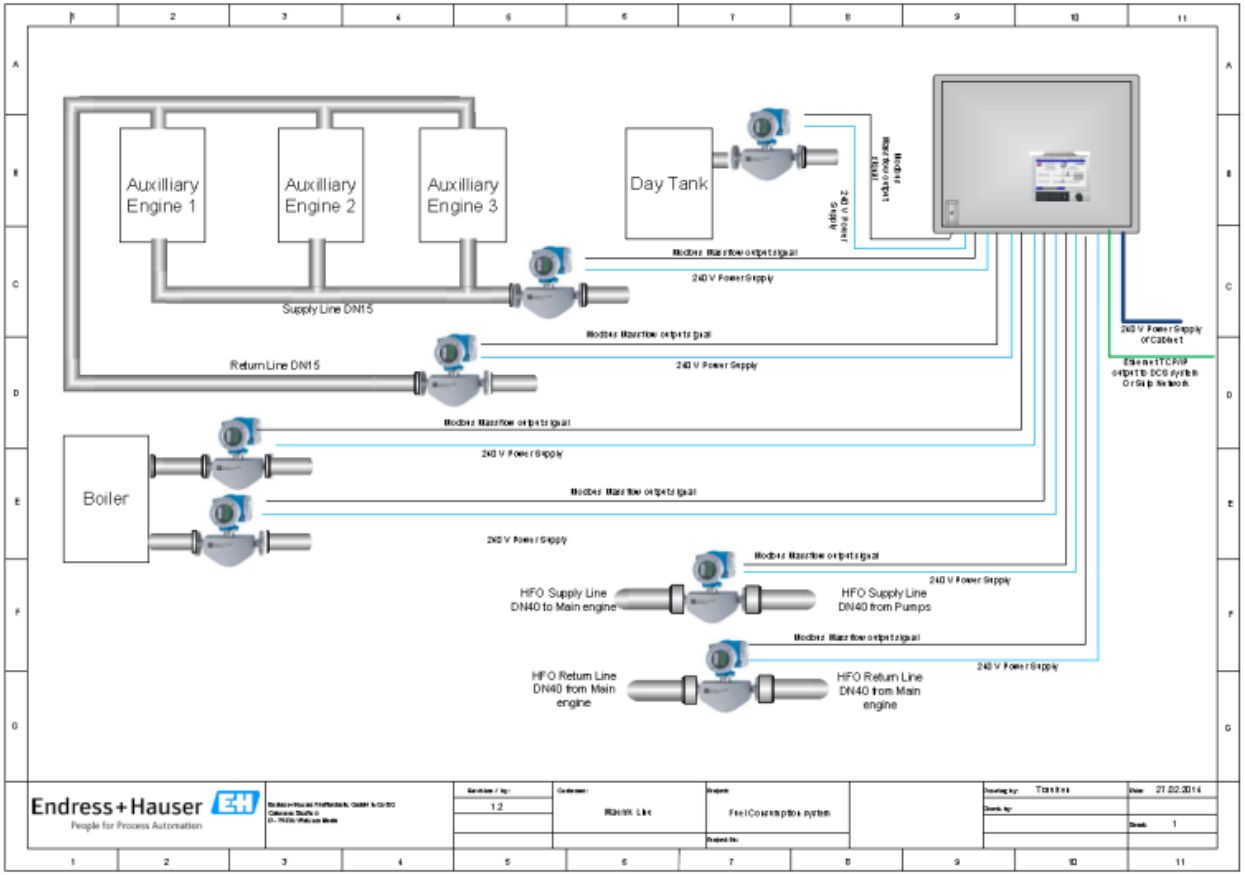


Monitoring results are only as good as field results

Optimization rules

1. Parameters need to be monitored in a transparent way
2. Monitoring is only possible with measurement of optimization parameters
3. Measurement must be must accurate and long-term stable
4. Bring most important values in comparison to another quality parameter to define KPIs

E+H proposal of the Fuel consumption System



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Flowmeter installation for Fuel consumption metering Promass F 100

