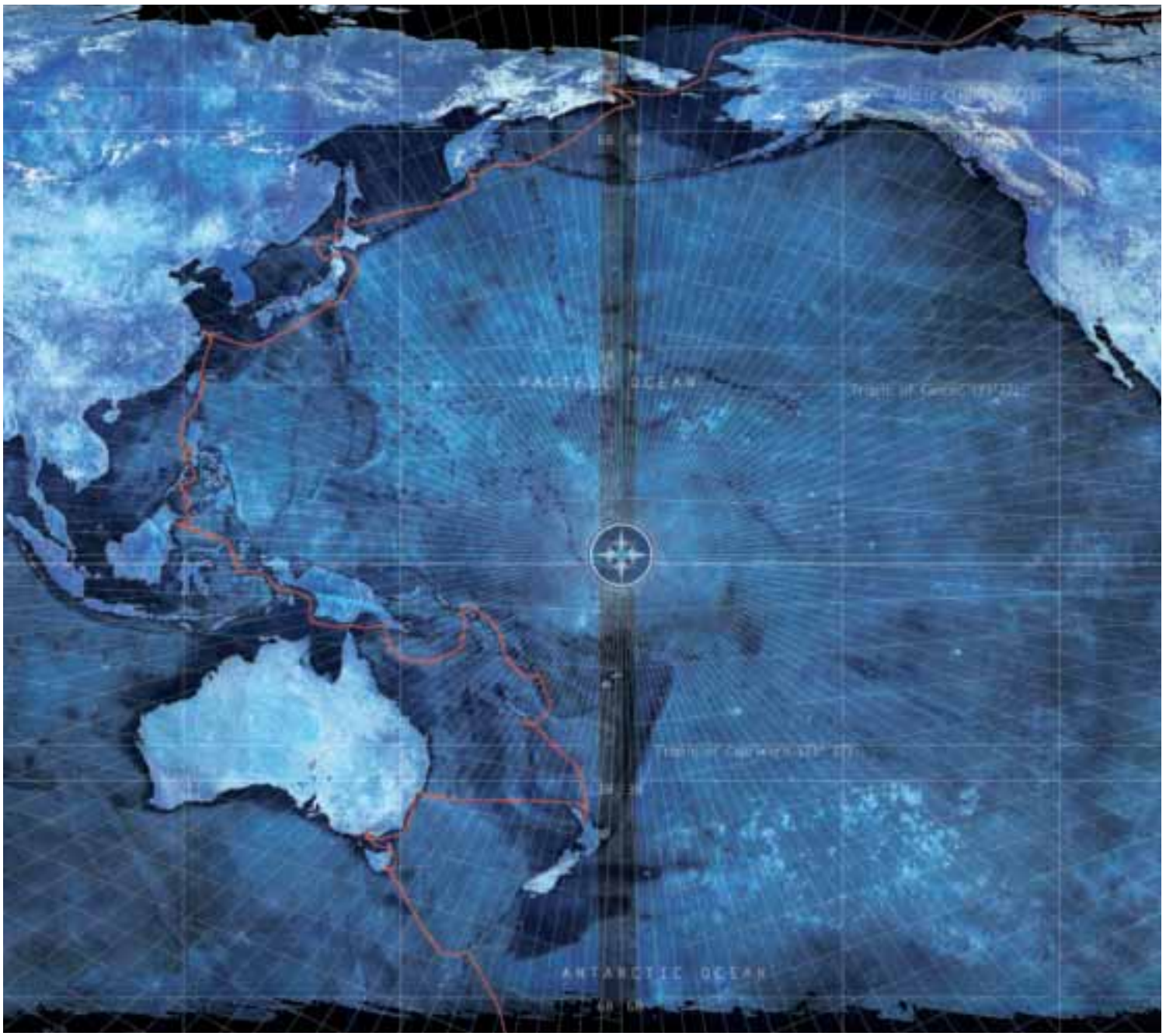
ISSUE 143
MAY 2013

The Superyacht REPORT

TRUTH • OPINION KNOWLEDGE • IDEAS AND EXPERT INDUSTRY ANALYSIS



CONVERSIONS

The transformation of *Enigma XK* from a military vessel into a superyacht, and the issues involved in such conversions.

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CAPTAINS FOCUS

Captains' concerns relating to security and safety; plus we look at the latest stabilisation products.

