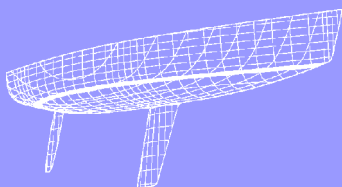




*World Leader in Rating Technology*

# OFFSHORE RACING CONGRESS



## ORC Stability & Hydrostatic Datasheet Explanation

## 1. INTRODUCTION

The Stability and Hydrostatic Datasheet provides information on the static stability of your yacht at various angles of heel, depicted in tabular as well as graphic form. This information will be useful to you the sailor, but to offshore race organizers interested in defining relevant safety standards in their entry requirements.

The Datasheet shows that the righting arm increases at first as the boat is heeled, and from that point on the stability decreases. With further heeling the righting arm which provides positive stability comes to zero. As the boat is rolled still further the righting arm becomes negative. That is, the boat wants to capsize and float upside down.

The crossover point is called the Limit of Positive Stability (LPS). The graph also shows the ratio of positive stability to the negative stability as the area under the positive part of the curve divided by the area above the negative part of the curve.

Stability curves vary for different types of boats. A wide, flat-bottomed boat will have high initial stability but after reaching an early peak, the stability declines rapidly. Its limit of positive stability may occur at  $90^\circ$  and if inclined this far the boat will not be self-righting. Some modern offshore racers have been of this type thus requiring screening and actual tests of self-righting ability.

In contrast, deep narrow boats with deep keels will not have high initial stability but their limits of static stability may extend to  $150^\circ$  or more. That is, they can be heeled past  $90^\circ$  by  $60^\circ$  more before they capsize. If one did capsize, only a small amount of rolling would move the hull into the positive righting area and the boat would come back upright.

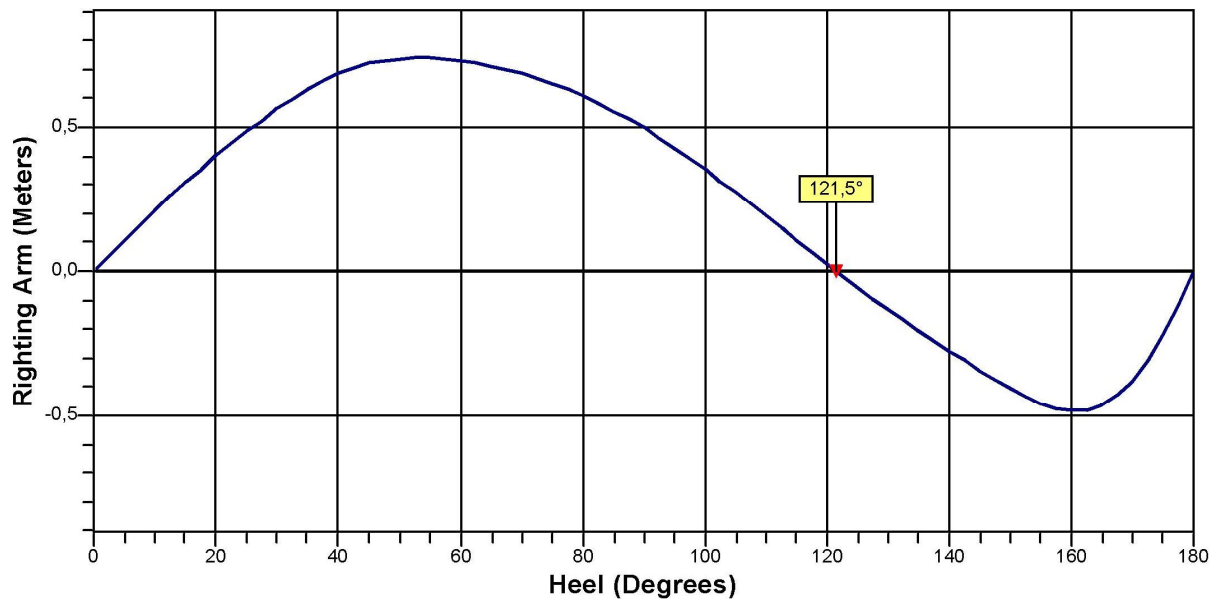
Specific values for LPS are often prescribed by offshore race organizers, so use this Datasheet to make sure your boat complies with these limits.

## 2. STATIC STABILITY

Numerous offshore races in recent years have focused attention on all aspects of yacht safety including stability with respect to capsizing. The hydrostatic analysis of stability is therefore an accepted practice in naval architecture, which requires a lengthy set of calculations based upon a complete description of the underwater portion of the yacht.

A positive righting moment acts to restore a heeled vessel to its upright condition. The conventional measure is righting moment per degree, which has been included in several rating rules to assess sail-carrying ability. This single parameter fails to account for the reduction in righting moment which occurs at large heel angles, however. For this reason, ORC takes account of the theoretical stability at  $25^\circ$  heel in predicting boat performance, and for safety purposes certificates also include calculations of the righting arm (righting moment divided by displacement) for several heel angles between  $2^\circ$  and  $165^\circ$  (the righting arm at  $180^\circ$  is equal to zero).

Examine the stability graph showing righting arm plotted against heel angle for your yacht. It may be instructive to compare this with the graph for a representative 41' keel boat (see below). The complete curve of righting moments includes a positive range, between zero and the "stability limit," where the boat is upright, and which varies from boat to boat. For the example boat the calculated limit is  $121.5^\circ$ .



In principle, a yacht which is heeled beyond the stability limit will capsize, since the righting moment and righting arm are negative beyond the stability limit. The area under the positive portion of the righting arm curve is proportional to the amount of energy required to capsize the hull. Conversely, the area enclosed by the negative portion of the curve is proportional to the energy required to return to an upright condition. These two areas are tabulated in units of degree-meters. The ratio of these two areas, also shown on the graph and data sheet, is a measure of relative stability in the upright and capsized conditions.

In the case of the example 41' keel boat, this ratio is equal to 3.88, implying that nearly four times as much energy is required to capsize the boat as to return it. A large value of this ratio implies that while sailing the capsized yacht will be returned to its upright condition by a succeeding wave, if not by the angular momentum in its original capsize motion.

If your yacht has a relatively small value of this stability parameter, you may wish to consult your designer regarding the appropriate explanation or corrective actions.

Note that the theoretical predictions of stability are affected by these several important assumptions and restrictions:

1. *The vertical position of the center of gravity is derived from the inclining test, and therefore may be subject to any possible measurement errors.*
2. *No account has been given to the positive buoyancy from deck camber, house, and other structures above the rail which, depending on their integrity, may improve the stability at large heel angles.*
3. *The negative effect due to cockpit volume has been neglected.*
4. *Internal fluid free surfaces, either in tankage or in bilge water, will serve to reduce both the positive and negative righting arm.*
5. *It is impossible to account for many of the factors which affect the dynamics of a hypothetical capsize in a steep breaking wave.*
6. *Stability information not derived from a full measurement and inclining test – as may be the case for some ORC Club certificates - may be prone to inaccuracy.*