Safer Shipping | Smarter Ports

OMC INTERNATIONAL

DUKC® Series 5

Giving even better depth to your understanding

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General Description

OMC's DUKC® Series 5 product suite is a world-class eNavigation solution, which integrates the proven core calculation engine with web technologies. DUKC® users can successfully execute under keel clearance related tasks via the web rather than the traditional desktop-based user interface.

The DUKC® Series 5 software consists of several modules integrated behind a web-based user interface. Each module is self-contained, developed and tested under ISO standards, and proven in the unforgiving world of maritime operations. The modules can be arranged and configured to help manage under keel clearance related problems ranging from long-term voyage planning to real-time onboard pilotage applications and to the monitoring of numerous vessels in real-time within a VTS environment.

At the heart of the DUKC® Series 5 software suite is a pair of critical engines: An Environmental Forecast Engine and a UKC Calculation Engine. Each engine consists of tested and proven sub-components, pioneered by OMC's Founder Dr Terry O'Brien AM, which have been operating for more than two decades without incident since the first installation in 1993. Built on top of the core engines are services which provide DUKC® applications for both web and non-web access to the underlying engines.

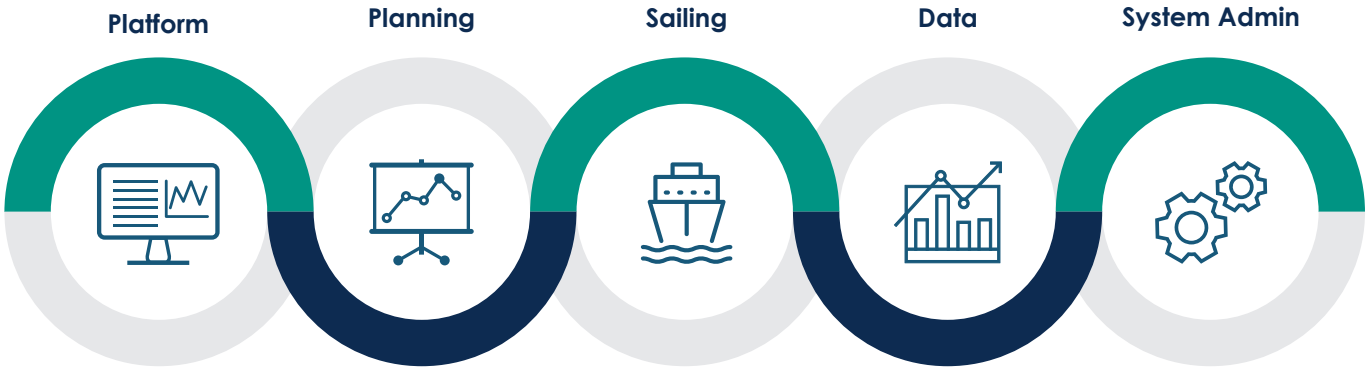
Networks of external data sources such as met-ocean sensors and AIS data streams are linked to the DUKC® system as required. All DUKC® outputs, diagnostics and statistics can be logged, queried or distributed in real-time to users.

To handle varying user requirements, the DUKC® Series 5 contains a Job Management Layer which serves as a calculation controller and routes requests to the appropriate engine. This allows for system scalability and provides the ability to schedule calculations to run automatically, anticipating a user's need for results.