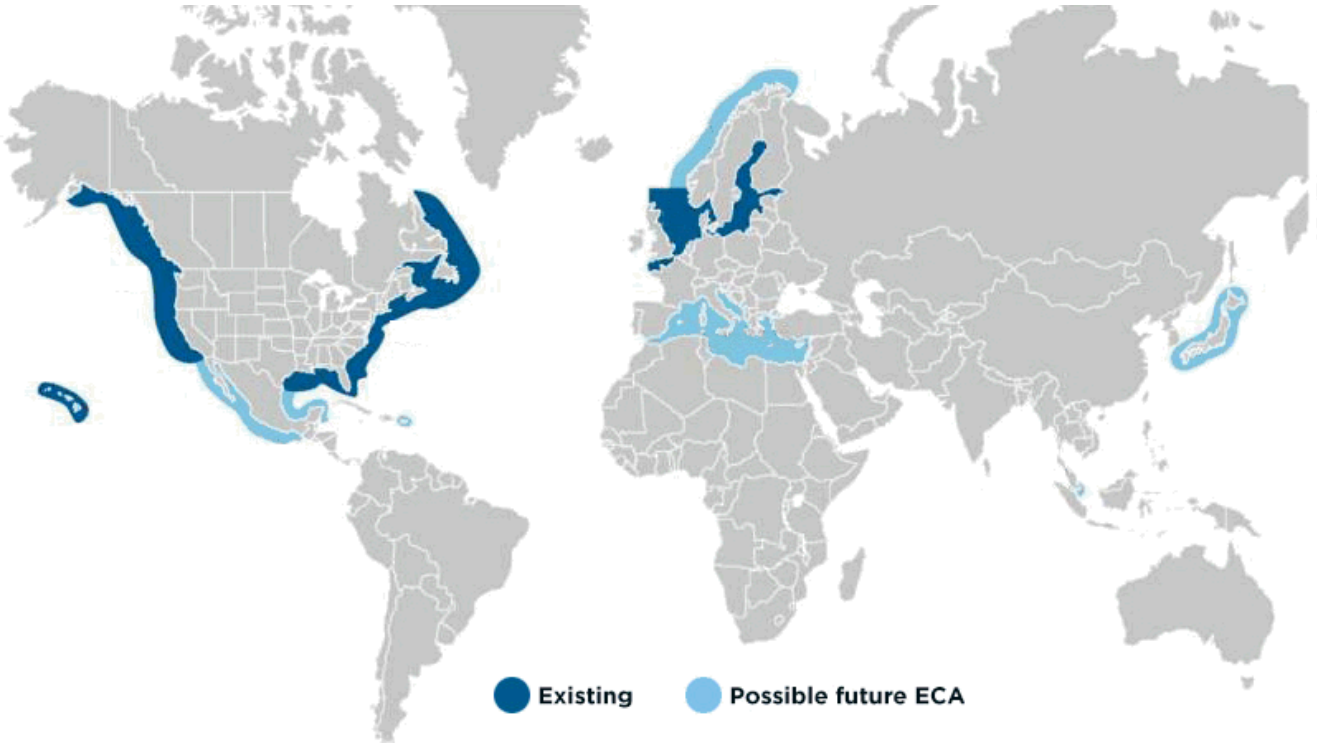
Boiler Inlet

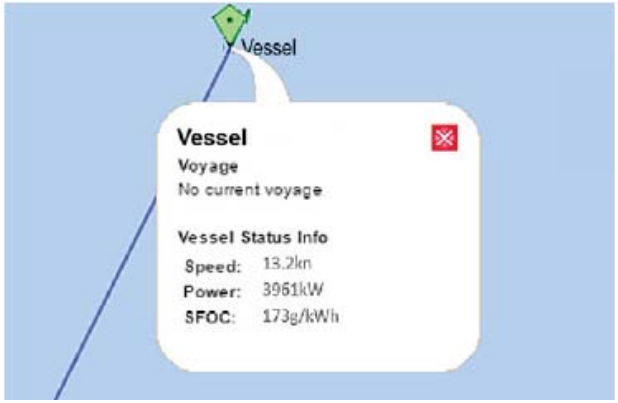
Supply line

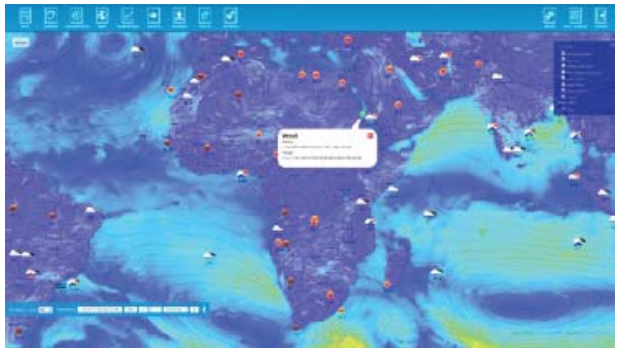
Drain Flow meter

Promass F 100 for Consumption

