

# EXPERT ON BOARD

RYA Yachtmaster Chris Beeson has raced and cruised over 40,000 ocean miles on hundreds of different boats in his 37 years as a sailor



## PERFECT SAILPOWER IN ANY WEATHER

### How to make a sail crossover chart

Use your electronics to build a chart so you know exactly when to change your sailplan. Chris Beeson explains how

**M**ost of us will probably confess to having left up too much sail for the conditions on the odd occasion. It could be seen as a fairly minor transgression in the eyes of the sailing gods but the upshot is more stress on the sails, rig and rigging, more weather helm, heel and leeway, and a less comfortable ride generally. What might not be immediately apparent is that bowling along with the rail under may actually be slower, too. This is where a sail crossover chart comes into play.

A sail crossover chart is essentially a set of rules, determined by you for your boat, that tells you exactly when you need to reduce sail. Rather than sitting in the cockpit trying to convince yourself that 'Another couple of knots of true and I might need to tuck one in,' you have it there in black and white: it's time to reef. It enables you to keep progressing quickly and comfortably in a seamanlike way rather than waiting until the boat starts rounding up and the whole business of reefing becomes that much more difficult and potentially dangerous.

This process will also let you know what to reef first: main or genoa. On a modern boat with a non-overlapping headsail and bigger mainsail, it's likely that you'll reef the main first, and there are two reasons for this. First, it's the bigger sail and its area is contributing to the drastic weather helm usually associated with too much sail. Second, furling genoas go a funny shape when reefed, with a bad entry at the luff and too much draught. This wrecks your ability to point and gives the sail a more powerful shape, which is not what you need.

To make a sail crossover chart, you'll need a steady breeze, true wind speed data and VMG



PHOTO: GRAHAM SNOOK/YM

*With a sail crossover chart, you'll reef at the right time and make more comfortable progress*

(velocity made good, see p17), which will be in your plotter or your instruments. Boats that have a true wind angle read-out can calculate VMG but if you don't have that, just drop a waypoint a couple of miles dead upwind and

the plotter will give you VMG.

Say you're under full sail in 15 knots' true. You're making 6.2 knots but you're over on your ear with 30° of heel and probably losing 15° in leeway. Take in a reef and you're heeling at a much more comfortable 20° and making only 5° of leeway. Boatspeed has dropped to 6.0 knots but your VMG is just the same and you're getting a much more comfortable ride. Once made, a sail crossover chart makes the decision for you.

All you need to do is note the true wind speed, perhaps the sea state too, then shape and trim the sails properly and just sail to windward. Make a note of your average VMG on either tack, how much weather helm you're carrying, and the heel angle too. If you don't

have an inclinometer on board there are smartphone apps that can do the job.

Once you're happy you've got steady data, put a reef in the main, or a second or third reef depending on the wind strength, shape and trim, then sail to windward and note VMG on either tack and heel angle again. Next, shake out the reef and take a couple of rolls in the headsail and do it all again. Soon, your results will make it very plain which is the best set up for the conditions. Do that for a variety of wind strengths and sea states and soon you'll have a chart that explains exactly what sail plan you need for any conditions.

This exercise is intended to demonstrate when you're supposed to reef, and what to reef first. It's intended to do away with the 'Maybe I should reef?' grey area and give you clarity so that, when the true wind reaches X knots, it's time to change gear. Clearly if there's a gentle 5-6 knots of true wind, tucking in a reef will not reveal anything remotely useful. Similarly if it's blowing 30 knots, don't start with full sail. →

**'It does away with the 'Maybe I should reef?' grey area'**

*It's easy to ignore the signs that it's time to reef, and end up in a situation where you'll struggle to do so. A sail crossover chart removes any doubt*



## What is VMG and how do I use it?

VMG is velocity made good. VMG uses some basic trigonometry to calculate what proportion of your boatspeed is being made directly up or downwind.