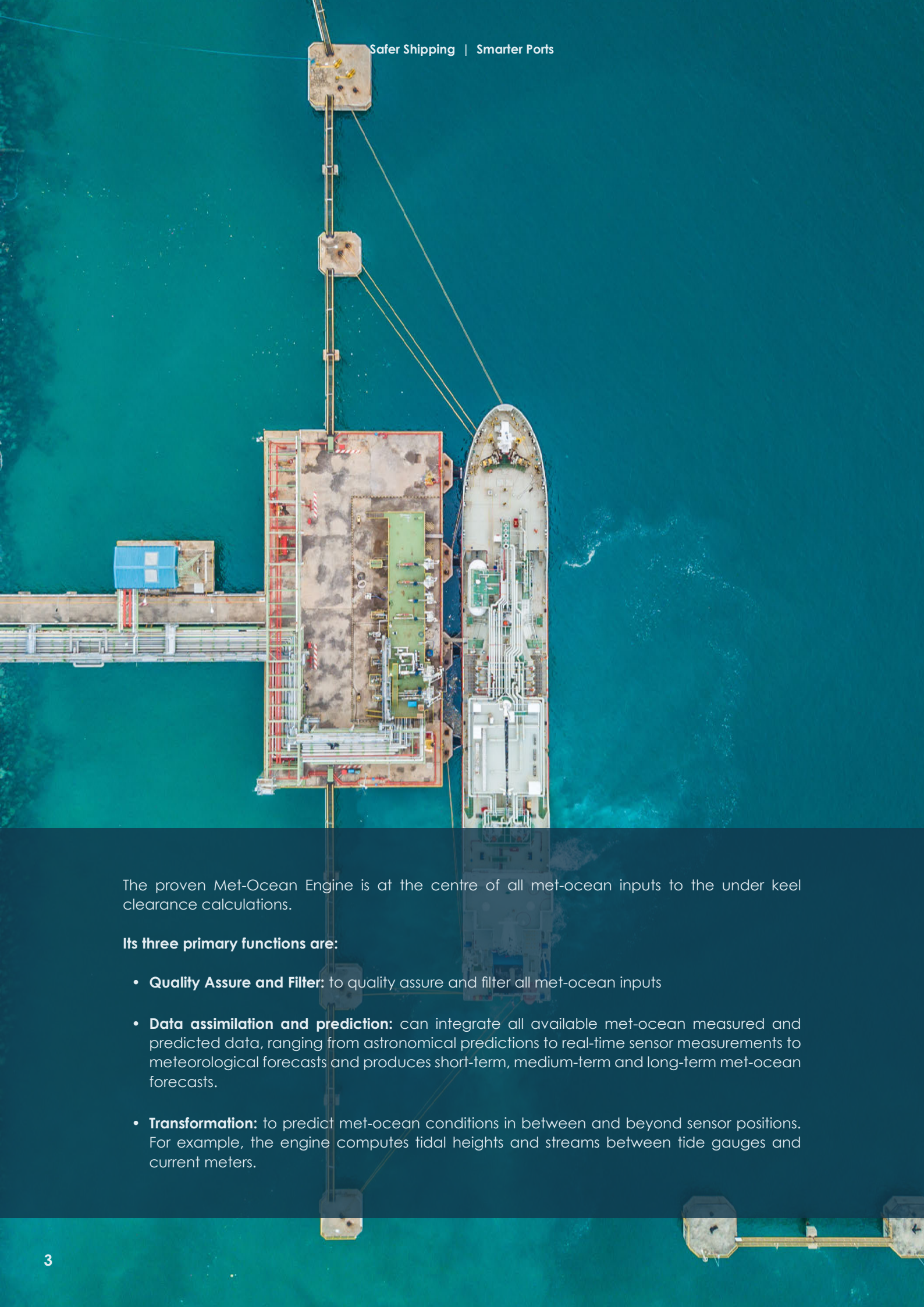
From the full collection of DUKC® Series 5 modules (see diagram below), five services can be configured to provide a UKC management system for any waterway.

The Calculation Engine and its subcomponents manage everything from complex vessel motion calculations to the logic of transit planning. Its purpose is to compute and solve under keel clearance questions.

DUKC® Series 5 Architecture



Platform	Planning	Sailing	Data	System Admin
• Base • Dynamic Sheltered • Dynamic Ocean	• Load and Window Planner • Port Optimiser	• Passage Planner • Passage Monitor Shore • Passage Monitor Ship • Chart Overlay	• Vessel • Met-Ocean • Reports • System Integration	• System Notification • System Health • User Management



The proven Met-Ocean Engine is at the centre of all met-ocean inputs to the under keel clearance calculations.

Its three primary functions are:

- **Quality Assure and Filter:** to quality assure and filter all met-ocean inputs
- **Data assimilation and prediction:** can integrate all available met-ocean measured and predicted data, ranging from astronomical predictions to real-time sensor measurements to meteorological forecasts and produces short-term, medium-term and long-term met-ocean forecasts.
- **Transformation:** to predict met-ocean conditions in between and beyond sensor positions. For example, the engine computes tidal heights and streams between tide gauges and current meters.

