

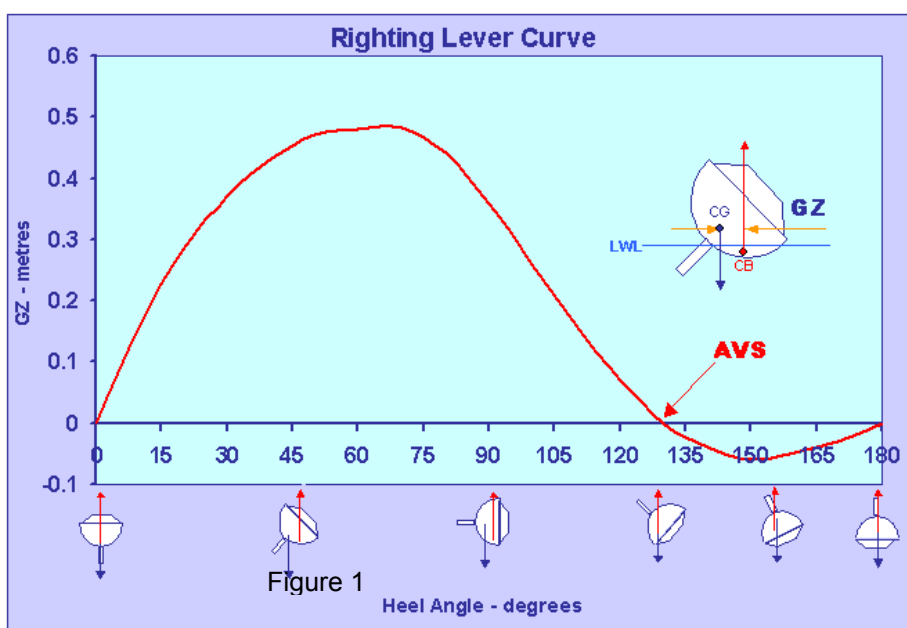
Just as it is mandatory for the fuel consumption of all new cars to be published so the RYA believes that stability information should also be available to a buyer of a boat

This section of the RYA website explains the fundamentals of stability and lists stability information made available to the RYA

Monohull Ballasted Yacht Stability

Monohull ballasted sailing yacht stability considerations come in two types – static and dynamic. Both are normally expressed in terms of transverse or longitudinal stability but mainly transverse. A stability curve is generated by plotting a stationary (static) boat's righting lever against its angle of heel. The lever is the horizontal distance between the boat's centre of gravity (CG) and a vertical line through its centre of buoyancy (CB). This lever is known as GZ and that's why the stability curve is often called a GZ curve.

When upright, the CG will be in the same vertical line as the CB (usually the centreline) and so there is no righting lever i.e. $GZ=0$. But, when a boat heels (through the action of wind or waves), whereas the CG will



remain in the same place (assuming no bilge water), the CB will move to one side and a righting lever is generated. As the boat continues to heel the lever will increase to a maximum and then start diminishing until the CB is once again on the same vertical line as the CG. At this point the righting lever is again zero but unlike when upright, the boat will tend to invert if its heel angle continues to increase. This point is called the Angle of Vanishing Stability (AVS). Once heeled past its AVS the GZ will become negative and an *inverting lever* rather than righting lever. Unless affected by some outside force, the boat will continue to 180 degrees of

heel until the CG and CB are once again on the same vertical line and the boat is *stable* although now upside down. Figure 1 shows a GZ curve for a typical monohull ballasted sailing yacht.

For ocean-going and offshore yachts one of the most easily seen and meaningful aspects of a GZ curve is the AVS.

