OCTOPUS-ONBOARD
The new generation decision-making support system to optimize ship performance in waves

Because you don’t want to take the risk...
What is OCTOPUS-ONBOARD?

OCTOPUS-ONBOARD contributes to the safety and economy of shipping in many aspects:

- OCTOPUS-ONBOARD is a monitoring system providing the immediate overview of the ship’s actual and attainable performance in waves.
- OCTOPUS-ONBOARD is a forecast system providing vessel performance predictions, weather windows, downtime warnings, and simulation features.
- OCTOPUS-ONBOARD is a routing system providing detailed voyage evaluations and optimizations taking into account the ship-specific behavior in waves.
- OCTOPUS-ONBOARD is the officer on watch’s objective assistant to safe navigation and resonance avoidance.

The success of OCTOPUS-ONBOARD is based on the unique combination of ship, weather, and navigation data to obtain a consistent picture and forecast of the ship’s performance. The co-operation with our clients and solution partners has resulted in the today’s OCTOPUS system, which truly eases the main tasks of the officer on watch: safe navigation, route or operation planning and damage avoidance. The result is a proven increased safety and economic performance of the ship and her crew.

Experience

AMARCON is the industries partner with key expertise in ship motion and performance analyses and software development. After the first installation of OCTOPUS-ONBOARD in 2002, many installations in different configurations have been supplied to renowned ship operators in co-operation with strategic partners like Classification Societies, system integrators, radar suppliers, and weather forecast providers.

AMARCON now presents the new generation OCTOPUS-ONBOARD system.

<table>
<thead>
<tr>
<th>Features OCTOPUS-ONBOARD 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Functional fusion of measurements and forecasts to support optimum and safe ship operation</td>
</tr>
<tr>
<td>Real-time insight in the impact of weather conditions on the ship’s stability, safety, workability and fuel consumption</td>
</tr>
<tr>
<td>Layered consistent presentation of information in resonance, polar, time trace and status displays</td>
</tr>
<tr>
<td>Satisfies IMO-MSC Circular 707 for resonance avoidance</td>
</tr>
<tr>
<td>Indicator for weather windows with first down-time and first up-time warning</td>
</tr>
<tr>
<td>Independent simulation and monitoring modes</td>
</tr>
<tr>
<td>Proven performance in integrated navigation bridges</td>
</tr>
<tr>
<td>Alarm management and self-diagnostic features</td>
</tr>
<tr>
<td>Designed for tracker ball or touch-screen operation</td>
</tr>
<tr>
<td>Modular and up-gradable from stand-alone PC-installation to high-end integrated configurations</td>
</tr>
<tr>
<td>Stand-alone replay and training installations available including a range of sensor simulators</td>
</tr>
</tbody>
</table>
Information is Value

OCTOPUS collects and processes the available information onboard through its sensor manager. The sensor manager provides the results via the network to multi-functional and dedicated OCTOPUS workstations. Each workstation has access to the same set of information. Alternatively, a stand-alone workstation can collect the information. Having this data available, OCTOPUS selects and displays the most relevant information to assist the officer on watch in monitoring the ship’s operating condition.

LOADING CONDITION data is monitored to get access to the ship’s actual mass distribution and stability data. OCTOPUS uses this information to calculate resonance diagrams, the motion and hull stress transfer functions, squat, and optimum trim with respect to fuel consumption and CO2-production\(^1\). Loading conditions are automatically imported from the loading computer if available on the ship’s network. By using the Digital Stability Booklet the officer on watch can also make a manual selection of the best suitable loading condition. The manual specification of the loading condition in terms of global mass properties and a GZ-curve is always an option.

NAVIGATION DATA is monitored to calculate the expected ship responses in waves and the probability for resonance for the ship’s active operating speed and heading. The interface with the navigation sensors is established by serial or network connections. The ship’s speed and heading can also be entered manually into OCTOPUS if there is no connection with the navigation network or to simulate the effect of a change of speed or heading.

VISUAL OBSERVATIONS of sea, swell, wind and current can be entered by the officer on watch. OCTOPUS displays how the ship will behave in that specific condition, and how it would behave after change of speed or heading. The observations are stored in an Electronic Log Book.

WEATHER FORECASTS by the world’s major marine weather forecast providers are monitored. OCTOPUS predicts the ship performance during the voyage in the upcoming weather and the resulting weather windows. OCTOPUS gives a warning if and when a signal is expected to exceed the critical level, or when there is a risk of ship motion resonance. Clear guidance is given on how to find an operating point in which all the criteria are satisfied by changing the speed and/or course. Interaction between OCTOPUS and the weather forecast system completes the total ship routing system.