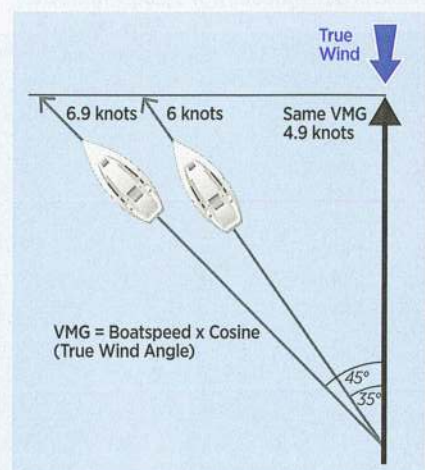
Say you're sailing to windward. Imagine a line from your boat pointing directly into the true wind, VMG is your speed along that line. In this case we're using it to identify which true wind speed indicates that it's time to reef, but there are other uses.

For instance, if you're plugging away hard upwind into a short head sea, it's likely that cracking off 10° will make the motion much more comfortable, reduce heel and boost boatspeed too, so your VMG may increase.

Let's say we are sailing to windward in 14kn of true wind. Our boatbuilder's computer-generated polars say we will make 6.3kn at 35° TWA (5.2kn VMG).

At 45° TWA, the boat is predicted to make 6.9kn (4.9kn VMG). If the 35° TWA is into a short sea, then it's likely that she will not be making 6.3kn boat speed.

If she is making only 6kn at 35° TWA, which doesn't seem unreasonable, then you get the same VMG, 4.9kn, as you would if you just cracked off 10° to 45° TWA. Your VMG is just as good and you get a much smoother ride. This is why it's worth keeping an eye on VMG upwind or down.



*When sailing upwind, cracking off a few degrees could mean a more comfortable ride with no VMG penalty*

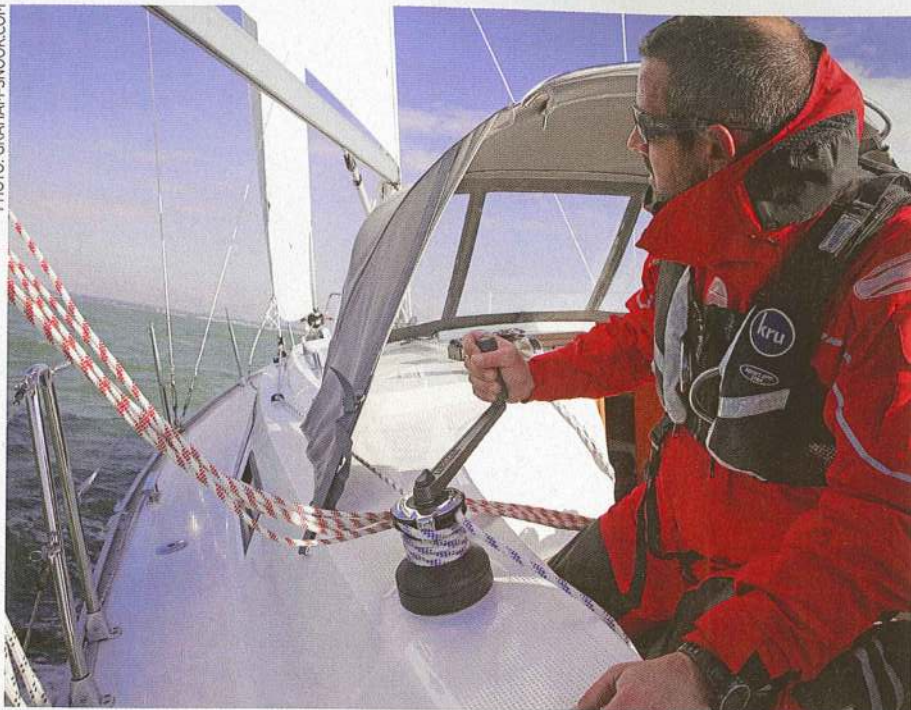
**Cosine (True Wind Angle) = adjacent (VMG) / hypotenuse (Boatspeed), or, in this case, Cosine (True Wind Angle) = VMG / Boatspeed**  
**So VMG = Boatspeed x Cosine (True Wind Angle)**

PHOTO: GRAHAM SNOOK/VM

GRAPHIC: MAXINE HEATH

# Should we be under full sail?

PHOTO: GRAHAM-SNOOK.COM



Having set the jib cars, we trimmed on the jib, then the mainsail

**W**e were sailing a Bavaria Cruiser 34 kindly loaned to us for a few days by Clipper Marine in Swanwick. She had a furling headsail and a furling mainsail, so taking in and dropping out reefs in both sails would be quick and simple. A furling main is slightly smaller than a fully-battened, slab-reefing one, as it has less roach, but there isn't much in it.