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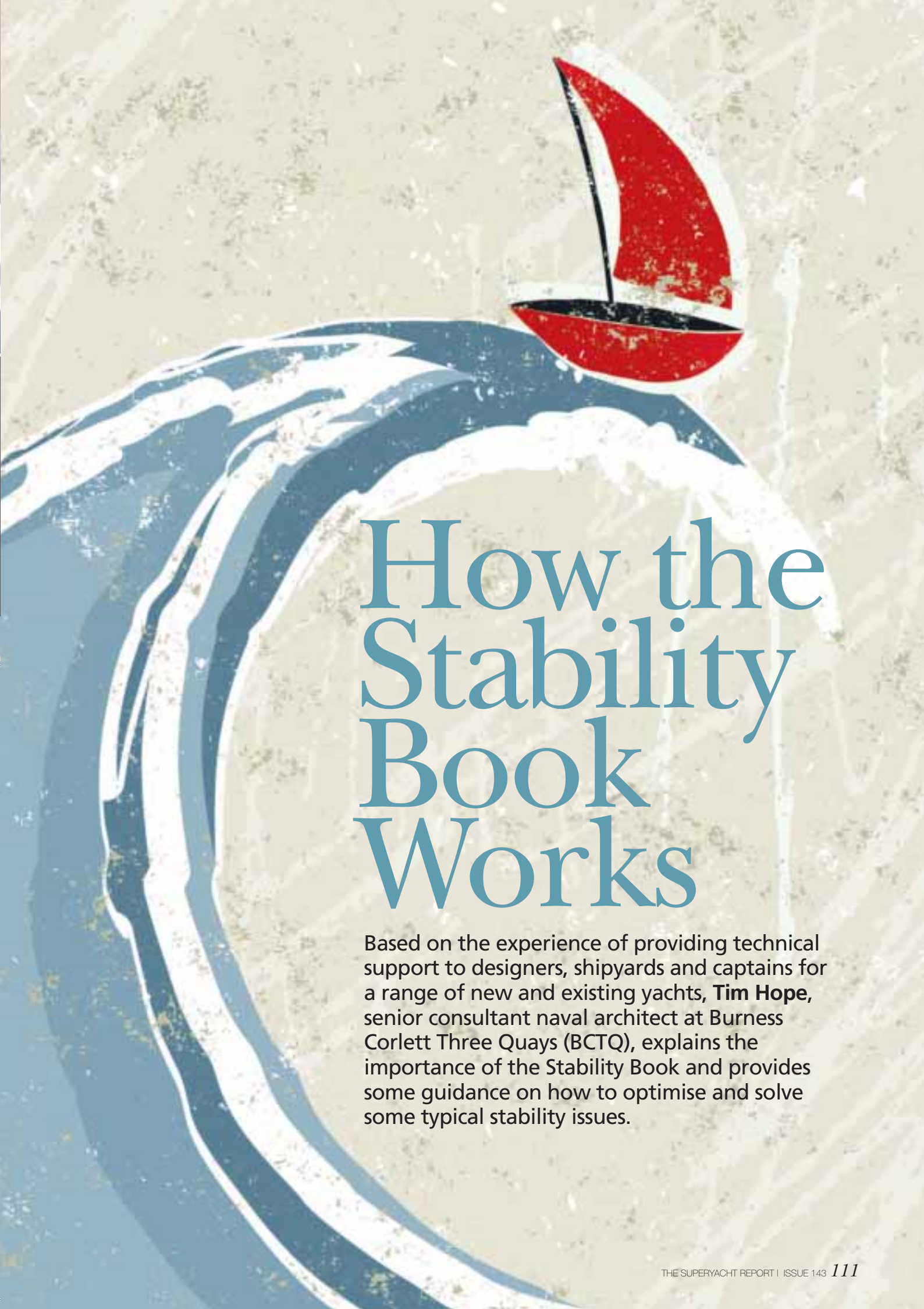


How the Stability Book Works

Based on the experience of providing technical support to designers, shipyards and captains for a range of new and existing yachts, **Tim Hope**, senior consultant naval architect at Burness Corlett Three Quays (BCTQ), explains the importance of the Stability Book and provides some guidance on how to optimise and solve some typical stability issues.

A YACHT FIT FOR PURPOSE

Behind the glamour and prestige of the superyacht are the fundamentals of naval architectural design and the more mundane, often-perplexing matter of stability. Stability is an essential quality of seaworthiness and provides a basic factor of safety to help protect against the dangers of overloading, capsize and sinking during the lifetime of every motor or sailing yacht.