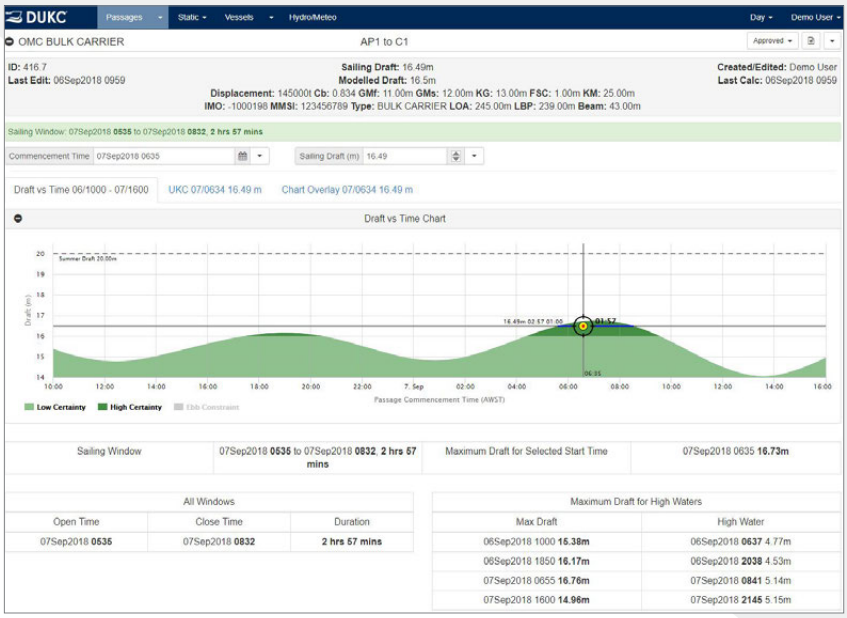


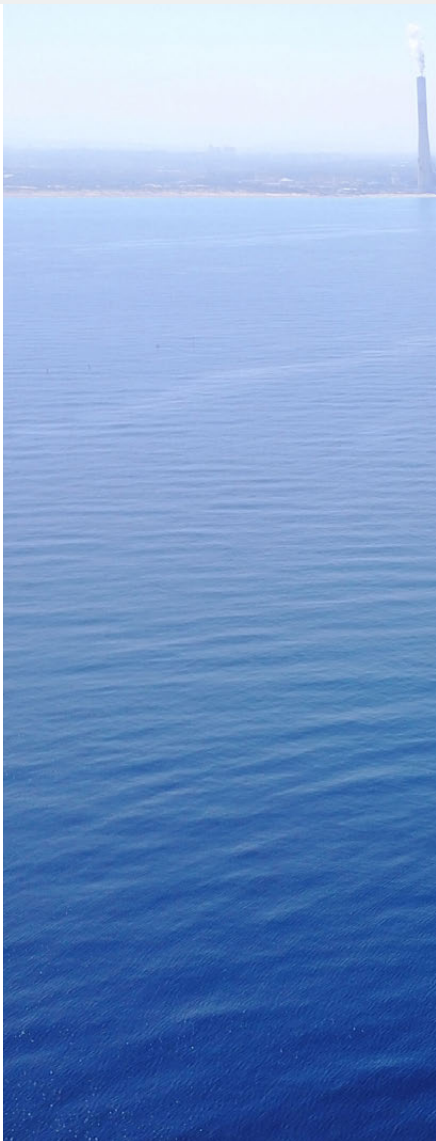
Figure 1: Sample maximum sailing draught vs. departure time output from the Voyage Planning Service.

Voyage Planning Service

The long-range (>24 hours) under keel clearance planning component of the DUKC® product suite uses environmental forecasts and climate statistics to estimate what the short-term (0-24 hours) sailing advice of the DUKC® will be at some future date. The Voyage Planning Service calculates probability distributions of waves and tides from astronomical tide forecasts and historical wave and tide statistics, and uses these to calculate a probability distribution of what the operational DUKC® will say when run closer to sailing time.

The Voyage Planning Service allows the user to specify a probability that the operational DUKC® result (close to sailing time) will have a lower maximum draught than predicted by the Voyage Planning Service result. This allows a scheduler to specify the level of certainty for the ship to sail on time. The scheduler may select different levels of certainty for different ships, or for different types of cargo, etc. (By contrast, if a static rule is used to determine draughts to load, the static rule has some implicit level of certainty of the ship being allowed to sail with this draught, but the scheduler does not know what this level of certainty is, and cannot modify the level of certainty for different situations).

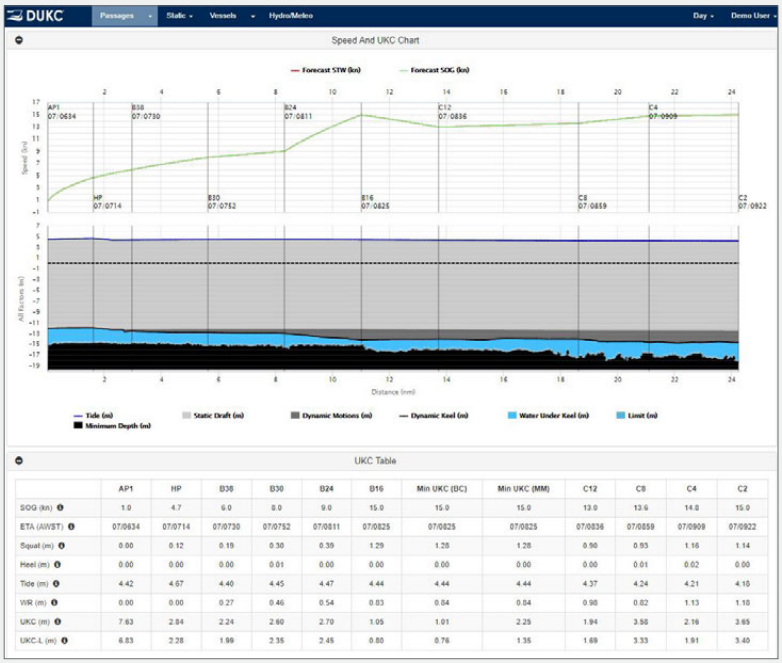
The Voyage Planning Service also allows the user to select a Minimum Window Duration, which can be used to specify the shortest duration sailing windows the user will accept. For example, if the user is not interested in windows shorter than 15 minutes because these are too short to allow for the practicalities of arranging ship departures, the Minimum Window Duration can be set to 15 minutes to ensure that the Voyage Planning Service only returns sailing windows (or maximum loading draughts) corresponding to sailing windows of this size or greater.



Transit Planning Service

Increases the safety and efficiency of transits by allowing real-time to short-term predictions of under keel clearance during transit.

Real-time to short-term predictions of under keel clearance, automatically updated from latest met-ocean observations. This is used to plan vessel transits (including providing speed control functionality in the planning) through the specified waterway using the latest met-ocean observations and accurate vessel load state information and AIS positions.



