

4.1 ABB Ability™ Marine Advisory System - OCTOPUS

A sophisticated yet flexible advisory system is needed as the operators have become more environmentally conscious and need to comply with the IMO Greenhouse Gas strategy.

ABB Ability™ Marine advisory system OCTOPUS answers all the requirements of individual operators through the diversified marine segments. The OCTOPUS advisory system is a modular and lean architecture allowing rapid development of new features and seamless integration through ABB's solutions and services as well as industry standard cloud to cloud integration possibilities.

The wide range of OCTOPUS modules cover different aspects of fuel & energy optimization and maximize the safety and availability of individual vessels and the overall fleet by modules that forecast and monitor the vessels' motions and accelerations.

The OCTOPUS advisory system can be easily retrofitted or installed to a new building at the shipyard. Through industry standard interfaces data collection is seamless and easy to set-up.

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ABB Ability™ Marine
Advisory System - OCTOPUS

Benefits of OCTOPUS advisory system

- Short pay-back-time through data driven operations
- Comprehensive energy, fuel and efficiency monitoring and benchmarking tool
- Maritime industry's most trusted motion monitoring and motion forecasting system

ABB Ability™ Marine Fleet Portal – single platform for onshore monitoring and analysis

ABB has brought its marine offering under single cloud platform called the Marine Fleet Portal. Single access provides access to all information ranging from Azipod propulsion unit's bearing temperature, motion behavior, to Fleetwide overview on energy efficiency. The Marine Fleet Portal also includes all documents and tickets between the customer and ABB for improved and transparent communication.

ABB Ability™ Marine Fleet Portal – Fleet Intelligence

The latest edition within the OCTOPUS portfolio functions as an add-on towards the Fleet Portal. This module provides onshore insight and smart KPI's dashboards towards vessel and fleet performance, ultimately leading to increased fuel and performance efficiency. Intuitive charts and gauges visualize important performance characteristics and provide onshore staff with the right toolset to determine new criteria and room for improvement when it comes to optimization of fuel and energy and overall vessel performance.



5.1 ABB Ability™ Marine Advisory System - OCTOPUS

The common nominator for the OCTOPUS Advisory System modules is the significance of full scale and real time measurements.

ABB has developed algorithms using multidimensional non-linear regressions model methods to measure and interpret the vessel operations. The algorithms provide much more accurate results than for example Computational Fluid Dynamics (CFD) calculations or towing tank tests by taking the real operational profile and environmental conditions into account. Most of the OCTOPUS modules require a three-month learning period after installation to fill in the statistical database. Using this data, the solution is then commissioned and the user interface providing the decision support is turned on.

The statistical model of the vessel provides very accurate results and moreover, perfect analysis tools for operations. The backbone of the energy modules is the Propulsion Power Breakdown Analysis which can separate the required propulsion power from the environmental and operational aspects. This enables Dynamic Trim advice for optimizing vessel's trim on any environmental conditions as well as analysis and reporting on hull and propeller condition.

Return on investment

When utilized correctly, case studies have shown that a combination of OCTOPUS modules can save up to 9% in propulsion energy costs, with a corresponding system payback time just over a couple of months.

This combined with the ease of creating automated reports and analyzing the collected data or

relying on ABB expert to prepare Energy Efficiency reports saves considerable amount of Fleet Manager's resources and allows data driven operations resulting in saved fuel and decrease in harmful emissions.

OCTOPUS for Energy Efficiency

PERFORMANCE MONITORING

With daily fuel costs taking in a huge portion of the daily operational costs of a vessel, and the new IMO 2020 low sulfur requirements within the shipping industry, having an insight in fuel consumption KPIs has become increasingly important for shipping companies.

The Performance Monitoring set-up consists of easy-to-install mixed sensors and a software solution that is capable of measuring and displaying the most important vessel fuel consumption KPIs and making this data available as well on the vessel as to the onshore operations department. The module can easily be extended to monitor an increased amount of signals and offers easy comparison of actual performance against the baseline performance, providing the right toolset for optimization of various (sub) systems, providing the right tools to reduce energy and fuel consumption.

By using ABB's Coriolis Master high performance fuel flow measuring instruments and connection to a third party torque measurement system, im-



— OCTOPUS module: Performance monitoring

portant fuel consumption and performance KPIs can be shown onboard the vessel on the onboard fuel advisory monitor.