WAVE MEASUREMENTS by the X-band navigation radar or a wave buoy can be used to calculate the ship responses in the actual waves and, optionally, to calibrate the weather forecasts. By measuring the sea surface around the ship a complete picture is obtained day and night even for complex multi-directional combined wave systems. OCTOPUS autonomously calculates and evaluates the ship responses in those complex sea states, which provides the complete picture of the actual ship’s operating condition.

HULL STRESS MONITORING SYSTEMS and MOTION SENSORS can be connected to OCTOPUS to monitor actual responses. Serial and digital communication protocols are supported. The measurement data can be used as reference values to calibrate the response calculations at physical and virtual sensor locations and to update the accumulated fatigue life. The measured responses can be incorporated in the OCTOPUS alarm system.

\(^1\) This functionality is planned for release by the end of 2007.
Combined polar display of responses and resonance zones. A warning or alarm is given to indicate exceed of one or more response criteria or risk for resonance.

Polar representation of roll motion for all headings at one speed. The weather components sea, swell, current and wind are displayed as well.
Detailed response status display showing the critical level and the actual value. An operator can set the allowable level.

Time traces showing the history, forecast, trend and allowable level of wave information and calculated or measured responses.
Weather windows are indicated graphically, where green is uptime and red is downtime (using automatic import of weather forecasts).

OCTOPUS generates an alarm if: a connected information source fails (the loading computer, a wave radar, a weather forecast, the connection with the navigation network or a measurement device); when the data gets older than allowed; when the ship responses are reaching critical high levels; or when a period of down-time is coming up.
Information Integrity is Vital

The officer on watch must be able to rely on the information that is presented by OCTOPUS. OCTOPUS uses a huge amount of information from different sources. A widely acknowledged benefit of the OCTOPUS system is the reduction of raw data which is achieved after the combination, processing and intelligent selection of the most critical elements. Only the most informative data is shown to the watch. Consistency of the information is guaranteed in OCTOPUS by continuously checking the integrity of the system components, the data ranges, and the actuality of the data.

Alarm Management

OCTOPUS generates an alarm if: a connected information source fails (the loading computer, a wave radar, a weather forecast, the connection with the navigation network or a measurement device); when the data gets older than allowed; when the ship responses are reaching critical high levels; or when a period of down-time is coming up. A clear distinction is made between System and Response alarms. Alarms can be acknowledged from any workstation running OCTOPUS Clients or by the ship’s central Alarm Management System (optionally).

Results OCTOPUS-ONBOARD 5

- Expected response levels and probability of exceeding critical levels as rational basis for navigation, lashing and offshore operations
- Standard results include ship motions, accelerations, hull loads and stresses, slamming and Motion Sickness Indices
- Warnings of resonance in waves for synchronous roll, parametric roll, broaching and surf riding
- Electronic log books with consistent histories of navigation data, loading condition, environmental conditions (wave radar, forecasts and visual observations) and ship responses
- Guidance on safe speed and course in any weather condition
- Trend analysis and online comparison with Hull Response Monitoring Systems
- Guidance on optimum trim and speed with respect to fuel consumption (and CO₂ production)
- Ship-specific route evaluation and optimization using operator-specific criteria
- Weather windows and indicators for remaining up- and downtime
- Alarm messages available on the central Ship’s Alarm Management system
OCTOPUS-ONBOARD Fits Any Ship

OCTOPUS can be configured to meet any need for almost any ship, whenever economy or safety is a decisive factor. OCTOPUS is the ultimate connection between the ship’s office, the ship’s navigation bridge, and the chart table.

HEAVY CARGO TRANSPORT VESSELS benefit from the combined monitoring and forecast of accelerations and roll motion, the advanced simulation mode and the response-based route optimization with weather window forecast.

CONTAINER SHIPS benefit from the resonance warning system in actual and forecast weather conditions. Optimization of trim and speed in shallow water results in reduced fuel consumption (and CO₂-production).

RORO/CAR CARRIERS benefit from the advanced routing features and the monitoring of accelerations on the car decks. In combination with weather forecasts OCTOPUS provides the input to rational lashing plans.

PIPE LAYING VESSELS benefit from the uptime and downtime indication feature based on the automatic weather and response forecast update.

LNG-CARRIERS benefit from improved predictability of ETA and the optimization of offloading scenarios.

OBO-CARRIERS benefit from the intelligent combined hardware/software-based hull monitoring features, estimation of speed-loss and reduced risk for slamming or water on deck.