New marine regulation – SECA zones







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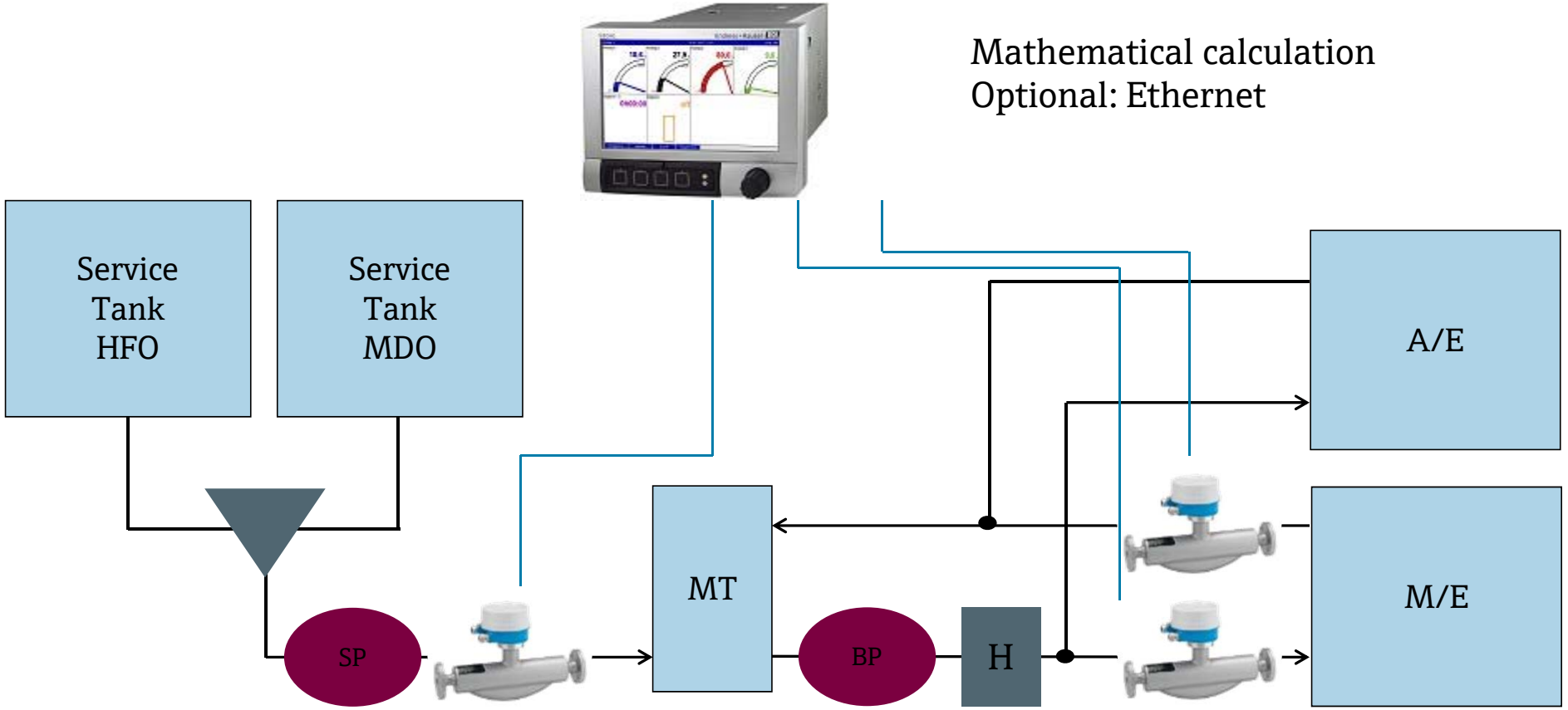
New marine regulations – Change in fuel system

