

Time to take a long hard look at tug safety

Dr Ugo Savona, salvage master and chief designer of Giano, the new design double-ended tunnel hull tugboat, and Dr Sotiris Skoupas, senior surveyor, stability load line & tonnage with Lloyd's Register Group, discuss the stability of escort, harbour and anchor-handling tugs and moves to improve operational safety



◀ Ugo Savona

Ugo Savona: Approaching the 200 years barrier in the history of mechanically propelled tugboats, an honest and forward looking assessment of the relevant aspects connected to the safety and efficiency of this industry's main tool, the tugboat, is now necessary, especially by a classification society with a responsible and long history.

Ship towing operations have always been seen as an ancillary help to blue water shipping, a sort of little brother, and it has developed along the same lines, following the changes in propulsion available at the time: steam, diesel, reversible engines, reduction reverse gear, variable pitch propellers, and Kort nozzle. From the 1950s onward, the Voith Schneider and azimuth thrusters, positioned in various configurations on the hull of tractor tugs, were in common use.

The actual rules that are in force among the IACS Registers for the classification of tugboats are well known to ship designers of escort tugs, providing the safety frame for designers and operators. The present outlook is for a review in the near future by a joint committee of classification societies.

It is revealing to observe the evolution, over the past 100 years, of one of the main elements of the tugboat, the hull form.

It is well known that the metacentric height GM, and the curve of righting levers GZ, are functions of the following elements: the moment of inertia of the water plane, the volume of the hull and the position of VCG. As a consequence, and in simple words, if two tugs have the same displacement, same water plane area, and same distribution of weights, the shorter one with a larger beam will be the more stable.

Accordingly, the beam of a tugboat that is subject to huge listing moments while working, is a crucial element of stability. Going back some 100 years in the design of ship handling tugs, we can see that an average of 6m beam was quite common in the 1930s to '40s, moving to 7m in the 1960s, to 8m in

the '70s, to 9m in the '90s and finally to 10m at the start of the 21st century.

Today the increase in beam has accelerated and in the short span of 15 years we have moved from the accepted standard of 10m for the bulk of escort tugs in service, to 11m, and recently, to 12m as the standard of any average escort tugs built with BP between 60 and 90 tonnes. The trend toward more compact tugs has also increased.

It is interesting to note that as one of the main elements of stability, the beam of the hull has taken almost 100 years to double in size. Considering that it was quite obviously the main way to increase the safety of the tug, one wonders why it has taken so long to be improved.

One of the possible answers is that this industry is quite conservative. It is a fact that for a long period, the design of ship handling tugs including propulsion, stability, position of tow points, winches and so on was by an 'in house' team of naval architects and marine engineers, with a life-long career in the same towing companies, but disconnected from the real operations on board (and the advice of the skippers concerning situations when they found themselves in trouble).

The following incident, that unfortunately has a sad ending, was told by a competent tug skipper some time ago, and may shine some light on the bias that sometimes we all get from established paradigms, and resistance to necessary changes.

The skipper met the designer of *Flying Phantom*, at the time the latest Clyde Shipping Company tug, built with conventional single screw Kort nozzle, in Scotland in 1981. He noticed that the towing winch was being placed high above the main deck, something that the designer was proud of. The skipper responded negatively, but being just a tug skipper, his opinion was dismissed. The tug was a strong terminal tug, and considered to be one of the very best of that period. Unfortunately it was over-run and girted while towing a 77,000 ton cargo vessel, resulting in the deaths of three crew.

An inquiry by the Marine Accident Investigation Branch (MAIB) later concluded that the tug's towing winch had not released quickly enough, which meant it was capsized by the vessel it was pulling.

The new tasks to which the escort tugs are called upon require an update of all elements relevant to safety. Quite often during escort operations, tugs are brought to their extreme limits with sometimes half of their deck underwater at severe angles of list.



◀ Sotiris Skoupas

Sotiris Skoupas: Special attention must be given to total manoeuvrability, to allow the skipper to handle any situation when under a ship, especially in the lead forward tow. Double-ended propulsion may be an available answer, if fitted in advanced designed hulls. Towing points at forward and aft ends may avoid the danger of girting.

The stability characteristics of the ship during towing and anchor-handling operations are subject to dynamic phenomena which cannot be evaluated completely by using the static properties of the GZ curve, such as the righting arm and metacentric height (GM) values. Today, beyond the existing prescriptive rules and regulations, there are alternative methodologies for assessing ship stability where real operational scenarios can be simulated by using time domain and computer fluid dynamics (CFD) tools as well as model tests. As a matter of fact Lloyd's Register (LR) has been working extensively over the past four years with the designers and builders of one of the new generation tugboats, matching above standards, and remains at the forefront of innovation.

It should always be borne in mind that the existing stability standards provide the minimum requirements for the safe operation of vessels. Owners, operators, crew, authorities and everybody involved in decision making during towing, anchor-handling or lifting operations, should always carefully assess all risks before taking action. The sad event of the capsizing of the newly built AHTS *Bourbon Dolphin* on 12 April 2012, when eight people lost their lives, increased the need to adopt new international standards in order to improve the safety level by design and during operations.

