

# ENTERPRISE BOAT SPEED

Written by Philip Kirk

It doesn't matter whether you are a keen racer or a Saturday afternoon cruiser, most of the time you want to get the best out of your boat.



The following sailing guide tells you how to sail your boat faster in a range of wind conditions. The tables below divide the conditions you are likely to see into three areas: Drifting (very light winds), Powering up and Overpowered. Please remember that these wind speeds given are a guide and a light weight helm and crew will become overpowered in less wind than a heavier pair.

## Upwind

Conditions	Drifting	Powering Up	Overpowered
	(0-4 Knots)	(5 –15 Knots)	(16+ Knots)
Boat Trim	Trim forward to lift transom	Trim level to maximise waterline length	
Boat Heel	5° to leeward to fill sails	Upright – 5° to windward	
Centreboard	Down		Raise 50-150mm
Jib Sheet	In firm	In tight	In tight (move fairleads aft 25mm)
Main Sheet	Ease boom to corner of transom	Bring boom to centreline	Ease sheet to spill wind in gusts.
Kicker	Take up slack		Pull on to flatten main sail.
Outhaul	On tight	Ease 12mm	On tight
Cunningham	slack	slack	Use to depower
Pointing/ Jib Tell-Tales	Don't pinch, tell-tales horizontal	Pinch but maintain speed, windward tell-tale lifting 45° to vertical.	

Depowering Options: Settings in the right hand column such as raising the centreboard, moving the fairleads back and pulling on the cunningham may be used separately as depowering options in heavy weather. It is very likely that the kicker will be on tight before this point.

## Reaching

Conditions	Drifting	Powering Up	Overpowered
	(0-4 Knots)	(5 –15 Knots)	(16+ Knots)
Boat Trim	Trim forward to lift transom	Trim level to maximise waterline length	Trim aft the lift bow and plane
Boat Heel	5° to leeward to fill sails	Upright on close to beam reach and 5° to windward on a broad reach.	
Centreboard	Close reach: raise $\frac{1}{4}$ , Beam reach: raise $\frac{1}{2}$ , Broad reach: raise $\frac{2}{3}$		
Jib Sheet	Trim to set tell-tales		
Pole/ Jib stick	Set to leeward on a beam to broad reach		Use if you still dare!
Main Sheet	Trim to set sail		Ease sheet to spill wind in gusts.
Kicker	Take up slack	Trim to fly top tell-tail on mainsail and control twist.	Trim to control mainsail twist.
Outhaul	Ease 25mm	Ease fully	Pull on to depower
Cunningham	slack	slack	Pull on for close reaches

### Top Tips:

1. Watch the luff of the mainsail  $\frac{3}{4}$  the way up for vertical wrinkles – a sign of not enough kicker.
2. If you have to push the helm to leeward to maintain a straight course you have raised the board too far.
3. Use the shortest jib stick allowed by the rules on a reach

## Running

Conditions	Drifting	Powering Up	Overpowered
	(0-4 Knots)	(5 –15 Knots)	(16+ Knots)
Boat Trim	Trim forward to lift transom	Trim level	Trim aft to lift bow and plane
Boat Heel	5° to leeward to fill sails	5° to windward to balance helm	
Centreboard	2/3rds up (use enough to retain control)		
Jib Sheet /Pole	Pole out to leeward	Pole out to windward	Pole out to windward in you can.
Main Sheet	Ease boom out to shrouds		
Kicker	Take up slack	Trim to control mainsail twist/ fly tell-tales	
Outhaul	On tight		
Cunningham	slack		

### Top Tips:

1. Adjust the heel angle of the boat to steer instead of using the rudder.
2. Too much kicker will close the head of the mainsail whilst too little will lead to deathrolling in strong winds. The top of the main should be at 90 degrees to the centreline of the boat.

## **Boat speed in more detail**

The information in the tables above tell you what to do, however in each section below I will try and explain why.

We start with the hull and foils because I feel that many people focus too much on sail trim and will buy a new sail in the search for speed before looking at the finish of their foils and hull. To put it into perspective air is 1.2% the density of water. Despite the fact that the air passes several times quicker over the sails than the boat passes through the water, the resistance from the hull is much greater than the resistance from the rig. If you are sailing the hull correctly you are more than half way there.