The evolution of the superyacht continues to create ambitious designs that tend to be driven by aesthetic form rather than function, but regardless of a yacht's chic appearance, stability is a quality that must not be compromised. A yacht can encounter a diverse range of environments: from the calm of Monaco harbour to the intrepid ocean voyage, and therefore stability characteristics must be given careful consideration from the early stages of design and throughout operational service life.

A yacht must have sufficient stability with adequate margins to be fit for intended purpose. For example, a good stability margin would allow a motoryacht to carry the required fuel capacity for a specified range without exceeding the design draught, and for a sailing yacht the ability to carry enough sail to achieve expected performance.

MANAGING STABILITY FOR A COMMERCIAL OR PRIVATE YACHT

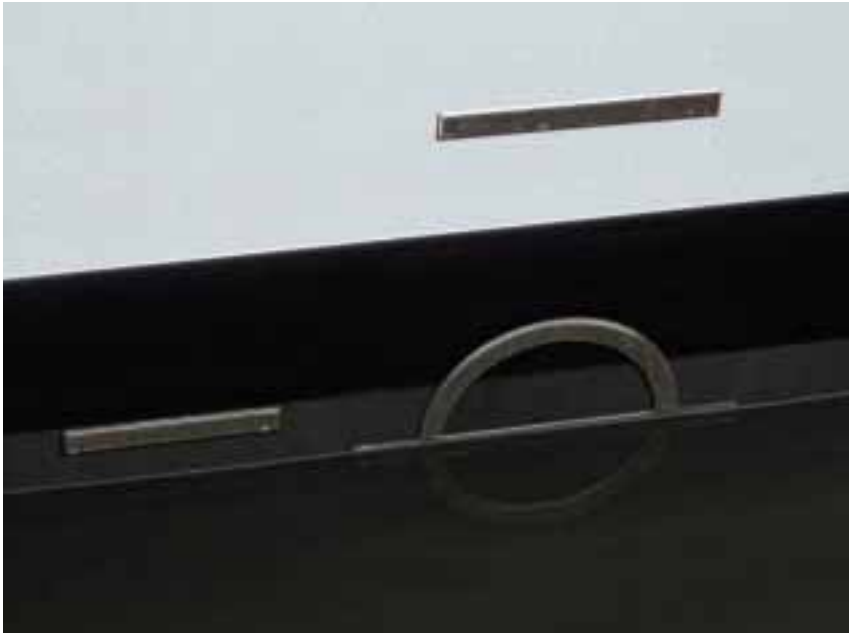
To manage stability the superyacht is equipped with a stability book. This is not a glossy coffee-table publication, but a statutory document produced by a naval architect to evaluate all aspects of a yacht's stability for compliance with the relevant stability standard and to provide the cardinal rules for calculating a yacht's draught, trim and conditions of loading.

> The stability book is mandatory for a yacht that intends to operate on a commercial basis as a charter yacht. It is also necessary for the safe operation of a private yacht to satisfy the yacht's insurance company.

The origins of the stability book stem from the legal requirement, under the International Convention on Load Lines 1966 (ICLL), that any commercial vessel with a load line length of 24m and above, including a yacht, cannot proceed to sea without a load line certificate. This certificate is issued by a classification society, such as Lloyd's Register, which assigns a maximum legal draught limit a yacht can be loaded to and is based on calculations for a minimum freeboard requirement that helps to ensure an adequate reserve of buoyancy for the yacht's intended use and therefore provides a significant contribution to safety.

To obtain a load line certificate, it is a mandatory requirement to have on board an approved stability book that validates a set of loading conditions for compliance with the minimum intact and damage stability criteria published by the relevant Flag State's code of practice, such as MCA Large Commercial Yacht Code for UK registered vessels. The stability book is mandatory for a yacht that intends to operate on a commercial basis as a charter yacht. It is also necessary for the safe operation of a private yacht to satisfy the yacht's insurance company.

For a shipyard and captain, one of the most important documents on board the yacht will be the stability book, for which there are many implications. To live up to the expectations of an owner taking delivery of a newly built or refitted yacht, the shipyard will have an obligation to meet the contractual technical specification that will specify the loading and stability requirements.