LR is continuously and closely working with IACS and the IMO in the development of new international standards for the safe design and operation of tugs. The IMO maritime safety committee at its 88th

session (MSC 88) agreed to include in the agenda an item regarding the development of amendments to the 2008 IS Code relating to towing and anchor-handling operations. After six years of extensive discussion among the IMO bodies, the agenda of the session of the maritime safety committee in November 2016 (MSC 97) included the consolidation and adoption of the agreed amendments to the introduction, part A and part B, of the 2008 IS Code with respect to vessels engaged in lifting, towing and anchor-handling operations. The intention of IMO bodies is that all the amendments will be adopted as a consolidated package and enter into force at the same time on 1 January 2020.

According to the new international standards, where a ship is expecting to carry out anchor-handling, towing or lifting duties, the necessary calculations should be carried out and the stability criteria satisfied. This will provide additional standard calculations to be assessed and approved where mandated by the flag administration. Approval would be carried out by the relevant flag administration or recognised organisation. Additionally, safe operation guidelines for the crew will be required.

With respect to the forthcoming amendments to the 2008 IS Code relating to towing operations there will be new requirements applicable to ships and other marine vehicles of 24m in length and above when engaged in harbour, coastal or ocean-going towing operations and escort operations. As part of these requirements a vessel engaged in towing operations should be provided with means for quick release of the towline, including vessels provided with towing winch systems.

According to the new definitions, 'ship engaged in harbour towing' means a vessel engaged in an operation intended for assisting ships or other floating structures within sheltered waters, normally while entering or leaving port and during berthing or unberthing operations.

'Ship engaged in coastal or ocean-going towing' means a vessel engaged in an operation intended for assisting ships or other floating structures outside sheltered waters in which the forces associated with towing are often a function of the ship's bollard pull. Reference is also made to the guidelines for safe ocean towing (MSC/Circ.884).

'Ship engaged in escort operation' means a ship specifically engaged in steering, braking and otherwise controlling of the assisted ship during ordinary or emergency manoeuvring, whereby the steering and braking forces are generated by the hydrodynamic forces acting on the hull and appendages and the thrust forces exerted by the propulsion units.

The new stability criteria will apply to newly constructed vessels engaged in harbour towing, coastal or ocean-going towing and escort operations and to vessels converted to carry out towing operations. The criteria for ships engaged in towing operations require

► *The Ugo Savona-designed Giano tug demonstrates the side stepping manoeuvre*

the calculation of the self-tripping and tow-tripping heeling levers as a function of heel, based on the propulsion and towing arrangement by using semi-empirical formulas. For the evaluation of the stability particulars during escort operations, for each equilibrium position the corresponding steering force, braking force, heel angle and heeling lever are to be obtained from the results of full scale trials, model tests, or numerical simulations in accordance with a methodology acceptable to the flag administration. For the purpose of stability for ships engaged in towing operations, the calculation of the heeling lever is to be taken as constant and equal with the maximum heeling lever of each relevant combination of loading condition and escort speed.

"Everyone involved in the design and operation of tugs should not compromise on safety and always follow the new international standards as minimum requirements"
Sotiris Skoupas, Lloyd's Register Group

In addition to the standard stability criteria given in part A of the 2008 IS Code, or the equivalent stability criteria given in chapter 4 of the explanatory notes to the 2008 IS Code, where the ship's characteristics make compliance with part A impracticable, the vessel should also comply with a new set of criteria depending on the type of operation (harbour, coastal, ocean-going or escort towing). The new criteria are based on the energy balance principle (similar to the weather criterion) saying that when a heeling moment is acting dynamically, the dynamic angle of heel is resulted from the equalisation of the work of the heeling and righting moments. For ships engaged in harbour, coastal or ocean-going towing operations, the static heeling angle resulted by the towing moment should be less than the angle of down-flooding, while for ships engaged in escort operations the resulted static angle should be less than 15 degrees.

The new criteria define the minimum requirements for ensuring that the righting moment during a towing operation will be sufficient in order to overcome the dynamic heeling moment and the static angle will not exceed specific limits.

Apart from the stability criteria, the new amendments to the 2008 IS Code also



include design precautions and operational procedures against capsizing. For example, the access to the machinery space (other than emergency and removal hatches) should, if possible, be arranged within the forecastle, while any access to the machinery space from the exposed cargo deck should be provided with two weathertight closures, if practicable. In addition, the area of freeing ports in the side bulwarks of the cargo deck should at least meet the requirements of regulation 24 of the *International Convention on Load Lines, 1966* or the *Protocol of 1988* relating thereto. During the operation, the arrangement of cargo stowed on deck should avoid blocking the freeing ports, shifting and not interfere with the movement of the towline.

In addition, the amendments to the code include guidance and requirements regarding the preparation and retention of the stability information and operational booklets onboard the ship as well as the calculations performed by computer loading instruments. For example, ships engaged in anchor-handling should be provided with planning tools in compliance with the operational manual requirements, while information such as ballasting and consumables sequences, permissible tension, working sectors, heeling angles and use of roll-reduction devices should be stated.

The amendments and adoption of new international standards comprise a significant step towards the reduction of the risk associated with loss of stability (capsize or sink) and aims to minimise the consequences by providing design and operational measurements. Although part B of the 2008 IS Code is non-mandatory and will have the title *Recommendations for ships engaged in certain types of operations, certain types of ships and additional guidelines*, everyone involved in the design and operation of tugs should not compromise on safety and always follow the new international standards as minimum requirements.

Further reading: LR Future IMO legislation, March 2016; LR Report to MSC 96, May 2016; IMO Documents: MSC 97/3/1, MSC 96/3/1, SDC 3-21, SDC 3-7; LK Kobylinski & S Kastner *Stability and Safety of Ships - Volume 1*, Elsevier, 2003