	AP1	HP	B38	B30	B24	B16	Min UKC (DC)	Min UKC (MM)	C12	C8	C4	C2
SOG (kn)	1.0	4.7	6.0	8.0	9.0	15.0	15.0	15.0	13.0	13.6	14.0	15.0
ETA (AWST)	07/0634	07/0714	07/0730	07/0752	07/0811	07/0825	07/0825	07/0825	07/0836	07/0859	07/0909	07/0922
Squat (m)	0.00	0.12	0.19	0.30	0.39	1.29	1.28	1.28	0.90	0.93	1.16	1.14
Heel (m)	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.00
Tide (m)	4.42	4.67	4.40	4.45	4.47	4.44	4.44	4.44	4.37	4.24	4.21	4.10
WR (m)	0.00	0.00	0.27	0.46	0.54	0.83	0.84	0.84	0.98	0.82	1.13	1.10
UKC (m)	7.63	2.84	2.24	2.60	2.70	1.05	1.01	2.25	1.94	3.58	2.16	3.65
UKC-L (m)	6.83	2.28	1.99	2.35	2.45	0.80	0.76	1.35	1.69	3.33	1.91	3.40

Figure 2: Sample output from Transit Planning Service.

Sample questions that can be answered by the transit planning service are:

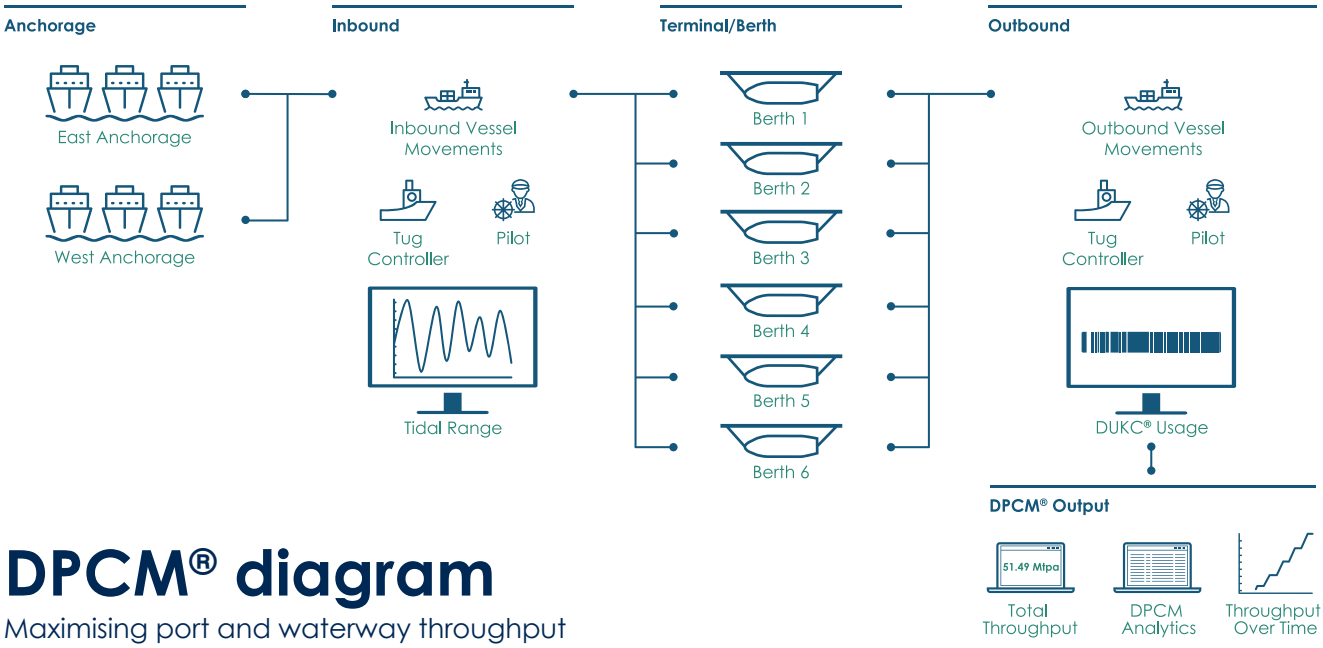
- Between what times can I safely enter this waterway on this vessel?
- What speeds should I travel at to safely pass all waypoints?
- What happens to the UKC if I slow down, or speed up?
- How much is this vessel predicted to heave, roll or pitch at various locations along the waterway?
- What is the minimum UKC along the transit?

Dynamic Port Capacity Model

Revealing your port's true throughput potential

The Dynamic Port Capacity Model (DPCM®) accurately simulates port operations, capturing the interactions that occur between the various elements within the port. The DPCM® takes a holistic approach to evaluate port performance, factoring in the uncertainty inherent in any port operations, to provide a reliable decision support tool.

The Dynamic Port Capacity Model (DPCM®) is the world's first and only port capacity model that fully integrates dynamic under keel clearance calculations, site specific environmental conditions, and unique port factors. Through a discrete event simulation model of a port's operations, the DPCM® provides a tool to assess the impact on port capacity from changes to variables such as ship loader rates, vessel fleet profiles, services and asset availability (tugs, pilots, etc), as well as the effects of port closures (e.g. due to cyclones or harbour resonance).



DPCM® diagram

Maximising port and waterway throughput

Example questions that can be answered:

- What is the capacity of the port's channel?
- What is the impact on throughout of a new type and size of vessel?
- What size and type of vessels should we charter to maximise throughput?
- How much more throughput can we expect if we add anew berth or a new loader?
- What is the impact on throughput if we modify our port operational procedures?
- If we add another tug, how many more vessels can be handled?
- Will this significantly reduce the need for capital dredging with its associated environmental costs?