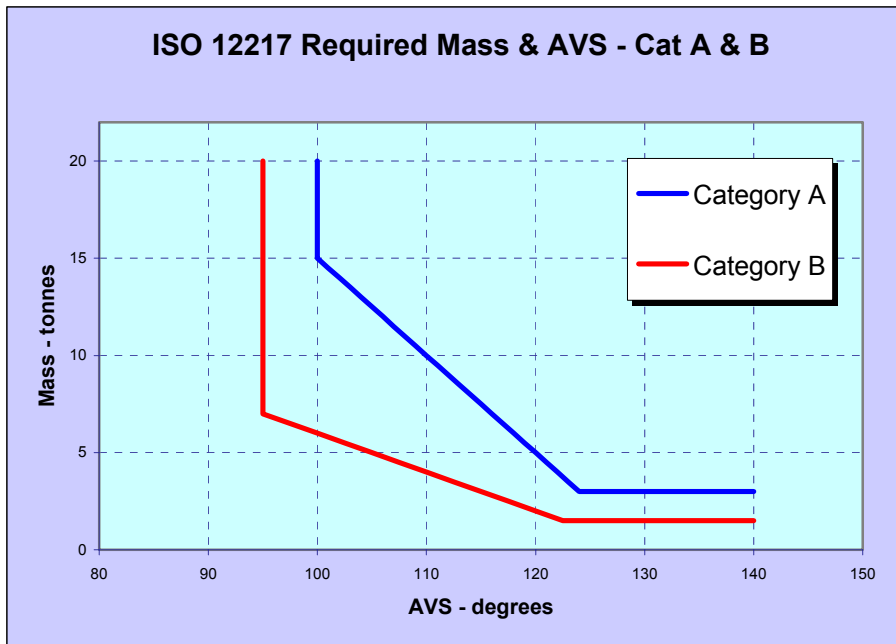
But a GZ curve and its AVS are by no means the whole transverse static stability story. A boat's mass (displacement) is also very important.

A lever, when multiplied by the force pushing it, becomes a moment. With a boat the lever is the GZ and the force is the boat's mass. So by multiplying GZ by the boat's mass gives a righting moment (RM) curve. As the area under this curve represents the energy needed to heel the boat, then for the same GZ curve, a boat of double the mass will need twice the energy to capsize (and twice the energy to re-right after capsize).

ISO 12217

It is for this reason that the recently launched International Standard dealing with the stability of monohull ballasted sailing yachts (ISO 12217-2) uses both AVS and mass as its two main static stability limits. RCD* Category A boat limits are a minimum mass of 3.0 tonnes and an AVS greater than $(130 - (2 \times \text{mass}))$ but always equal to or greater than 100° .

RCD* Category B boat limits are a minimum mass of 1.5 tonnes and an AVS greater than $(130 - (5 \times \text{mass}))$ but always equal to or greater than 95° .



Diagrammatically this means an RCD Category A boat needs to be to the right of and above the blue line in figure 2 and an RCD Category B boat to the right and above the red line.

Unlike static stability, the assessment of dynamic stability is far more difficult as there is little quantitative information on the subject. The RORC Triple S Numeral developed in the 1980s and the RYAs own STOPS number used for smaller MCA Code vessels since the 1990s start to approach the problem but both in a very rudimentary manner (nevertheless both are very successful).

It was from work on these two screening formulae that the ISO working group drafting the new stability standard developed its own stability index screen known as STIX. The RYA played a major part in this work. The STIX screen is applied by the standard in addition to the above limits of mass and AVS.

STIX

STIX, which scores a boats stability on a scale of 1 to 100, uses a boats length as it's prime factor adjusting this by seven other factors including assessment of a boat's

- ability to withstand a capsize by considering the area under it's GZ curve,
- recovery from inversion by looking at it's AVS and mass,
- recovery from knockdown by overcoming water in the sails,
- displacement-length factor giving credit for a heavy displacement for a given length,
- beam-displacement factor recognizing problems associated with topside flare and excessive beam,
- wind moment representing the risk of flooding due to a gust and
- the risk of downflooding in a broach or knockdown.

STIX is arguably the most sophisticated stability screening tool yet available. The required RCD* STIX limits which are applied in addition to the above limits on mass and AVS are:-

Category A equal to or greater than 32
 Category B equal to or greater than 23
 Category C equal to or greater than 14
 Category D equal to or greater than 5

Since June 1998 all new recreational boats sold in the EU have been required by law (the RCD*) to have undergone a stability assessment with the preferred method being the application of ISO 12217. This means that all but a very few new monohull ballasted sailing boats sold in the UK (including all of those imported) should have had a GZ / RM curve generated, their displacement and AVS determined and a STIX calculated. To this end, by the time you read this, the RYA will have circulated a copy of this article to builders together with a request for stability data on their models. Where this has been received it will have been published on the Technical part of the RYA web site. If the data is not there then ask for it and also suggest it should be sent to the RYA. If it's still not made available then smell a rat.

*RCD stands for Recreational Craft Directive, an EU Directive setting down minimum safety standards for the construction of recreation craft

A more detailed explanation of this and other factors affecting a boat's stability is given in the RYA book G23 - Stability and Buoyancy available from the RYA at a price of £4.15 plus p&p, call on 0845 345 0372 for details of how to order.