

# OPCAL / OperabilityViewer

## Operability analyses of ships and floating structures

The program OPCAL is used to compute ship responses in irregular seas based on the transfer functions of the ship motions obtained from seakeeping calculations. This allows the user to translate the ship motions into relevant responses for the ship's operability and to perform a workability analysis as a post-processor for seakeeping calculations.

### Method

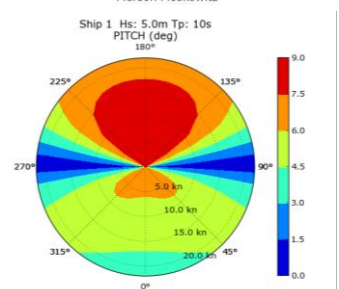
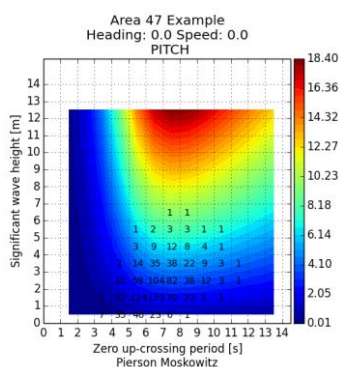
A workability analysis comprises:

- The seakeeping behaviour characteristics of the structure
- The environmental conditions
- Limiting criteria

### From transfer functions to responses in irregular seas

The seakeeping behaviour characteristics of the structure are defined with linear and quadratic transfer functions. The linear transfer functions are generally defined in terms of the six degrees of freedom of the ship or structure. Opocal facilitates the manipulation of this information to obtain relevant ship responses in irregular waves such as:

- Local absolute and relative motions, velocities and accelerations
- Risk of slamming and green water events
- Seafastening and internal loads
- Mean drift forces
- Effective Gravity Angles
- Comfort indexes such as Illness Rating, Motion Sickness Incidence, and Motion Induced Interruptions



Example of OPCAL results for the pitch motion shown as on a weather scatter diagram [top] and as a polar plot for a given sea state [bottom].

The short term statistic values of the responses are computed by means of spectral convolution using different wave spectra (e.g., JONSWAP, Pierson-Moskowitz) and considering short and long crested waves.

OPCAL produces databases of the relevant responses for a range of significant wave heights and zero up-crossing wave periods. These databases are the basis of the operability analyses in which the environmental conditions and the limiting criteria are combined to obtain downtime values and limiting weather conditions. The operability analyses are performed as a post-process with the aid of the tool OperabilityViewer.

## Input

The input for OPCAL consists of:

- Linear and quadratic transfer function databases
- Wave spectra characteristics
- Parameters to compute relevant ship responses

The input for OperabilityViewer consist of:

- Wave scatter diagrams or Sea States
- Limiting criteria

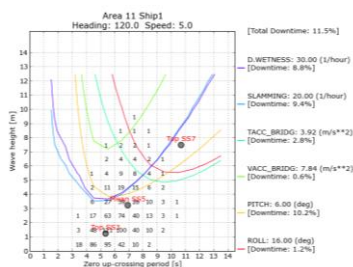
## Output

OPCAL generates:

- Transfer function databases with derived ship motions
- Databases with response values for a range of irregular sea conditions

OperabilityViewer generates:

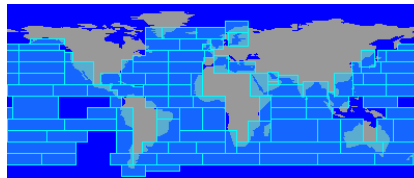
- Downtime figures
- Plots showing operable and inoperable sailing conditions



Example of downtime values and operational limiting lines for different responses for a given weather scatter diagram.

## Climate

The wave climate at a given area of operations is defined by means of a so-called wave scatter diagram. The user can select from the available scatter diagrams representing the climate at different areas of the world or input their own scatter diagrams. Alternatively, specific sea state conditions can be defined by means of a significant wave height and a wave (peak, zero up-crossing, or mean) period.



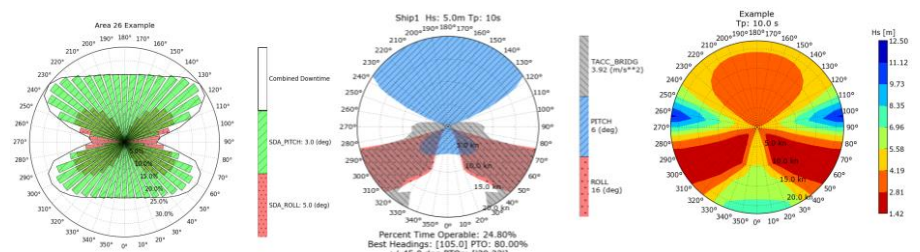
Map showing the available weather scatter diagrams by default in OperabilityViewer.

## Criteria

Limiting criteria are supplied by the user for each of the responses. Based on the supplied criteria, downtime values are computed and weather conditions for which such criteria are exceeded are highlighted.

## Downtime and operability plots

The operability of a ship or structure can be assessed in different ways by taking into account the weather conditions of an area of operations (scatter diagram) or specific sea state conditions, as well as its operational profile (e.g., speeds and wave headings). OperabilityViewer allows the user to generate a variety of operability plots.



Examples of polar plots showing the downtime values for a given scatter diagram [left], the (non-)operational sailing conditions for a given sea state [middle] and the limiting wave heights for a given wave period [right].

## Applications

OPCAL and OperabilityViewer allow for the quantification of the performance of ships and structures and the identification of the limiting weather and sailing conditions in terms of:

- Safety of crew and passengers
- Habitability
- Equipment operational limits
- Passenger and crew comfort
- Seafastening loads
- Fatigue problems
- Bow emergence and related impact loading
- Shipping of water
- Added resistance of ships

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