Case Study

The DPCM® has been successfully applied at Port Hedland, the world's largest bulk export port, to evaluate the port's total capacity. Utilising the DPCM®, Port Hedland's declared port capacity has increased by 16 per cent from 495 million tonnes per annum to 577 million tonnes per annum. This increase is one third of the additional capacity proposed by the now shelved Outer Harbour project, which had an estimated cost of AUD$20b.

> The model evaluates potential port investments and operating scenarios to maximise throughput through the port. It has enabled PPA to model additional capacity through increasing sailing drafts, larger and more draft efficient vessels, and sailing more ships on a tide.
>
> **Pilbara Ports Authority,**
> November 2015

> The modelling looked at recent operational changes at the port including the use of innovative maritime technology, which has resulted in increased sailing drafts, the shipping companies' move to larger and more draft efficient vessels, and the port's ability to sail more ships on a tide.
>
> **Transport Minister Dean Nalder,**
> November 2015

Optimiser Service

Increases efficiency by allowing the optimisation of multiple vessel departures on a single tide.

The Optimiser Service allows the optimisation of multiple vessel departures on a single tide whilst considering constraints such as tug availability, current restrictions and booking priorities. A few sample screenshots are provided in the figures below.

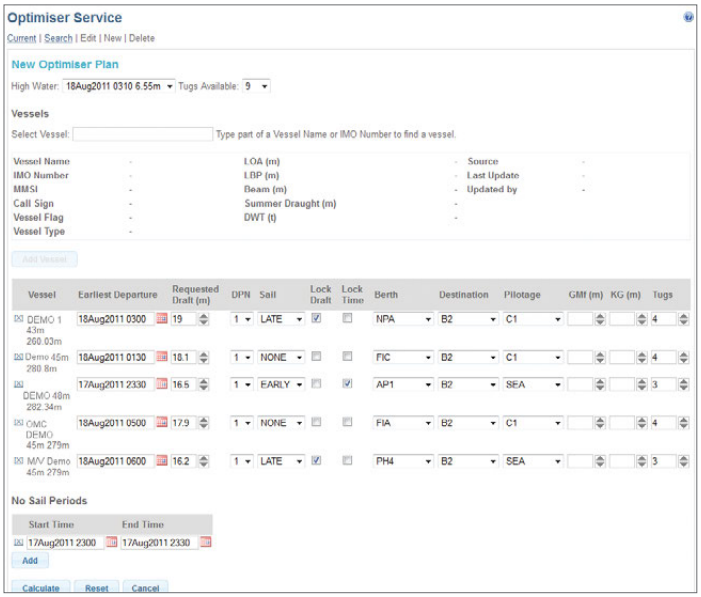


Figure 3: Sample input screen for the planning of multiple vessels on a single tide. In the example above five vessels are added with various draughts, priority numbers, earliest departure times and required tugs.

Figure 4: Sample output screen for the departure of multiple vessels on a tide. The example shows the computed optimised sailing slots and draughts whilst considering priorities, tug availability and requested draughts.

Transit Monitoring Service ASHORE

Further increases the safety of transits by tracking the under keel clearance of one or more vessels simultaneously.

The Transit Monitoring Service automatically tracks and monitors the under keel clearance of 'active' transit plans. Users who have been assigned permissions to access monitoring functionality can track the under keel clearance of one or more vessels simultaneously.

The under keel clearance information is updated continuously based on using the latest met-ocean observations, vessel load state information and AIS positions. Tracking of vessels occurs automatically once a transit plan has been issued ('active').

The Transit Monitoring Service can include a monitoring chart to allow operators to view the UKC status of all tracked vessels in a geographic sense. See also Figure 5 (right).

Figure 5: Sample maximum sailing draught vs. departure time output from the Voyage Planning Service.

Figure 6: Sample Chart Overlays from the Voyage Planning Service.

Transit Monitoring Service ONBOARD - Chart Overlay Service

The onboard solution displays DUKC® information as an overlay on top of an Electronic Charting Package (ECP). This allows UKC information to be displayed more intuitively to marine pilots and allows horizontal navigation aspects o be included in the assessment of under keel clearance. DUKC Chart Overlays have been proven under the most demanding safety critical conditions; being relied to manage situations including main engine failures and cyclonic swell events.

Figure 7 shows the Chart OVerlays in use. Red areas indicate 'no-go' regions where the DUKC® predicts the vessel to have insufficient under keel clearance.