As mentioned earlier, these data relate to this boat – not any Bavaria Cruiser 34 but this one specifically. As a stock boat she had new sails, a clean bottom, and she was pretty much unloaded, apart from gear for her three crew, some water in the tanks, fenders and lines. Indeed so new was she that her safety kit hadn't been fitted yet so we all wore our lifejackets throughout.

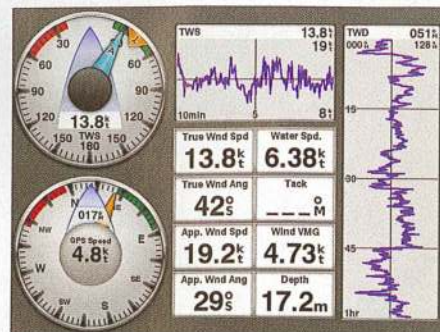
PHOTO: GRAHAM-SNOOK.COM



Theo takes a plotter screengrab to record the data onto an SD card

## What are the conditions?

On the day the wind was a touch variable. According to Bramblemet, a mini weather station on a post marking the Bramble Bank,



Performance data under full sail

## True wind speed and VMG data

- Average true wind speed 13.9 knots
- Average true wind angle 41°
- Average apparent wind speed 18.8 knots
- Average apparent wind angle 29°
- Average VMG 4.4 knots
- Heeling angle 25-35°

**Comment** Lots of weather helm, moving on board is difficult when deep heeled and she kept rounding up

we had between 12-21 knots from the ENE across the three hours we spent testing. However, according to the true wind speeds we recorded on board, we had between 11-16 knots, the top end of a Force 4, with a top gust of 18 and a lull of 10. I suspect either Bramblemet was over-reading, or we were under-reading, by three knots. Whichever it was, we used the boat's data as that's what we have in front of us when we're making these decisions. Either way, these looked like ideal conditions for finding out whether she needs a reef or not.

The sea state was a short little chop. We started at around 1030, just after High Water, so we expected sea state to smooth out as the current turned and ran with the wind.

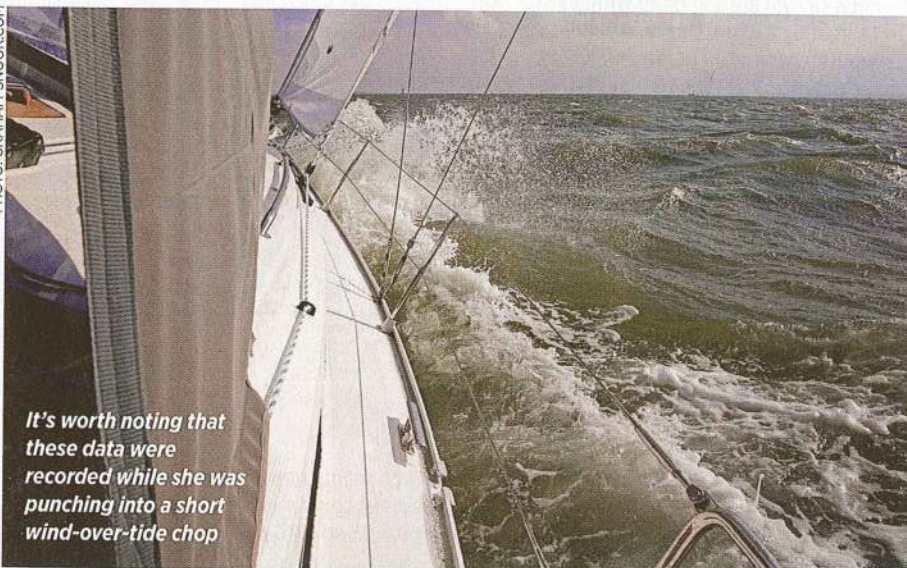
We used a data screen on our Bavaria's Garmin plotter and took screengrabs at regular intervals to record the data. These grabs downloaded to an SD memory card that we took with us for analysis later.