- Vessel must operate with low sulphur fuel
  - LSFO has very low viscosity and must be cooled
- Change-over from HFO to LSFO is very critical
  - Today very often manually
  - M/E can only take a certain temperature change per minute
- As LSFO is much more expensive a mixing will be used more and more
  - So called Diesel Switch will be used
  - On high sea 100% HFO , in California 100% LSFO, rest mix
- New buildings will adopt immediately
- Existing vessels have to be converted

System integration – Stand-alone solution



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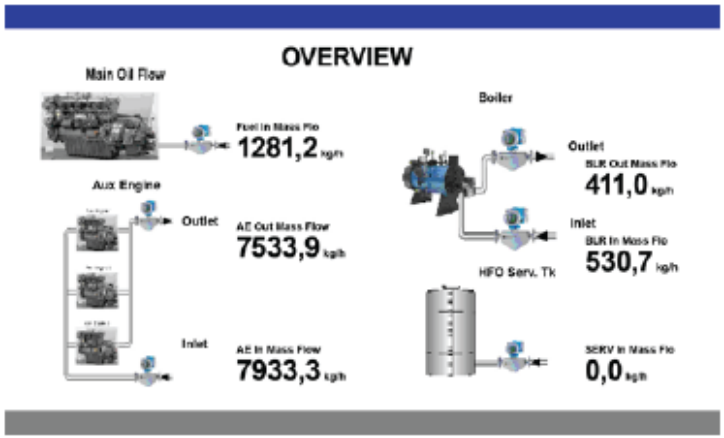