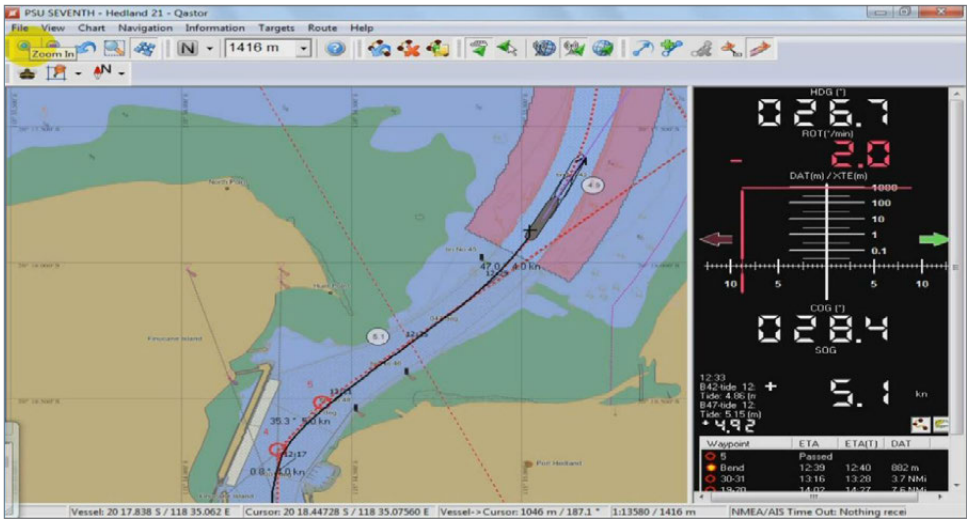
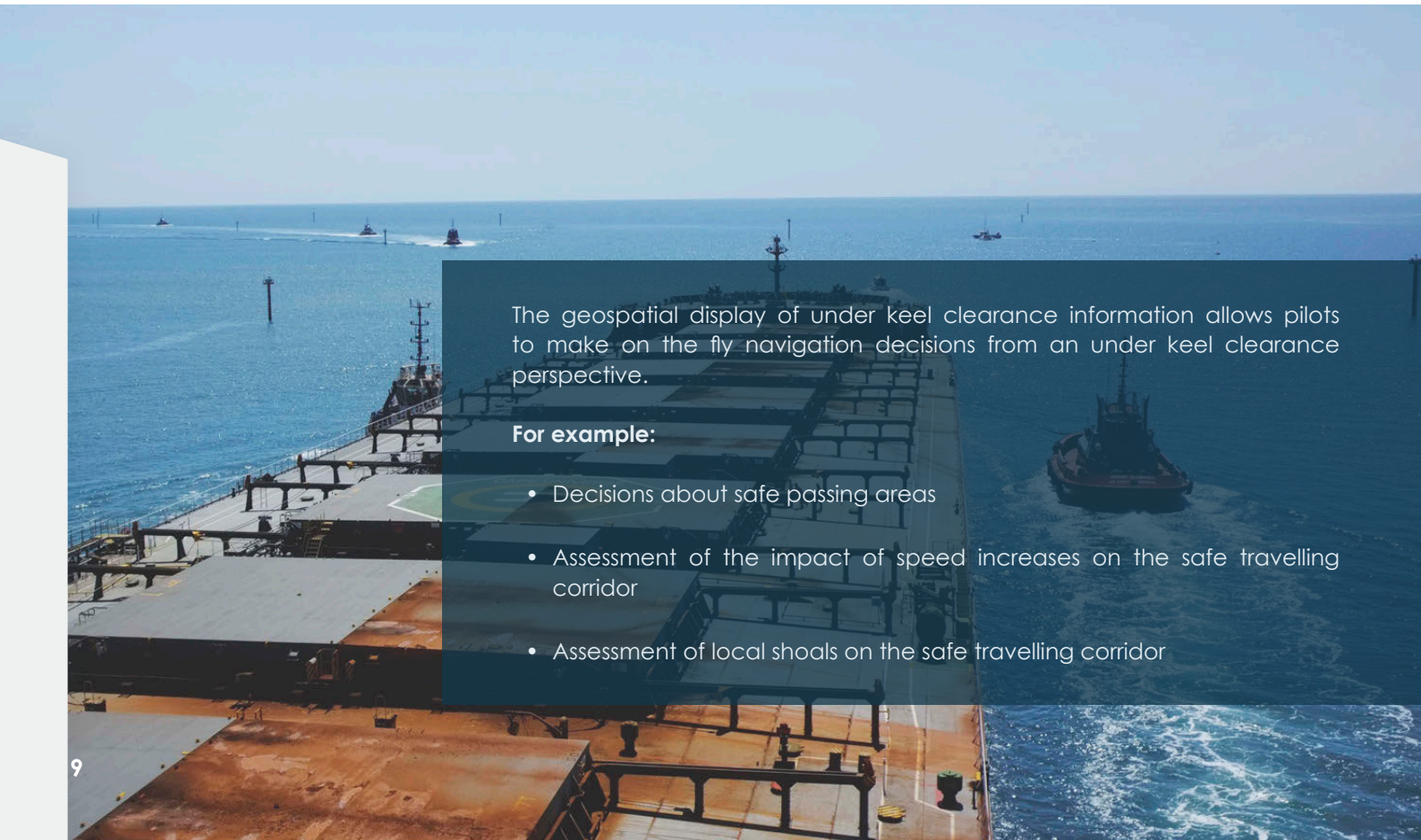


Figure 7: Sample of Chart Overlay used onboard of a vessel.



The geospatial display of under keel clearance information allows pilots to make on the fly navigation decisions from an under keel clearance perspective.

For example:

- Decisions about safe passing areas
- Assessment of the impact of speed increases on the safe travelling corridor
- Assessment of local shoals on the safe travelling corridor

Vessel Service

Allows interaction with a comprehensive list of recognised vessels and their particulars which is used as the authoritative source of vessel information within the system. The vessel service can be linked up to external vessel data sources such as port information systems.

