THE A/B RATIO IS A Myth

By Stephen R. Seaton

As you can guess, part of a designer’s job is to insure the safety of the vessel; nothing earth shattering here. So sometime during the process of designing the boat, a client will usually want to discuss the stability of his or her vessel. I will try to explain ultimate stability but in reality, what they really want to know is, "..... At what point will my vessel roll over and capsize?”

I have found that often they may have read Captain Robert Beebe’s book (as revised by James Leishman), ***Voyaging Under Power***. Or maybe they read something on a forum or talked to an “expert”. They will then tell me they understand that the optimum A/B ratio should be less than 2.6. “What is the A/B ratio on the boat you are designing for me?” they will ask. It soon becomes clear that my client has a lack of understanding of what is important to stability. So I usually answer in my most professional manner with, "...heck if I know." I do this to set the stage for what is to come. It is time to have a lesson in basic Naval Architecture 101.

Back in 1975 my friend, Capt. Robert Beebe, wrote the original "***Voyaging Under Power***" where he gives a wealth of practical information about long range cruising on a power boat. In his book, Beebe mentions several of my designs. However, his book was never intended to be a dissertation on Naval Architecture. I believe the problem began when Beebe came up with the concept of the A/B ratio as an important consideration in determining the stability of a vessel. And this notion has survived the more recent revisions by James Leishman. With apologies to (the late) Captain Beebe and Mr. Leishman but the A/B ratio really isn’t relevant to a vessel’s stability.

Yes, a layman may think that too much top hamper (area above the static waterline) as compared to the area below the waterline is not the proper way to design a boat. "Less above and more below is good"; or so most people would think.

Let me back up just a bit before I get too far ahead of myself. Voyaging Under Power lists the A/B ratio as one of the 4 most important coefficients or ratios used in boat design. The A/B ratio as defined is “the ratio of area of the side view of the vessel above water to that below water”. For yachts, Beebe (and Leishman) considers a resultant number in the range of 2.0 to 2.6 to be acceptable and any number above that to be of concern. Again in layman's terms, more below and less above is good.

Now I own or have read almost every book on yacht design and naval architecture and none of them, as far as I'm aware, mentions an A/B ratio……period. For naval architects, there is no such thing as an A/B ratio. The reason for that, I believe, is that the A/B Ratio neglects several areas of importance to the stability of a vessel. In a nutshell, the following areas of design are what govern the stability of the vessel.

- The vertical and horizontal center of gravity
- Beam of the vessel
- The shape of the hull
- Tankage and location of same
- Non-watertight openings and where they are located.

These are just a few of the conditions that go into the calculations. The A/B ratio does not consider any of these.

Just for fun, think of a modern submarine on the surface. They have a great A/B ratio; a lot of area below the waterline and little above. Now think of an aircraft carrier which has a lot of area above the waterline and in comparison, little below the waterline. We all know which is more comfortable at sea and yet both are safe. In this example the A/B ratio is reversed from what you would think would make a proper design. Believe me when I say, "been there, done that" as I experienced this while I was serving in the US Navy. Of these two examples, I would choose the aircraft carrier, (with the worse A/B ratio) any day.

In the past, naval architects had to do laborious calculations by hand to determine static stability. Today we have computer programs that automatically calculate the stability of our designs and with many variables. A normal group of calculations would include:

- just launched (completely empty)
- 25% of wet loads
- 50% of wet loads
- 75% of wet loads
- fully pressed (with all her wet loads)
- And many other sets of loading conditions (supplies, crew, gear, etc.)

All of these calculations are also run at different center of gravity locations. As an example, a client might have 20-30 people standing up on the boat deck watching the 4th of July fireworks or a Christmas Parade. The A/B ratio will not take into consideration that change in stability at all. Also, any dinghy off center, loading and unloading under the various condition noted can effect the stability of the vessel. There are just too many other conditions to note here so let's just leave it at these two examples. As a side note we also might wish to run the above with a "sea running". Yes we can even model the waves (several different types by the way) during a stability calculation (thanks to our computers), this is called Dynamic Stability Calculations.

Once we have modeled all the various parameters, we then let the computer do the math and give us a print out to compare the numbers for this boat to our expectations, past designs we have done, and other known data. In a matter of minutes, the computer mathematically rolls our design while calculating its tendency to either return upright or continue rolling to a greater angle and capsize. The data generated by the computer is the so-called "righting moment curve". This typically depicts a curve that starts at zero moment and zero degrees, increases to a maximum at around 60 degrees and then returns to zero at about 140 degrees. Up to 140 degrees, the so-called range of positive stability, the craft tends to return to the upright position. (Some boats can go to 180 degrees and come back upright but these are rare.) Beyond that, the vessel will keep on rolling and turn completely upside down. If anyone is wishing to learn more, I will be happy to give them a list of books and papers that discuss this subject in great detail.

One more point. Stability calculations are a result of an artificial condition that the boat probably will never encounter exactly. Remember, the designer "mathematically rolls" the boat in still waters. This is known as the "Static Stability" calculations. This is clearly not an accurate representation of what happens when the boat is at sea but a calculation that must be done by the designer to insure the safety of the design. This curve is only the first step in the process. Overlaid on the righting moment curve are further calculations of how wind heeling will degrade her stability, the effects of off center loading (such as putting a dinghy overboard), or high-speed turns. These additional calculations are especially important if you are modeling the vessel in "high seas", racing down the face of a giant wave in near broaching conditions.

Now again back to the A/B Ratio Yes, it is easy to understand. And the naval architect's method of calculating "sort of the same thing" is very complicated. But I suggest we forget the A/B ratio as it is not relevant to stability and may do more harm than good by giving us a false sense of security.

Drop me a line and we can talk more of this subject if you wish. All designers I know will tell you the same story I have outlined here. I am confident that we are all singing from the same page of music when it comes to the A/B ratio.

Again, "Sorry Captain Beebe and James Leishman".