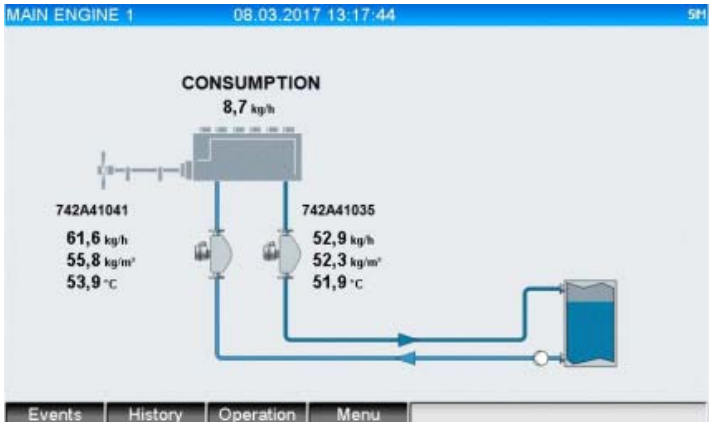

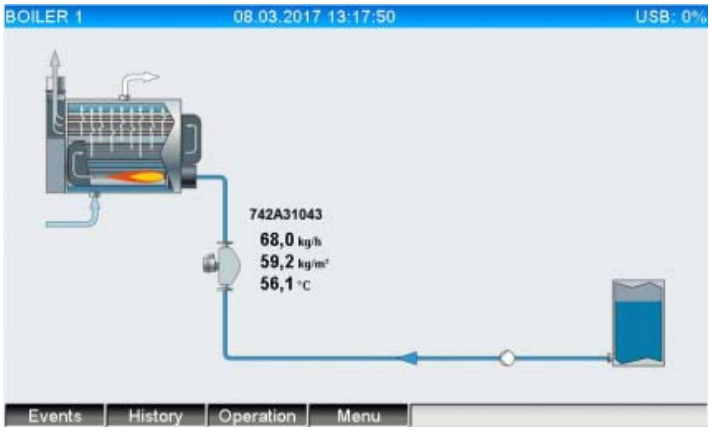

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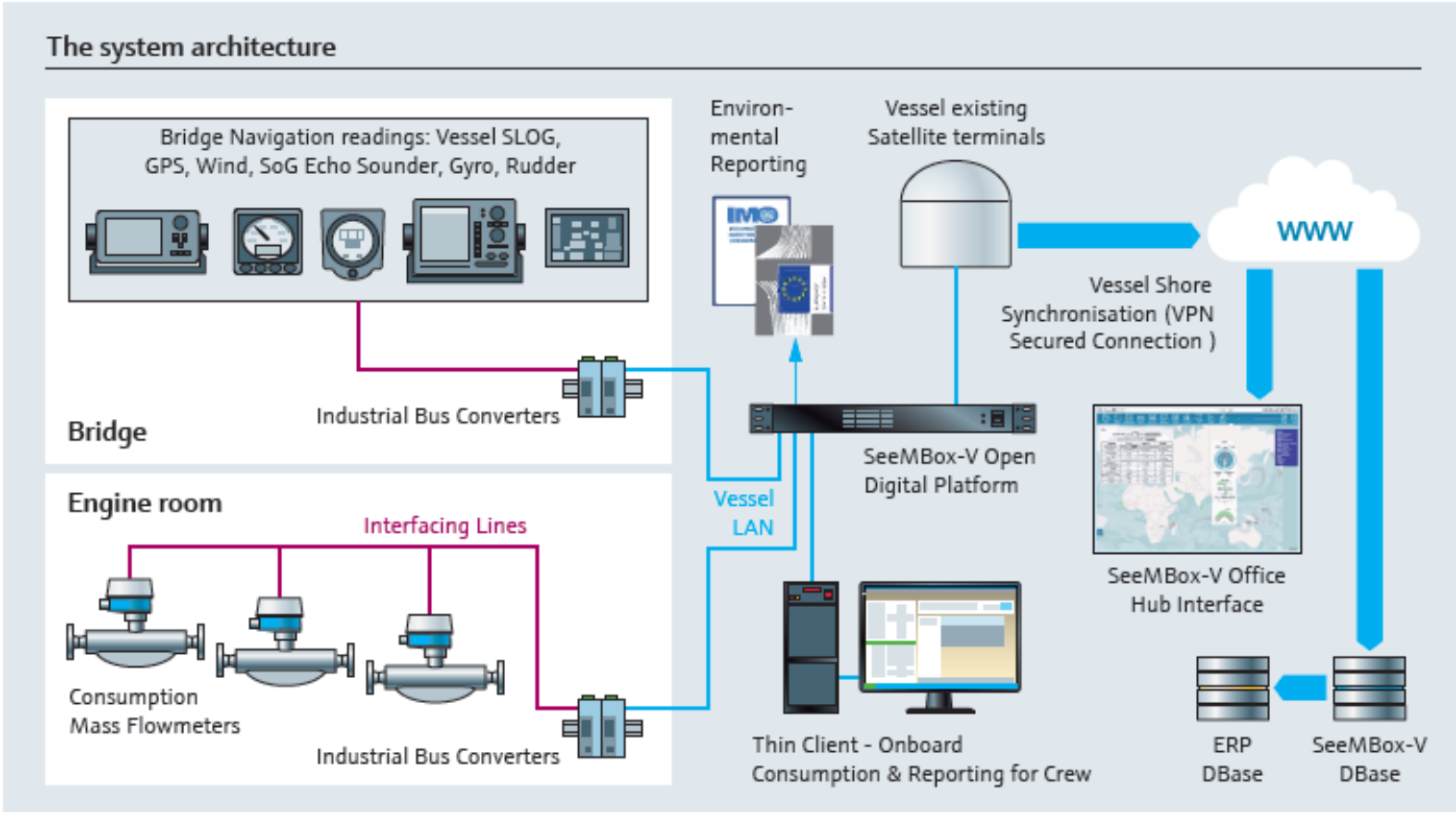
System integration – Remote Monitoring System