## How did she fare?

It very soon became clear that, with the apparent wind hitting 23 knots, we had too much sail up. We had a lot of weather helm, carving up our wake, and judging by that wake we were making a good deal of leeway.

We were also heeling to an uncomfortable degree, a degree that spacious, beamy boats like our Bavaria are not designed to handle. To her credit she kept tracking. She never heeled more than 35° because that is the heel angle at which the root of the rudder leaves the water, the rudder loses grip and she rounds up, as she did a couple of times, putting a kink in our wake. This was the wrong configuration for these conditions: too much sail.

PHOTO: GRAHAM-SNOOK.COM



It's worth noting that these data were recorded while she was punching into a short wind-over-tide chop

# Should we put a reef in the main?

PHOTO: GRAHAM-SNOOK.COM



*With one reef in the main and full jib, she gave a more comfortable ride and the same VMG despite a knot less wind*

**W**ith our full sail data recorded, we ran off downwind to give ourselves room to beat to windward with our new rig. Towards the end of the leg we gybed onto starboard and came up onto a fetch to reef the main, a trick we learned from Sailing Holidays' Barrie Neilson, who knows a thing or two about using furling sails (furl or unfurl on starboard if it furls anticlockwise, port if clockwise).

We gave the main a good looking at and decided that, once the Elvstrøm logo had been rolled into the mast, the main had one reef in it. Had she been ours we would have stuck some blue circular sailcloth patches at strategic points along the foot of both sails,

marking first, second and third reefs, so that we knew how deeply we were reefing.

We had already set up the jib, tensioned the halyard for the conditions and positioned the cars to get the right sheeting angle (pointing at the middle of the luff) to get the same tension in the foot and the leech. The jib remained unreefed, preserving its nice, clean entry at the luff.

## What are the conditions?

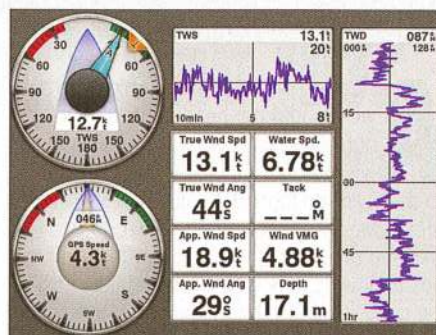
The wind was very gradually fading and, on average, the true wind speed was almost exactly one knot less for the single-reefed main and full jib data. The lowest true wind speed in our data was 11 knots and top 'gust' was 15 knots, so the gusts were not as strong as our full sail data, but neither were the lulls. It was, in general, steadier.

It certainly seemed a touch smoother but that may have been related to the fact that we were no longer on our ear.

## How did she fare?

Comparing the data with full sail, the obvious and most pleasing fact is that we had the same VMG: 4.4 knots. Our progress directly to windward was just as quick as it was with full sail, despite having a knot less wind.

We weren't rounding up because the heel angles had gone down. We were heeling fully 10° less than we were with full sail, and, as well as significantly reducing leeway, which also helps VMG, that makes moving around on deck much easier. We felt we could move around without jeopardy, which means we were more likely to scoot around to deal with a line over the side or to tweak the leech line to silence a fluttering leech. In every respect, heeling less is safer. This was the right sail plan for these conditions.