AIRCRAFT CARRIERS benefit from the short-term motion prediction features based on the measurement of the spatial incoming wave field using wave radar².

CRANE VESSELS benefit from the weather window forecasts and the heading optimization feature.

FPSO’S benefit from the intelligent structural monitoring capabilities using a minimum sensor setup, including a wave radar or wave buoy. Offloading scenarios can be optimized using the weather window forecasts and the simulation mode.

YACHTS, CRUISE VESSELS AND FERRIES benefit from the motion optimization features to forecast, control, and improve the comfort onboard and to avoid seasickness.

DREDGERS benefit from the flexibility of OCTOPUS to select wave buoys, wave radars, or weather forecasts of major suppliers as input to the OCTOPUS-system to calculate workability on- and off-location.

² This feature is currently under development.
Interfaces and Communication

OCTOPUS is an open system that can be operated as a stand-alone installation or integrated in a shipboard network. Intermediate solutions are possible. The OCTOPUS design philosophy is to have interfaces with commercially available sensors and packages using industry standard protocols. When necessary, the OCTOPUS sensor manager converts third-party data to industry standards. The OCTOPUS sensor manager can handle the following information:

LOADING COMPUTERS: LOADSTAR, SEACOS, CAPSTAN, LOCOPIAS, CPC, SHIPLOAD, EASEACON
WEATHER FORECASTS: SPOS, ORION, UKMET, ARGROSS, Bon Voyage, C-MAP WeatherView
WAVE RADARS: WAVEX, SeaDarQ, WAMOS, SM-050
WAVE BUOYS: Datawell
NAVIGATION DATA: NMEA-0183
MEASUREMENTS: ADAM, TSS, ETHERCAN, MRU, DIMMAX, OBAS
ALARMS: NMEA, e-mail, SMS, client-server
COMMUNICATION: ETHERNET LAN, CAN-BUS, serial ports, USB, e-mail, SMS, GPRS, file-transfer by diskette

OCTOPUS-ONBOARD, the Scalable Solution

OCTOPUS uses network technology and industry-standard interface protocols. The new generation OCTOPUS system is a modular, scalable and upgradable state-of-the-art tool, configurable from a single stand-alone PC installation to a high-end integrated solution. OCTOPUS can be installed on most of today’s modern navigation bridges. OCTOPUS has been integrated in various navigation bridges already both on new-buildings and ships in operation.

---

(1) OCTOPUS-ROUTING is only available in combination with Meteo Consult’s onboard weather routing software SPOS.

3 Other interfaces are available on request.
OCTOPUS-RESONANCE

Guidance to the Master for Avoiding Dangerous Situations in Adverse Weather and Sea Conditions

The Maritime Safety Committee of the International Maritime Organisation at its sixty-fifth session (9 to 17 May 1995), approved the IMO-MSC/Circular 707 as Guidance to the master for avoiding dangerous situations in following and quartering seas. A view is presented providing Masters with a basis for decision making on ship handling in following and quartering seas, thus assisting them to avoid dangerous phenomena that they may encounter in such circumstances.

A revision of the MSC/Circ.707 was submitted by Germany in June 2005 on the 48th IMO Session (SLF 48/4/8), in which also possible dangerous situations in beam, bow and head sea conditions have been considered.

OCTOPUS-RESONANCE is the onboard software application that displays the conditions at which large motions can be expected due to wave excitation. The system gives a warning if the ship is operating in one or more of the following resonance zones:

- Synchronic roll.
- Parametric roll.
- Surf-riding/broaching.
- High wave groups.

The resonance zones are displayed in one polar diagram for sea, swell and the interfering wave system. The operating point of the ship is indicated by the speed-vector.

Guidance is given on the required change of speed and course to avoid potentially hazardous situations.
**OCTOPUS-RESONANCE** uses the following information:

- Ship main particulars.
- Ship stability data.
- Wave and swell conditions.
- Vessel speed and course.

**OCTOPUS-RESONANCE** features interfaces with:

- The ship’s navigation system using the NMEA-0183 protocol.
- Loading computers for stability parameters.
- Weather forecast providers to use sea and swell forecasts.
- Wave sensors (wave radars or buoys) to use actual wave data.

Stability data can be entered manually, or automatically imported from a loading computer.

---

**Satisfy the IMO Guidelines**

The resonance diagrams are automatically generated by the OCTOPUS system according to the [IMO-MSC/Circ. 707](http://www.imo.org) extended with the revision [SLF 48/4/8](http://www.imo.org) of June 2005.