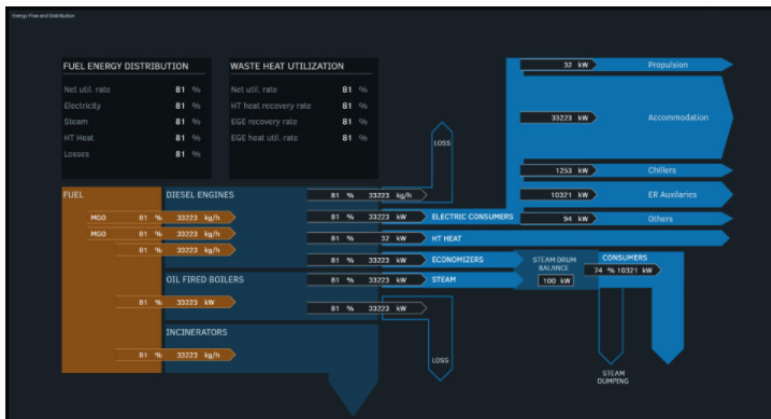
ENERGY FLOW

The Energy Flow module visualizes the energy flow of the vessel all the way from fuel into various consumers, showing how much energy is wasted due to steam dump and other losses. The module gives clear indication of energy optimization possibilities, providing the ship-owner the correct means to reduce the carbon footprint, reduce fuel consumption and showcase its sustainable and green company profile.

SFOC MONITORING

The SFOC Monitoring module gives dynamic view to the performance of diesel generators. The performance is evaluated by calculating how much fuel the engine uses to produce certain amount of energy in g/kWh (SFOC). The performance is visu-

— OCTOPUS module: Energy flow



alized with two SFOC curves. SFOC Monitoring makes the slow changes in the engine performance visible. This approach makes it possible for the shipowner to retrieve an insight in the actual performance of the engine and to assess and plan maintenance needs, keeping the performance and efficiency in acceptable range, whilst reducing emissions and contributing to a sustainable operating profile.

POWER PLANT OPTIMIZER

The Power Plant Optimizer is a tool for minimizing the fuel consumption of a vessel. The system advises the user on how to operate the power plant in the optimal way in order to save fuel. The system monitors the status and load of each engine. In addition to displaying the required power demand, the Power Plant Optimizer provides the user instructions on when to start and stop engines and how to balance the load in the most efficient way. During the optimization, the system also considers the external conditions (such as weather) and vessel auxiliary loads (such as reefer containers or HVAC). If fuel flow measurements, weather data and vessel speed measurements are available, those readings can also be used to calibrate the system.

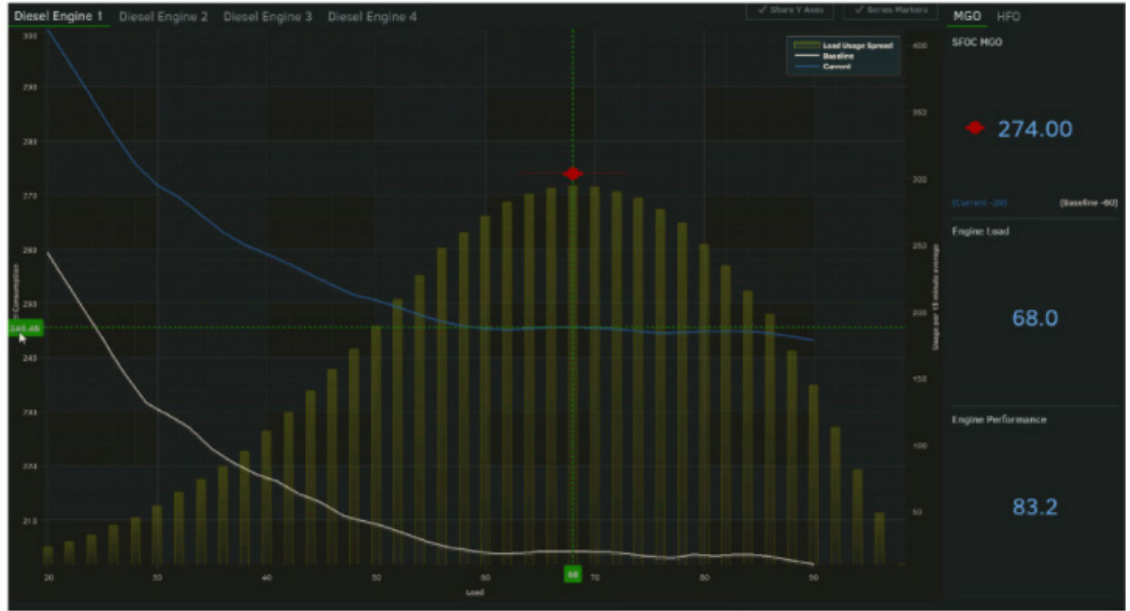
DYNAMIC TRIM & PROPULSION ANALYSIS

This solution advises the operating crew on the vessel's optimum trim in all operating conditions (including variations in conditions such as speed, draft, water depth, wind and waves). Depending on the vessel type and operational profile, the savings potential can be up to 5% of propulsion energy costs. The user interface follows the latest design guidelines in user experience and works intuitively without any user input or configuration.