WARNING SIGNS: A YACHT FLOATING DOWN TO OR EXCEEDING ITS LOAD LINE MARKS SHOULD BE INVESTIGATED.

The flip side for the shipyard not meeting the contracted stability requirements can result in heavy financial penalties, and the captain, who is responsible for the safe and efficient operation of his or her command, will have to contend with a yacht with poor stability that is unable to achieve the required range or performance.

USING THE STABILITY BOOK

For the captain as end user the sight of the stability book can appear a daunting volume filled with a multitude of calculations and computer print-outs. There is no doubt that stability is a complicated subject; however, to mitigate matters, the stability book can be seen to serve two purposes. Firstly, as previously mentioned, it demonstrates a yacht's compliance with the stability requirements set out in the code, hence all those calculations. Secondly, it provides a simplified stability information manual that will allow the captain to assess stability in any loading condition.

It is the captain's duty to have a sound knowledge of how to use the stability book and it is the naval architect's job to ensure that all information contained has been clearly explained. Fortunately, to help ease the pain of any calculation work, the exact stability information can also be produced at the push of a button by using an on-board loading computer; there are various companies that offer this service using Class/Flag-approved software.

A stability book needs to be handled with some care too. The stability information will not immunise against a capsize or ultimate loss of the yacht, as it still remains the captain's responsibility to exercise prudence and good seamanship with regard to the weather, area of navigation and the prevailing conditions.

On a yacht the most common symptoms diagnosed that cause a stability problem relate to weight and its effect on draught and vertical centre of gravity (VCG) and its effect on stability. Experience has shown there is general trend for a yacht's weight and VCG to change, but in the wrong direction, and that is UP!

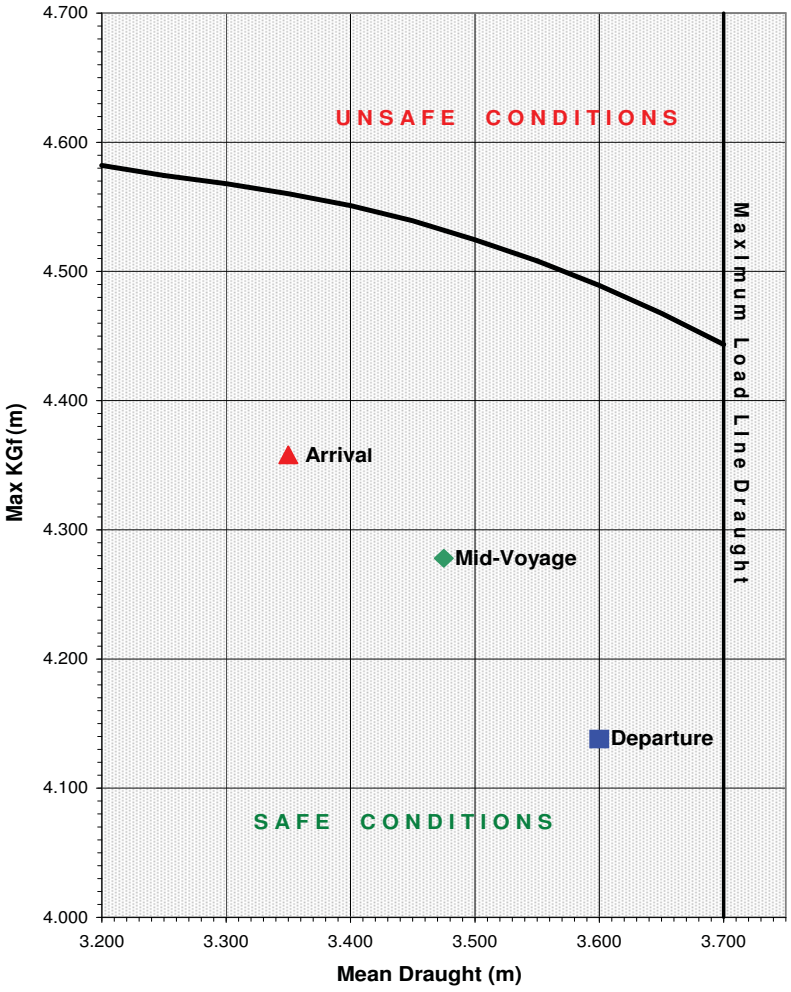
Similar to humans, a yacht can become overweight in its lifetime. Over time, most yachts will accumulate weight during refits from modifications, fitting additional equipment and refurbishing accommodation spaces, which tend to shift the weight above the existing VCG. Unfortunately, some new yachts are born heavy too. A new yacht in build can be subjected to various design changes by an owner and, as a result, the yacht can suffer from an increase in weight and a higher-than-anticipated VCG, eroding any available design margins.