*Data with one reef in main, full jib*

## True wind speed and VMG data

Average true wind speed 13.0 knots  
 Average true wind angle 41.2°  
 Average apparent wind speed 18.0 knots  
 Average apparent wind angle 29°  
 Average VMG 4.4 knots  
 Heeling angle 15-23°  
 Comment Much less weather helm, more stable directionally, easier to move around on board

PHOTO: GRAHAM-SNOOK.COM



*With a reef taken in the main, we hardened up the main outhaul, trimmed on and set off*



*She heeled less and, with less chop and tide turned with the wind, made easier progress* ➔

PHOTO: GRAHAM-SNOOK.COM

# Should we put a reef in the jib?



PHOTO: GRAHAM-SNOOK.COM



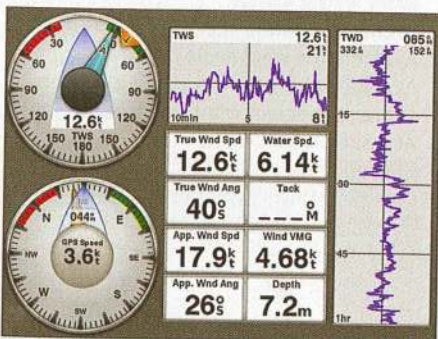
We took the reef out of the main, rolled one into the jib and set off upwind

PHOTO: GRAHAM-SNOOK.COM

As before, with our data gathered we brought her head down to give ourselves sea room. On the way down we took in a couple of rolls of jib, up to the Elvstrøm logo, defining that as a single reef as we had done with the main, and shuffled the cars forward to a guestimated position while they weren't under load. Then we came up on starboard gybe to roll out the reef in the main.

We had a test beat to fine tune the position of the jib cars, matching their positions on either tack, and we were ready to head back

The jib cars needed resetting to account for the new sheet angle, but it's clear the jib doesn't look right, wrinkled and too full



Read-out with full main, one reef in jib

## True wind speed and VMG data

- Average true wind speed 11.9 knots
- Average true wind angle 41.6°
- Average apparent wind speed 18.1 knots
- Average apparent wind angle 29°
- Average VMG 4.2 knots
- Heeling angle 20-26°

**Comment** Much more weather helm, a real kick, and heeling more in less wind

upwind and find out if this was the right sail configuration for these conditions.

## What are the conditions?

The wind continued to fade ever so slightly and the average true wind speed for this part of the process was down to 11.9 knots, another knot down on the previous beat. Having said that, the lowest true wind speed we recorded was 10.7 knots and the highest gust 15.6 so this was a touch more gusty than the previous trial.

By this time the ebb was running with the wind, and the sea state seemed a touch smoother judging by the photos of this trial.

## How did she fare?

Looking at the data, despite pointing higher, 29° apparent wind angle on average, VMG was down to 4.2 knots. This is partly because of the slight drop in true wind, but also

because we were heeling more, right on the limits of comfort at 20-26°, and feathering up as a result, to compensate for the unbalanced canvas. Indeed in one unrecorded but noted gust of 21 knots' true wind, she heeled to 38°, beyond her 35° threshold, decided she'd had quite enough and rounded up again.

It felt wrong. The steering had that springy weather helm that speaks of a badly balanced sail plan. The full main was too much for the conditions and, with less jib to keep her head down, she felt even worse than she did with full sail. This is pretty much consistent with common sense when it comes to the non-overlapping fractional rig: the bigger main should be reefed first or you end up with far too much weather helm, because the sails' centre of effort is far too far aft, and too much heel because there's too much sail area up. Clearly this was the wrong sail configuration for these conditions.

*With a single reef in main and jib, she felt much happier than she did with full main*

PHOTO: GRAHAM-SNOOK.COM



# Should we put a reef in main and jib?

**W**ith the feeling at the helm being quite so awful under full main and reefed jib, it was a relief at last to be able to ease the mainsheet and run off downwind again. With the jib cars already in the right position, all we needed to do was come up on port towards the end

of our run and take a reef in the main. With that done, we were all set to check our fourth configuration: one reef in both main and jib.

## What are the conditions?

There was, on average, 13.9 knots of true wind: a couple of knots more than we'd seen in the previous trials, bucking the fading trend, and the same average strength as we'd had in the full sail trial. The lowest true wind speed according to our data was 11.1 knots and the highest gust 16.4 knots, which we recorded on three occasions.