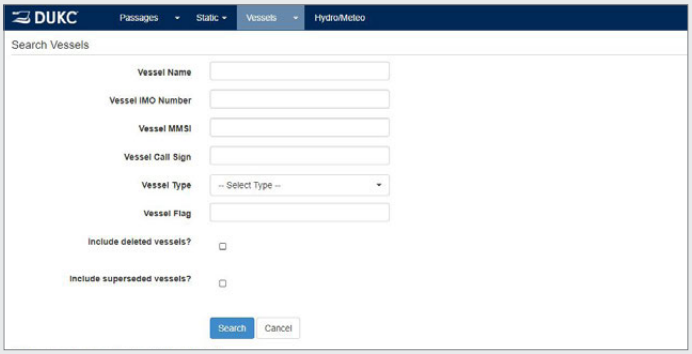


Figure 8: Searching for vessel information.

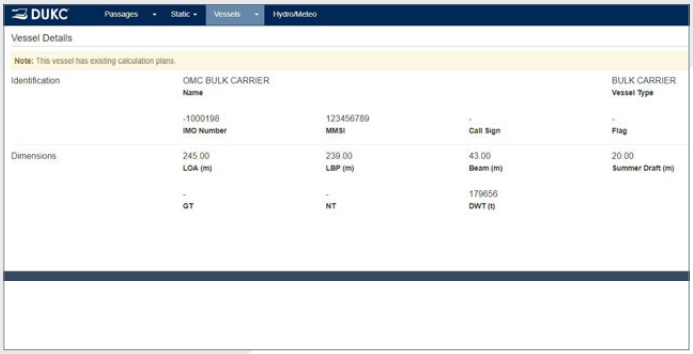


Figure 9: Sample vessel information stored within the Vessel Service.

Met-Ocean Data Service

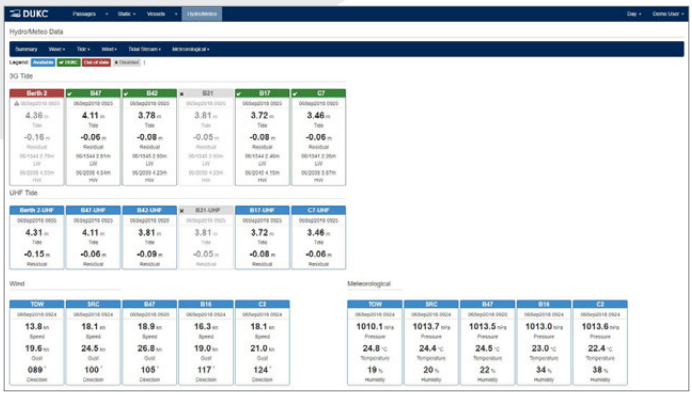


Figure 11: Sample summary screen in the Met-Ocean Data Service.

Figure 10: Sample detailed tide information available in the Met-Ocean Data Service.

Allows interactions with the met-ocean engine described above and handles all requests related to met-ocean data. OMC has unified the data displays available with Met-Ocean Data Service, which can display met-ocean measurements, forecasts and predictions from many different sources within a single view.

Sample questions that can be answered by the met-ocean service are:

- What is the latest recorded tide height at location X?
- How has the tide height varied over recent hours or days?
- How high are the waves right now?
- How high were they in the last few hours?
- How are they predicted to change?
- How strong will the tidal streams be in the coming day?
- Is this gauge still working?

Reporting Service

Built in data query, security and auditing facilities.

Allows searching and retrieval of archived outputs, previous calculations, errors and diagnostics. All calculations, errors, system messages and diagnostics are logged and can be queried if desired.

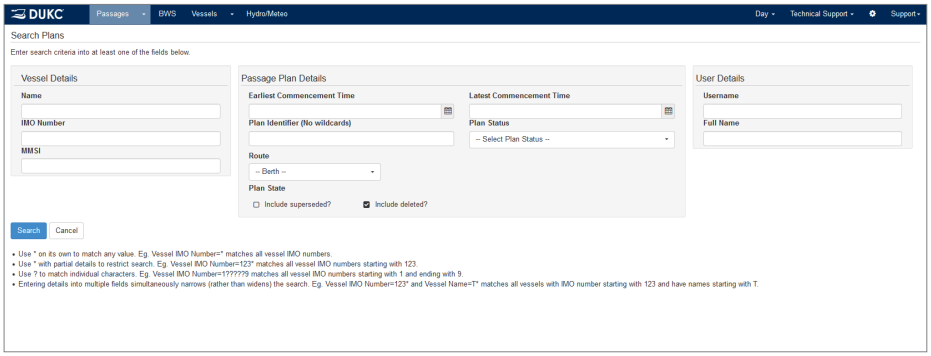


Figure 11: Sample data mining capability within the Reporting Service.

Sample questions that can be answered by the reporting service are:

- How many transits has my organisation undertaken in the past 3 months?
- Which user issued this transit plan? What changes were made to it?
- How many vessels were monitored successfully in the past year?

Underlying the core engines and services are the various data storage components. Most data inputs and outputs are stored within SQL databases; some are stored in (system) log files. Storing data in SQL databases allows for efficient storage and built-in data query, security and auditing facilities.

For example, all vessel information within the system is stored within a single database register of vessels. Other data storage structures include databases for voyage plans, transit plans, met-ocean data and business messages.