Advantages of using the **OCTOPUS-RESONANCE** system compared with the use of printed documentation are:

- **OCTOPUS-RESONANCE** correctly positions the resonance zones due to sea, swell, and the wave interference system relative to the ship, giving the clearest thinkable overview of the situation.
- **OCTOPUS-RESONANCE** displays the resonance zones exactly for the roll period as specified by the officer on watch. Pre-printed documentation requires look-up of the graphs that correspond best.
- **OCTOPUS-RESONANCE** gives clear warning or alarm messages when the ship is in a potential dangerous situation. The alarms and actions can be logged.
- The integrated solution automatically uses the most recent stability data obtained from the loading computer.
- The integrated solution can link up with a weather forecast provider or wave sensor to monitor the wave conditions.
- Resonance diagrams are always displayed for the actual speed and heading.
- The system informs the officer on watch when source data (stability, navigation or wave data) gets outdated.

During normal operation, **OCTOPUS-RESONANCE** does not need special attention of the officer on watch. When the ship should enter or already operates in a resonance condition, the system warns the officer after which he is given guidance on the proper countermeasures. Guidance is given according to the IMO Guidelines.
OCTOPUS-FORECAST

OCTOPUS-FORECAST is used to forecast the ship performance along the planned voyage and to increase the schedule accuracy and the safety of the voyage. OCTOPUS-FORECAST can calculate the optimal route based on the weather forecasts. The expected ship motions, performance, and fuel consumption in the upcoming weather can be evaluated.

OCTOPUS-FORECAST has been developed in co-operation with our solution partner Meteo Consult, the world’s largest provider of weather forecast data, and works optimally in combination with the onboard weather routing software SPOS.

The user can influence the computed optimum route by setting criteria for fuel consumption, ship motions, slamming, Motion Sickness Index (MSI), or hull loads. Weather windows are clearly indicated in the OCTOPUS-display. A warning is given when the time until downtime becomes shorter than specified.

OCTOPUS-FORECAST can be operated on a stand-alone PC or integrated in the ship’s navigation network.

Dec 2004 : Meteo Consult’s SPOS in Motion(s)

“A close cooperation between Meteo Consult and AMARCON resulted in an integrated application of vessel response information in the SPOS weather and voyage planning software.”

“Since the whole integration is brought into the SPOS interface, the use of the system is extremely simple.”

“The AMARCON system called OCTOPUS (as implemented in SRA of Germanischer Lloyd) is used for predicting vessel motions, accelerations, and forces in real time. The combination with SPOS enables the user to calculate optimum tracks with forecasted weather and predicted vessel motions. The user can predefine a combination of up to 6 maximum motion criteria and the SPOS system will automatically advice tracks avoiding areas where those criteria are to be exceeded.”
OCTOPUS-DSS

OCTOPUS-DSS (Decision Support System) assists the Master and officer on watch in taking the best decision with respect to safe and effective ship operation. Compliance with the schedule and prevention of damage to the ship and cargo in heavy seas are decisive factors affecting the profitability of a ship. Combining measured and forecasted wave conditions with a state-of-the-art computational model and the actual loading condition makes it possible to compute ship responses in the form of motions and hull loads. OCTOPUS makes use of a unique ship-specific database-concept based on state-of-the-art 3D radiation/diffraction codes. This part of the system has been developed and validated in co-operation with our solution partner Germanischer Lloyd.

OCTOPUS-DSS combines all the information obtained from weather forecasts, measured wave conditions (e.g. directional spectra), the ship’s loading condition, speed, course, heading, route and hull response monitoring systems to monitor and forecast ship responses, possible hazards and their consequences. Ship responses of interest can be displayed on any workstation in the network.

OCTOPUS DSS is the most complete integrated OCTOPUS-configuration.

Using OCTOPUS-DSS, SRA has become proven reality

OCTOPUS-DSS is the software system that is the heart and control center of Germanischer Lloyd’s Shipboard Routing Assistance system. Since its introduction, SRA has been installed on Panamax and Post-Panamax container ships in operation and on new-buildings.