## **Balance**

Everyone who races will tell you how important the correct balance is for making a boat go fast however few sailors really sail their boat upright. It is noticeable that the boats at the front of a race will be upright and be going faster than those behind. So to go fast on the beat and when reaching keep the mast pointing at the sky and the deck level.

The simple rule for good boat balance is to be able to sail in a straight line with the tiller on the centreline of the boat. This will ensure that the rudder is not slowing the boat down. You should be able to let go of the tiller or hold it lightly with a finger and thumb without losing control of the boat. When sailing upwind this can only be achieved by sailing the boat upright. The hull will then travel straight through the water because the underwater part is symmetrical. If the boat is heeled over it will become unsymmetrical and will want to turn. To correct this, you will have to compensate by turning the rudder, slowing the boat quite significantly.

When an Enterprise heels more than about 5 it will immerse one of the lower chines at the transom into the water causing turbulence behind the transom, slowing the boat. The presence of turbulence in the water is a good indicator to the helm that the boat is heeled too much. If you glance through the transom flaps you will be able to see the turbulence.

## **Balance on the Run**

When sailing on a dead run with the jib poled to windward the boat will want to turn when it is upright. The larger mainsail creates more power than the jib so the combined power from both sails will be towards the side of the main and this is why the boat wants to turn. To stop this and avoid using the rudder, heel the boat to windward until the helm feels neutral. A heel angle of about 5 should do it. You should now be able to let go of the tiller without the boat veering off course. To achieve this balance it is usual for the helm to sit on the windward side with the crew sitting directly opposite, to leeward. On a run you will notice how sensitive the boat is to small angles of heel and it is possible to steer it by heeling the boat one way or the other. The effect of this heel angle is just the same on other points of sailing but is less noticeable when beating and reaching.

## **Balance in light winds**

In very light winds on all points of sailing heel the boat slightly to leeward until the sails fill. This should occur when the leeward hull bottom panel is horizontal. Don't heel the boat anymore than you have to because the boat will want to turn. You will need to use a little rudder to keep the boat travelling straight but you will not go anywhere unless the sails are filling. Use this slight leeward heel on all points of sail in these drifting conditions.

## **Trim**

In non drifting conditions and on all points of sail the top tip here is to just touch the transom on the water, maximising the waterline length of the boat and hence speed. If you move too far aft for the conditions the transom will drag in the water forming turbulence. This will slow the boat significantly. On a reach or run when the boat is sailing faster, you can move back further without the transom dragging. The bow will lift and the boat will start to plane. However if the stern wave behind the boat becomes steeper and starts breaking, the boat will slow down. When you see this happening or feel the boat slowing, move forward again.

If you are sitting too far forward in strong conditions the bow will throw up a lot more spray and the boat will be difficult to control. The lack of control produced by sitting too far forwards is one of the main reasons that people capsize when sailing down wind in a blow. Lighter crews will have to sit further back than heavier

sailors to stop the boat from nose-diving, and it is not uncommon to see the helm behind the aft thwart, but be careful not to slide off the back.

## **Trim in Light Winds**

In very light winds waterline length is not important for speed and the boat should be trimmed forward to lift the flat sections of the stern off the water. This reduces the area of the hull touching the water, reducing resistance. The helm and crew should sit by or just inside the shrouds opposite each other to maximise this effect.

The transition between light-wind trim and normal trim occurs when the boat starts forming a bow and stern wave. At this point you want to maximise the waterline length to reduce resistance and increase speed. This transition will occur between about 5–8 knots of wind speed.

## **Centreboard**

Quite simply the centreboard stops the boat sliding sideways through the water allowing the force from the sails to be converted into useful forwards drive. The centreboard acts like an underwater wing passing through the water at a small angle of attack producing lift and drag forces and because the lift from the centreboard opposes the force on the sails so the pressures on the board are high.