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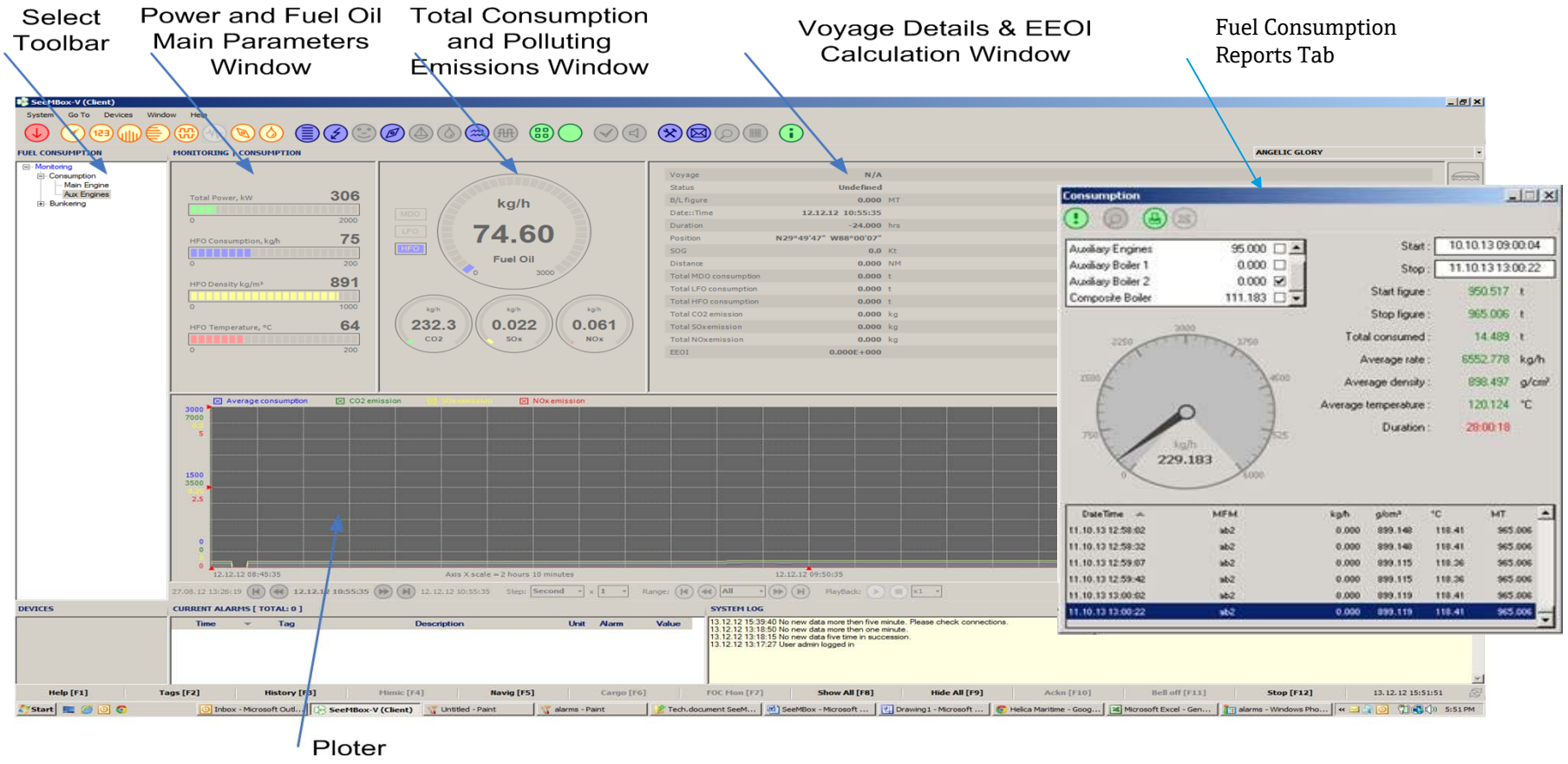
Office view



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Ship efficiency and performance System

- The Endress+Hauser Ship efficiency and performance Sytem provides the advantage of digital Transformation
- The consumption readings are combined with other automated readings (e.g. speed, position and distance) and the crew's manual entries on the monitored events(sailing, berthing, loading etc.)
- The system automatically produces the required MRV reports at the end of each period.
- The data is automatically transferred to the shore Head Office, thus allowing constant monitoring as well as analytical records on vessel's consumption and efficiency KPIs as required by the regulations.
- Automatic validation at entry minimizes human error mistakes and provides seamless and accurate reporting.

The solution is designed to accommodate any new forthcoming regulation that is bound to the fuel consumption such as the one expected from IMO.

Thank you very much for your attention