“Shipping lines and charterers are concerned about improving schedule integrity and navigation in adverse weather conditions – to ensure their ships arrive on time with their cargo intact. One means of achieving these goals is to lower the risk to crew, cargo and ship by avoiding critical seaways. Now the Shipboard Routing Assistance (SRA) system developed by Germanischer Lloyd promises to provide a master with the support he needs to avoid seaways that could damage ship and cargo” (GL News June 2005).
OCTOPUS Onboard installations

Current Installations:

<table>
<thead>
<tr>
<th>Name of Vessel</th>
<th>Vessel type</th>
<th>Owner / Manager</th>
<th>Year of OCTOPUS Onboard installation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sealand New York</td>
<td>Container</td>
<td>Costamare Shipping</td>
<td>2002</td>
</tr>
<tr>
<td>New York Express</td>
<td>Container</td>
<td>Costamare Shipping</td>
<td>2003</td>
</tr>
<tr>
<td>Hamburg Express</td>
<td>Container</td>
<td>Hapag-Lloyd Germany</td>
<td>2004</td>
</tr>
<tr>
<td>Lorelay</td>
<td>Pipe Lay Vessel</td>
<td>Aliseas</td>
<td>2004</td>
</tr>
<tr>
<td>Colombo Express</td>
<td>Container</td>
<td>Hapag-Lloyd Germany</td>
<td>2005</td>
</tr>
<tr>
<td>Kyoto Express</td>
<td>Container</td>
<td>Hapag-Lloyd Germany</td>
<td>2005</td>
</tr>
<tr>
<td>Chigago Express</td>
<td>Container</td>
<td>Hapag-Lloyd Germany</td>
<td>2005</td>
</tr>
<tr>
<td>E.R. Canada</td>
<td>Container</td>
<td>E.R. Schiffahrt GmbH &amp; CIE</td>
<td>2005</td>
</tr>
<tr>
<td>Arca</td>
<td>Oil combat</td>
<td>North Sea Directorate</td>
<td>2005</td>
</tr>
<tr>
<td>Rigoletto</td>
<td>Container</td>
<td>CMA CGM</td>
<td>2006</td>
</tr>
<tr>
<td>Transshelf</td>
<td>Semi Sub Heavy Lift</td>
<td>Dockwise Heavy Transport Shipping</td>
<td>2006</td>
</tr>
<tr>
<td>Voyager</td>
<td>RoRo</td>
<td>Norfolk Line</td>
<td>2006</td>
</tr>
<tr>
<td>Happy Buccaneer</td>
<td>Heavy Lift</td>
<td>Biglift Shipping</td>
<td>2006</td>
</tr>
<tr>
<td>Willift Eagle</td>
<td>Heavy Lift</td>
<td>Offshore Heavy Transport</td>
<td>2006</td>
</tr>
<tr>
<td>Willift Falcon</td>
<td>Heavy Lift</td>
<td>Offshore Heavy Transport</td>
<td>2007</td>
</tr>
<tr>
<td>Mighty Servant 1</td>
<td>Semi Sub Heavy Lift</td>
<td>Dockwise Heavy Transport Shipping</td>
<td>2007</td>
</tr>
<tr>
<td>Fairmount Fjell</td>
<td>Semi Sub Heavy Lift</td>
<td>Fairmount Heavy Lifting</td>
<td>2007</td>
</tr>
<tr>
<td>Fairmount Fjord</td>
<td>Semi Sub Heavy Lift</td>
<td>Fairmount Heavy Lifting</td>
<td>2007</td>
</tr>
<tr>
<td>Schieborg</td>
<td>RoRo</td>
<td>Wagenborg</td>
<td>2007</td>
</tr>
<tr>
<td>NYK Argus</td>
<td>Container</td>
<td>NYK</td>
<td>2007</td>
</tr>
</tbody>
</table>

Confirmed future installations:

<table>
<thead>
<tr>
<th>Name of Vessel</th>
<th>Vessel type</th>
<th>Owner / Manager</th>
<th>Year of OCTOPUS Onboard installation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Holwerda Vanquish</td>
<td>Container</td>
<td>Scheepvaartonderneming Gretina B.V.</td>
<td>2007</td>
</tr>
<tr>
<td>M/V Ancora</td>
<td>Heavy Lift</td>
<td>Offshore Heavy Transport</td>
<td>2007</td>
</tr>
<tr>
<td>White Shark</td>
<td>Container</td>
<td>CMA CGM</td>
<td>2007</td>
</tr>
<tr>
<td>Marlin</td>
<td>Container</td>
<td>CMA CGM</td>
<td>2007</td>
</tr>
<tr>
<td>Kingfish</td>
<td>Container</td>
<td>CMA CGM</td>
<td>2007</td>
</tr>
<tr>
<td>Ceasar</td>
<td>Pipe Lay Vessel</td>
<td>Helix Energy Solutions</td>
<td>2007</td>
</tr>
<tr>
<td>TBA (3 vessels)</td>
<td>Shuttle &amp; Regas Vessel</td>
<td>Höegh LNG</td>
<td>starting 2008</td>
</tr>
</tbody>
</table>
... but sail safe and smooth