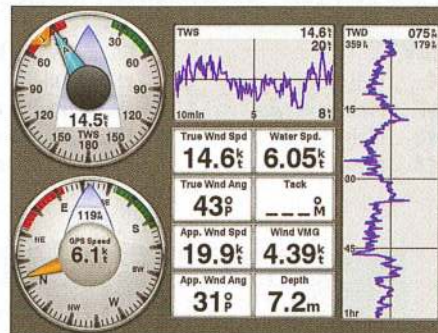
With the ebb now well established, even a knot or two more breeze wasn't going to ruffle the surface much. It remained slight.

## How did she fare?

The headline figure is 4.3 knots VMG, almost as good as the reefed main and full jib data, just 0.1 of a knot off. However true wind was up by a knot compared to that trial so slightly better performance should be expected. A contributing factor – and a surprising one at that – is that, even with a couple of rolls in the jib, which should in theory damage our ability to point, we were still making 29° to the apparent wind.

Our average apparent wind speed was 18.5 knots, which is beginning to feel very much like the point at which this boat needs to change gear. The performance is certainly respectable enough but falls just short of that with one reef in the main and full jib.

In terms of feel at the helm, again it doesn't quite match up to one reef in the main and



Performance with a reef in main and jib

## True wind speed and VMG data

- Average true wind speed 13.9 knots
- Average true wind angle 40.7°
- Average apparent wind speed 18.5 knots
- Average apparent wind angle 29°
- Average VMG 4.3 knots
- Heeling angle 12-23°
- Comment Certainly lighter on the helm, less weather helm, and a comfortable angle of heel

full jib. As you would expect the weather helm was much, much lighter, just a notch or two below perfect. Heel was much reduced too and we were all happy to wander about on deck – just as well because a crease in the top of the furling genoa had started the leech buzzing and I spent a fair amount of time to leeward trying, and failing, to calm it down with the leechline. ➔

PHOTO: GRAHAM-SNOOK.COM



*With less heel, I was happy to work to leeward to stop the reefed jib's leech buzzing*

# So how do we make our chart?



PHOTO: GRAHAM SNOOK/YM

*On this Contessa 32, the large overlapping headsail provides most of the power so maybe you should reef the genoa first?*

The data conclusively show that, for sailing this particular Bavaria Cruiser 34 upwind at a true wind angle of 40° in true wind speeds of 12-14 knots, the middle of a Force 4, the best sail configuration is one reef in the main and full jib. There's no more 'I think we'll just hang on,' or 'She goes better with a bit of heel,' you know that you should get on deck and take one reef in the main. It's there in black and white and there's no room for doubt. It's time to reef.

VMG and seamanship will help you build a chart of the best sail configuration for any wind speed and point of sail. I say seamanship because, when running downwind, the quest for VMG may tempt you to leave up too much sail: it's good for VMG but, with the lower apparent wind, it's easy to forget how quickly situations can escalate. If she starts to develop a bit of a roll, or the wind is building steadily, all too soon you can find yourself broaching with the rail under and the boom end ploughing the sea. Again, with a sail crossover chart, you remove any doubt about when to reef. If the true wind hits X knots when you're broad reaching at 150°, it's time to take in a reef. This will improve safety.

You'll also need to rely on your seamanship when beam reaching, as VMG is pretty much

zero because you're not making any progress either into, or away from, the true wind. In this case, you'd be well advised to use heel angle as your guide. This is not just for comfort on board and safety on deck, important though they undoubtedly are, but for keeping the rudder fully immersed. As soon as the rudder's root leaves the water it stalls and stops working as a foil, which means she'll round up.