The ABB propulsion power analysis tool allows to understand where shaft power is used to and what are the possible reasons the underperformance and overconsumption of the vessels. The module can extract the effect of e.g. hull & propeller fouling, trim, squat, wind, rudder.

The combination of both applications provide the crew with the right tools to reduce fuel consumption and harmful emissions, whilst contributing to a green and sustainable profile of the the company.

OCTOPUS module: SFOC monitoring



OCTOPUS module: Power plant optimizer



HULL AND PROPELLER CONDITION MONITORING

OCTOPUS can collect and store data and calculate relevant KPIs (Key Performance Indicators) to allow measurement of changes in hull and propeller performance as described in ISO 19030. This is based on the propulsion power breakdown model providing the calm water resistance of the hull and propeller. The tool is called Cleanhull and it helps to plan the hull and propeller maintenance schedule and to calculate the return on investment.

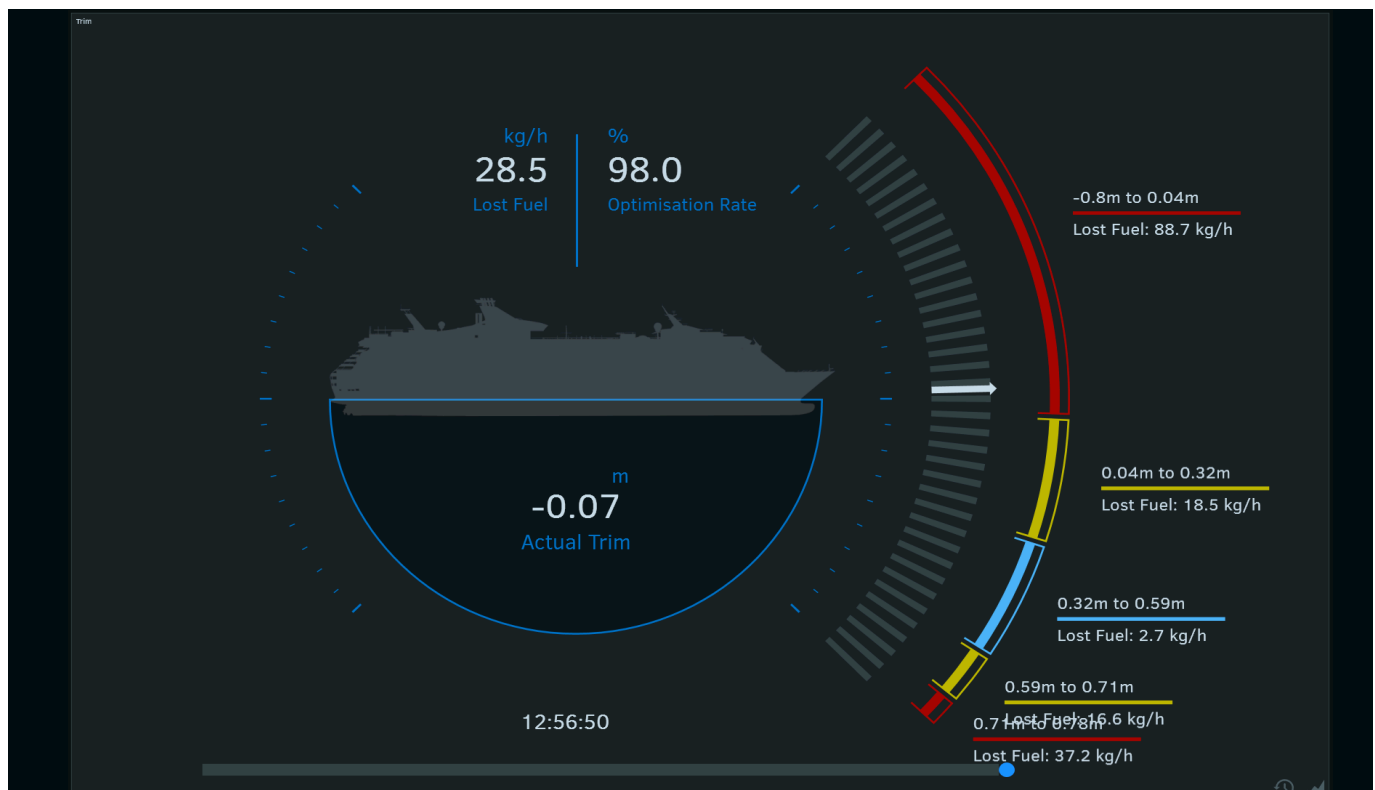
OCTOPUS for Safety and Availability

MOTION MONITORING

The Motion Monitoring module consists of the needed software including a motion sensor. For example, for container vessels, Motion Monitoring is an affordable solution for measuring roll and pitch of the vessel. OCTOPUS records real-time data from one motion sensor, typically (but not necessarily) placed in or near the center of gravity of the vessel. The technology is highly applicable on vessels (for instance container vessels) where it is important to monitor and store the most relevant motions (roll and pitch) and accelerations.

By transferring this data to the Fleet Portal for onshore insight, critical situations or accidents can be analyzed, leading to increased understanding of vessel limitations and prevention of situations where the vessel and her cargo are at risk.

OCTOPUS module:
Trim Optimization





OCTOPUS module:
