Three Sheets
NORTHWEST

by Vincent Pica

How small of a wave can capsize my boat?

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The U.S. Navy and Coast Guard have amassed a tremendous amount of information about how large vessels can avoid capsizing, but there is little data on how the translates for, say, a 25-foot powerboat in heavy seas.

Background
Wind and waves are the agents of capsizing. To understand the forces of capsizing and how those changes when you load a boat, let's start with some basic terms.

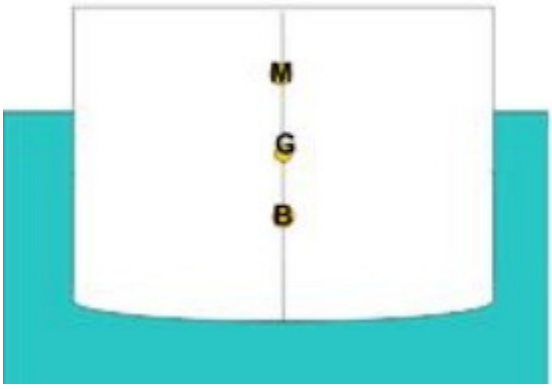
Most of us understand "center of gravity" (G) instinctually. But what is the center of buoyancy? The center of buoyancy (B) is the center of the volume of water which the

hull displaces.

When a ship is stable, the center of buoyancy is vertically in line with the center of gravity of the ship. So as long as the center of gravity (G) pushing the boat down is above the center of buoyancy (B) pushing the boat up, we're good.

How good? That is a *very* good question and as with many good questions, it requires more information to answer properly.

Take a look at diagram A below.



What is that "M" sitting up there above our trusty center of "G"ravity and the center of "B"uoyancy? That is something very important called the "M"etacenter.

The metacenter remains directly above the center of buoyancy regardless of the heeling (tilting caused by external factors such as wind or waves) or listing (tilting caused by internal factors such as poorly stowed cargo or on-boarding of water by wind or waves) of a boat.

Take a look at Diagram B below.

If you are starting to worry about the distance between “G” and “M”, called the “Metacentric height” (or “GM” in naval architecture parlance), you’re catching on quickly. The math gets pretty complicated from here, but suffice it to say that the ability of the boat to right herself (i.e, her “righting arm” or “righting moment”) has a lot to do with GM. The larger the GM acting as a lever, the better.

Sailboats are designed to operate with a higher degree of heel (greater GM) than motorboats but the principles are exactly the same.

From this to wave height?
Yes. If you have a powerboat, you can infer that its center of gravity and center of buoyancy can’t be too far apart when the entire distance from the keel to the floorboards is probably something like two or three feet. Think of a powerboat’s draft — it isn’t a big number, even for a 40-footer.

That’s not reason to panic, but you now realize that M, G and B can’t be that far apart for a powerboat to safely be able to resist capsizing — which means that GM can’t be that great either to avoid capsizing. And GM is a surrogate for the righting ability of your boat.

But wait, you say. You’ve been out in some pretty steep seas and think your powerboat handled it well. That may well be the case; studies conducted by the Society of Naval Architects and Marine Engineers (SNAME) determined that three things must exist for a capsizing to occur:

1. The boat is broadside to the wave. Yes, a boat can be pitchpoled (tossed end over end), but the size of the wave needed to do that greatly exceeds the size of the smaller wave needed to knock a boat down when broadside to a wave.
2. The boat is struck by a breaking wave.
3. The wave height exceeds a certain percentage of the boat’s length.

If those three factors are in place, the wave will contain enough energy to overcome a

boat's righting moment.

What is that "certain percentage?" If we're talking about powerboats, at only 30 percent of the boat's length (about six feet from trough to crest for a 20-foot boat), things enter directly into the realm of high danger. If a wave is 60 percent of a powerboat's length, it is nearly certain that if it hits you broadside and is breaking, your boat and crew are in a potentially fatal situation.

(Sailboats, on the other hand, have keels that often add feet of draft. The righting arm of a sailboat is much longer than a powerboat, and therefore it would take a wave that is a larger percentage of a sailboat's length in order to capsize it.)

So before trying to transit potentially dangerous waterways around the Northwest, think about just how much of a righting arm your boat can possibly have.

This post is courtesy of Capt. Vincent Pica, chief of staff for the First District, Southern Region, United States Coast Guard Auxiliary.

BTW, if you are interested in being part of USCG Forces, email me at JoinUSCGAux@aol.com or go direct to the D1SR Human Resources department, who are in charge of new members matters, at DSO-HR and we will help you "get in this thing…"