While you're out sailing, heel and weather helm will let you know that you're approaching a change of gear. That's when you need to play with your sail area – reef or shake out a reef in the main or jib – note VMG and heel, decide which is the best sail configuration for the true wind speed and angle and put it into your sail crossover chart. Over the course of a season, you'll be able to create a chart that will tell you when you need to change gear. Stick to it and you'll be safe and more efficiently. ▲



PHOTO: GRAHAM SNOOK/YM

*The huge mainsail on this Etap 28 will take two reefs before the jib needs furling*

## Sail crossover chart

**KEY**

- M**..... Full main
- M1**..... Main one reef
- M2**..... Main two reefs
- M3**..... Main three reefs

- T**..... Trysail/No main
- J**..... Full jib
- J1**..... Jib one reef
- J2**..... Jib two reefs
- J3**..... Jib three reefs

- S**..... Storm jib
- C**..... Cruising chute
- K**..... Symmetrical spinnaker
- X**..... Motor

**True wind angle**

	40°	50°	60°	70°	80°	90°	100°	110°	120°	130°	140°	150°	160°	170°	180°
4 knots	M J	M J	M J	M J	M C	M C	M C	M C	M C	M C	M K	M K	X	X	X
6 knots	M J	M J	M J	M J	M C	M C	M C	M C	M C	M C	M K	M K	M K	M K	X
8 knots	M J	M J	M J	M J	M C	M C	M C	M C	M C	M C	M K	M K	M K	M K	M K
10 knots	M J	M J	M J	M J	M C	M C	M C	M C	M C	M C	M K	M K	M K	M K	M K
12 knots	M J	M J	M J	M J	M J	M C	M C	M C	M C	M C	M K	M K	M K	M K	M K
14 knots	M1 J	M1 J	M J	M J	M J	M J	M C	M C	M C	M C	M K	M K	M K	M K	M K
16 knots	M1 J	M1 J	M1 J	M J	M J	M J	M J	M J	M C	M C	M K	M K	M K	M K	M K
18 knots	M1 J	M1 J	M1 J	M J	M J	M J	M J	M J	M J	M J	M K	M K	M K	M K	M K
20 knots	M1 J1	M1 J	M1 J	M J	M J	M J	M J	M J	M J	M J	M J	M J	M K	M K	M K
22 knots	M1 J1	M1 J1	M1 J	M1 J	M J	M J	M J	M J	M J	M J	M J	M J	M K	M K	M K
24 knots	M2 J1	M2 J1	M1 J1	M1 J1	M1 J1	M1 J	M1 J	M1 J	M1 J	M1 J	M1 J	M1 J	M1 J	M1 J	M1 K
26 knots	M2 J1	M2 J1	M2 J1	M2 J1	M1 J1	M2 J	M2 J	M1 J	M1 J	M1 J	M1 J	M1 J	M1 J	M1 J	M1 K
28 knots	M2 J2	M2 J2	M2 J1	M2 J1	M2 J1	M2 J1	M2 J	M2 J	M2 J	M1 J	M1 J	M1 J	M1 J	M1 J	M1 J
30 knots	M2 J2	M2 J2	M2 J2	M2 J1	M2 J1	M2 J1	M2 J1	M2 J1	M2 J1	M2 J	M2 J	M2 J	M2 J	M2 J	M2 J
32 knots	M3 J2	M3 J2	M3 J3	M3 J2	M3 J2	M3 J2	M2 J2	M2 J2	M2 J2	M2 J2	M2 J2	M2 J2	M2 J2	M2 J2	M2 J1
34 knots	M3 J3	M3 J2	M3 J3	M3 J2	M3 J2	M3 J2	M3 J2	M3 J2	M3 J2	M3 J2	M3 J2	M3 J2	M3 J2	M3	J2
36 knots	T S	M3 J3	M3 J3	M3 J2	M3 J2	M3 J2	M3 J2	M3 J2	M3 J2	M3 J2	M3 J2	M3 J2	M3 J2	J2	J2
38 knots	T S	T S	T S	M3 J3	M3 J3	M3 J3	M3 J3	M3 J3	M3 J3	M3 J3	M3 J3	M3 J2	M3 J2	J2	J2
40 knots	T S	T S	T S	T S	T J3	T J3	M3 J3	M3 J3	M3 J3	M3 J3	M3 J3	M3 J2	J2	J2	J3