Custom interfaces between the DUKC® Series 5 modules and the various met-ocean sources, ship information systems and VTS users are configured (or developed where necessary) by OMC for the DUKC® system. OMC has extensive experience configuring and developing such interfaces and has an extensive library of tried and tested interfaces available.

User Management Service

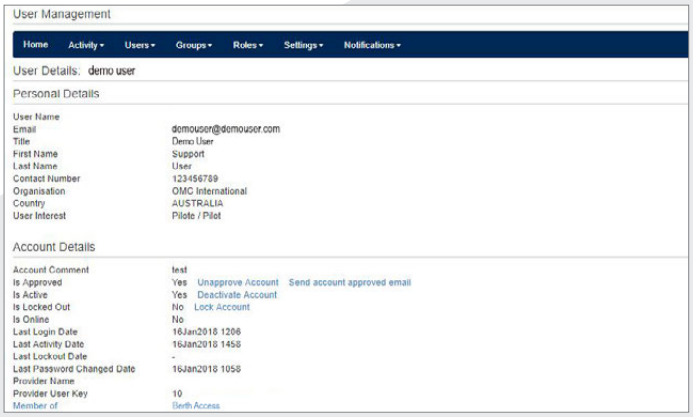


Figure 12: Sample definition of user groups within the User Management service.

The User Management Service allows system administrators to manage user accounts and permissions. Access to most functional aspects in the DUKC® Series 5 can be controlled via user permissions. Administrators have the possibility to grant or deny individual users or user groups access to particular functions within the system.

It is possible for administrators to define new user groups, lock user accounts, define new user accounts or configure a password policy.

DELIVERING TOTAL PORT SOLUTIONS

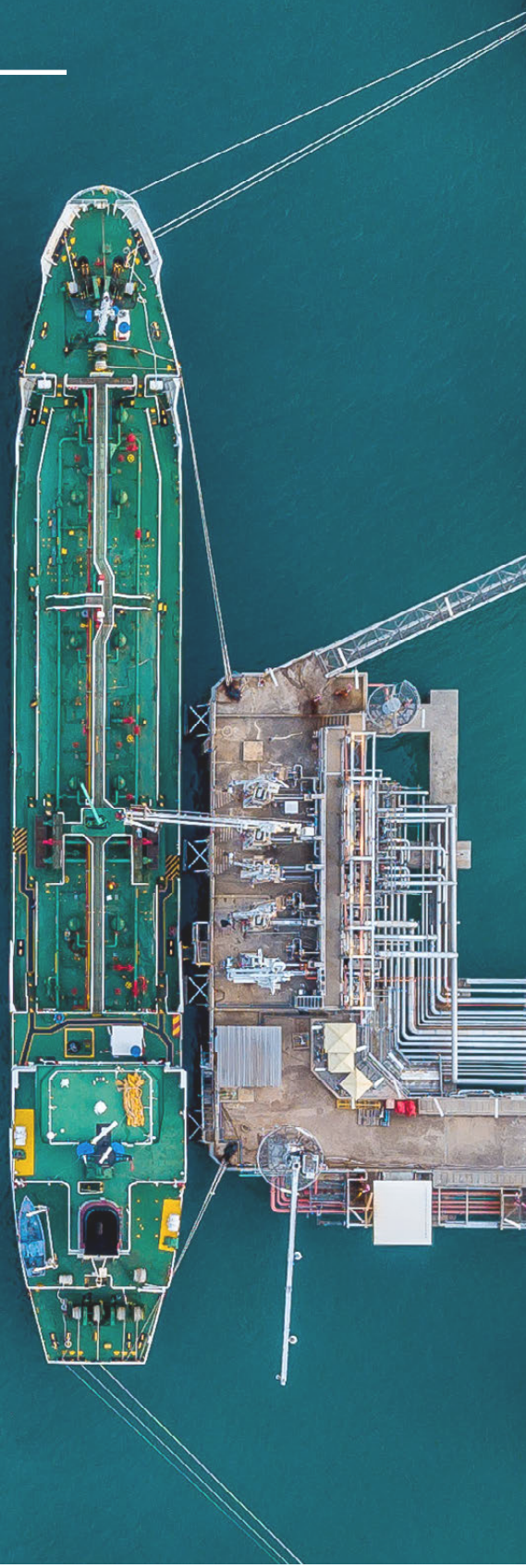
DUKC®

DUKC® has assisted more than **120 port facilities, terminals,and waterways to safely and efficiently conduct 165,000+ deep draft transits**. Utilising state-of-the-art modelling techniques, DUKC® is the world's most comprehensive, and extensively validated, operational UKC management system.

Drawing on a team of engineers, environmental scientists, naval architects, and master mariners, OMC's waterways design expertise is built on a 25 year history of leading the development and implementation of operational UKC technology (Vertical Dimension).

Our unique technology has been extended to include the Horizontal Dimension, port operations and statistical modelling techniques. This enables us to provide an even more precise cost benefit analysis for our clients.

Our optimisation methods enable dredging to be targeted, ensuring maximum return on investment and minimum environmental impact.



OMC's additional capabilities:

- Horizontal and Vertical Channel Design
- Met-ocean Data Measurement and Forecasting
- Capital and Maintenance Dredging Optimisation
- Channel Siltation and Maintenance
- Dynamic Port Capacity Modelling
- Ship Motion Analysis
- Mooring Design and Berth Warning Systems
- Ship Simulation

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