Response forecast

RESPONSE FORECAST

The Response Forecast module provides a forecast for motions, velocities and accelerations for a vessel and her cargo. It facilitates the crew to take the vessel responses into account when planning (and making changes to) the route, leading to saved fuel and time, and increased safety for the vessel, cargo and her passengers.

Prevention of cargo damage or loss (for instance on container vessels, PCC's, Heavy Lift vessels/ Transportation of Wind Turbines or project cargo)

- Increased passenger comfort and prevention of motion sickness on passenger vessels.
- Better decision making with regards to routing of the vessel, leading to fuel and time savings
- Integral solution for safe and economic navigation
- Advice on safe speed and heading in heavy weather
- Warning against parametric roll, bow-and stern-slamming, green water, high lashing loads, propeller racing and more (for cargo or passenger vessels).
- Reduced operational costs
- Increased comfort of the cargo owner

DYNAMIC POSITIONING FORECAST

For vessels equipped with a Dynamic Positioning system, ABB's DP Forecast software includes a prediction if the vessel is capable to maintain her DP position during an operation. This leads to maximized workability, less fuel consumption and more productive hours during operations where the DP system is used. The DP software calculates an onboard forecast of the mean and slowly varying forces acting on the vessel due to currents, wind and waves.

Benefits:

- A clear and complete indication of the operational windows for weather-sensitive operations at sea
- Reduced fuel consumption because of efficient usage of DP thrusters
- Better and efficient preparation and execution of projects
- Less damages and stress to the vessel
- Optimal use of man and machine in a safe environment, leading to significant cost reductions.



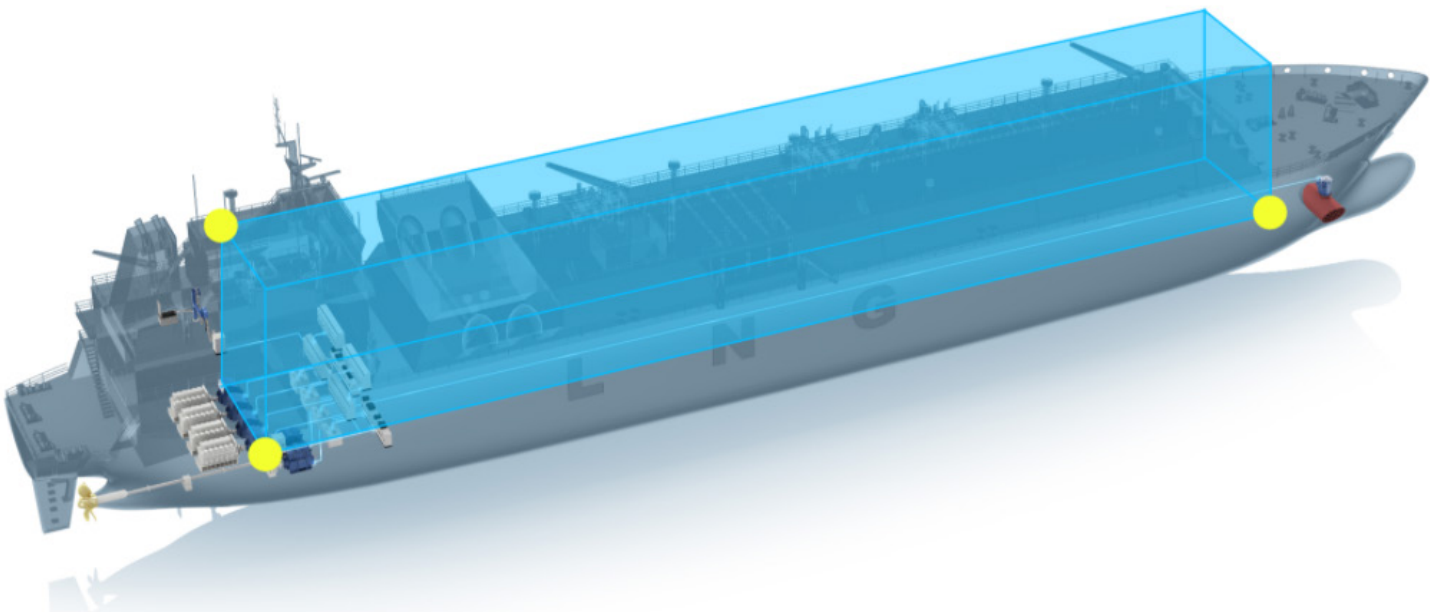
OCTOPUS module:
Dynamic positioning
forecast