STABILITY TROUBLESHOOTING

The prognosis for any new or existing yacht that is deemed to be overweight with a high VCG is not good news and may trigger the owner to seek technical assistance in solving the problem. To cure stability problems, such as exceeding load line draught, failing to meet stability criteria, excessive trim, an inherent heel or the yacht just feeling less stable, various measures can be taken.

Maximum allowable KGf curve

For any loading condition, the vertical centre of gravity fluid (KGf) must always be below the max KGf curve and the mean draught must not exceed the load line.



MEETING THE STABILITY REQUIREMENTS: ALL YACHT LOADING CONDITIONS SHOULD MEET THE MAXIMUM ALLOWABLE FLUID VCG (MAX KGF) OR MINIMUM FLUID GM CURVE WITH A HEALTHY MARGIN.

INVESTIGATION WORK: SOMETIMES A 3D LASER SCAN OF THE HULL GEOMETRY CAN BE A NECESSITY TO HELP CHECK HYDROSTATICS AND DRAUGHT MARK POSITIONS.

The following case studies describe solutions to some typical stability problems encountered:

CASE A – A NEW YACHT IN BUILD

A stability problem became apparent during the final months of completion. The yacht's lightship weight and VCG had increased during the design and build.

Investigation

- The inclining experiment was repeated to establish the latest lightship characteristics.
- The position of load line and draught marks were checked and found to be correct.

Solution

- To fit sponsons (buoyant structures added to the side of a yacht) to add additional waterplane area to improve transverse stability and to increase the required displacement.
- Permanent ballast was fitted to lower VCG.
- The shipyard submitted a revised stability book for approval.

CASE B – AN EXISTING YACHT IN SERVICE

Alterations had been made to the yacht's general arrangement. In service, the yacht's stability had become tender and had developed an excessive trim. Draught marks were either incorrect or missing. The yacht's certification was withdrawn since the Flag surveyor had noticed the load line was underwater in a half-load condition.

Investigation

- The yacht was dry-docked to conduct a 3D laser scan of hull to establish the correct location of the draught marks and to check the hull geometry with the hydrostatics.
- The load line marks were found to be incorrect and a discrepancy found in the hydrostatics.
- An inclining experiment was undertaken and analysed using the scanned stability model.
- It was discovered that the damage stability no longer complied with the criteria of the MCA Large Yacht Code.

Solution

- A new tank arrangement was defined to improve the distribution of deadweight in the departure and arrival conditions.

• Permanent ballast was added inside skeg.
• All intact and damage stability calculations were re-analysed for compliance with the code.
• A new stability book was produced and issued to Flag to obtain certification for commercial operation.

CASE C – THE CLASSIC YACHT

Similar problems to Case B.

• In general, classic yachts can be an issue because the internal layout and number and the disposition of watertight bulkheads make it more difficult to get them to comply with the damage stability requirements of the Code without making radical changes which can totally alter the classic ethos of the yacht. In a number of cases the only way round this is to assign a short-range notation.
• The client asked for the yacht to be re-certified for unrestricted operation; however, this was not possible and had to remain certified as a short-range yacht.
• To keep sympathetic with a classic yacht's appearance, fitting sponsons or changing the hull form to improve stability is not usually considered an option.
• Changes to the hull form could affect the gross tonnage, which may have significant implications in meeting other regulatory requirements such as structural fire protection, safety and manning levels etc.

From the design and build, to operational service life, a yacht's weight history should be carefully monitored to ensure that the yacht remains fit for purpose and continues to meet the regulatory stability requirements and the expectations of the owner.

Unfortunately, in achieving compliance with regulatory stability requirements a yacht can suffer from the law of unintended consequences, as exemplified by possible increases in gross tonnage. To use an old adage, prevention is better than cure. A yacht needs to be designed with good in-build and future growth margins to allow for inevitable increase in weight and VCG during the life of the yacht.

From the design and build, to operational service life, a yacht's weight history should be carefully monitored to ensure that the yacht remains fit for purpose and continues to meet the regulatory stability requirements and the expectations of the owner. ■

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