ADVANCED MOTION MONITORING

The Advanced Motion Monitoring provides measurement of motions, velocities and accelerations in any thinkable location on the vessel, such as CoG of the cargo or a high point in a crane boom tip. By the installation of three MMS acceleration meters, the user can monitor any location by simply adding a virtual location in the system, the MMS-3 system calculates with high accuracy the motion and acceleration at the given virtual location. With this setup all critical parts of the vessel and cargo can be monitored with redundancy and without the need of a physical sensor installed on difficult locations.

The system includes full alarm management for real-time and statistical values. The system ensures reliable monitoring with a minimum of setup cost for each project / cargo. For this reason the system is the primary choice for shipping companies involved in project transportation. For this reason the system is the primary choice for shipping companies involved in project/heavy lift transportation. Other typical vessel segments that benefit from this technology are PCC's (Pure Car Carriers), to prevent damages to the cargo, or passenger vessels to increase passenger comfort.

OCTOPUS module:
Advanced motion
monitoring



“For us, OCTOPUS-Onboard is indispensable during offshore construction projects”

“We use OCTOPUS-Onboard on a daily basis to give us the optimum heading with regards to crane motions and for the DP system.”



This is a quote from Teun Hofman, Offshore Construction Manager at Jumbo Shipping. The Dutch company Jumbo Shipping operates multipurpose heavy lift vessels, equipped with cranes used for heavy-lift cargo transportation and subsea offshore installation. "When our vessels are deployed in an offshore construction project, they operate in DP mode. Due to crane usage, such operations are highly dependent on the weather. We use OCTOPUS-Onboard on a daily basis to give us the optimum heading with regards to crane motions and for the DP system. Based on the OCTOPUS motion forecast, we can accurately determine the heading in which the least severe motions will occur. This enables more-accurate planning of our operations, and gives us a better insight into the availability and operational window of our vessels during weather-sensitive operations."

In order to generate a motion forecast, Amarc, a member of the ABB Group, prepares a 3-D hydrodynamic database that is used within OCTOPUS-Onboard. This database contains detailed information on the behavior of the ship at sea for a range of drafts. By combining the information on the actual draft given by the loading computer, and derived from the location and speed of the vessel, combined with information from the hydrodynamic database, OCTOPUS-Onboard can predict the sea-keeping behavior of the ship at its actual draft. OCTOPUS-Onboard uses data from

the onboard weather forecast to predict how the forecast weather conditions will affect the vessel's motions.

Jumbo Shipping originally started out in the late 1950s, as a heavy lift cargo transporter. Since 2001, the company has also operated an offshore construction division. Hofman says: "Jumbo Shipping is increasingly becoming involved in offshore construction projects. We are engaged in a broad range of projects, such as the transportation and installation of topsides, wind turbine foundations and subsea manifolds."

Jumbo shipping currently operates a fleet of twelve specialized heavy lift vessels, with lifting capabilities varying from 500 to 1,800 tons. Two new K-Class vessels have been ordered for delivery at the end of 2013. These vessels have a lifting capacity of 3,000 tons at an outreach of 20 m and will also be equipped with OCTOPUS-Onboard.

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Teun Hofman, Offshore
Construction Manager
at Jumbo Shipping