When sailing upwind the sideways force from the sails is large so the centreboard needs to be lowered to counter this force. On a reach more of the sail's driving force is pushing the boat forwards so the board can be lifted, reducing resistance and increasing speed. On a run all the drive from the sails is pushing the boat forwards so even less board is needed. There comes a point when the boat becomes uncontrollable because the centreboard has been raised too far, so don't bring it all the way up.

When beating in strong winds (or when overpowered) raise the centreboard by 10-15cm to stop the boat heeling over as much. You will have gathered from the section on balance that the boat must be upright to go fast. The boat will slip sideways a bit more but if you can keep it upright and going faster you will make better progress than the boats heeling over.

## **Sail Trim**

In this section I will explain the key points of sail trim that will improve your boat speed. A sail is an aerofoil just like the wing on an aeroplane or the spoiler on a F1 racing car and uses the same principles to create lift. The sails on an Enterprise have to work in a great range of wind speeds as the conditions. The tables in the previous section teach you the use of the different sail controls for a range of conditions and points of sail. This section will go further and explain why.

## **How a Sail Works**

All sails set in a curved shape so the wind travels further and hence faster on the leeward (or convex) side creating a low pressure. The air on the windward side is compressed against the sail creating higher pressure. The pressure difference between the two sides of the sail means that a force is created sucking the rig and hence the boat along. This force acts roughly perpendicular to the boom but to work efficiently the wind must travel around both sides of the sail and must leave the trailing edge smoothly.

Just like the spoiler on the F1 racing car, the wing of a plane is highly efficient but is optimised for a specific air speed and angle of attack. If we could always guarantee constant conditions for our sails they could be as efficient however there are many variables that have to be taken into account when a sail is designed and made.

The sails must set efficiently in a wide range of wind speeds.

- They must set on both tacks.
- They must work efficiently on a range of courses, for instance upwind, on a reach and on a run.
- The wind speed increases with height above the water.

- The boat will pitch up and down as it passes through waves moving the rig around.
- The speed of the boat will vary given the wind speed and the boat's relative heading.

So we want one set of sails to work well through all these variables and so unlike the aeroplane's wing a sail must be adaptable to remain efficient.

## Upwind Sail Trim

Most rigs are optimised for sailing upwind where being able to point high, sail fast and limit heeling forces are all important factors. To point high and limit heeling forces the sails need to be quite flat which means they will create a limited amount of forward drive. To maximise boat speed we must trim the sails to reduce the resistance or drag that holds the boat back. The Enterprise will not plane up wind so will not exceed its hull speed (dictated by hull length). This means that the differences between a well sailed and badly sailed boat are small. If we want to win races we need to find these small gains.

## Jib

In all but light winds the jib should be sheeted in very tight to flatten the sail. This will dictate how close to the wind we can sail. In these conditions the boat should be helmed so the windward telltales on the jib are lifting at 45 degrees to vertical. If you follow this an Enterprise will point higher than most other boats. In light winds the jib sheet maybe eased  $\frac{1}{2}$  inch and the helm should aim to keep the telltales horizontal for maximum power but sacrificing some pointing.

## Mainsail

The mainsail should be flattened in light or strong winds by tightening the outhaul however in moderate conditions it may be eased by 12mm to develop more power. Again in moderate conditions the boom should be kept on or close to the centreline. By keeping the boom on the centreline, the slot between the main and the jib will not be constricted. Take the slack out of the kicker and use the mainsheet to control the twist of the sail. You will need to trim the mainsail continuously to get the best out of it. Keep an eye on the leach telltale next to the top batten. If the leach is too tight it will hook to windward and the telltale will hang down or hide behind the sail indicating the sail is stalled, creating lots of drag and less power. Ease the mainsheet slightly to get the telltale flying again. If the sail is twisted off too much, vertical wrinkles will appear by the mast about  $\frac{3}{4}$  the way up the sail. By keeping an eye on these two points you will be able to achieve good sail trim.

## Beating in light winds

When the boat is barely moving and you are heeling the boat to allow the sails to fill ease the main sheet so that the end of the boom is above the transom. With the kicker also slack the top of the sail should open out creating an efficient curved shape. Adjust the sails gently to avoid disturbing the flow of air over them. Rapid adjustments will slow the boat.

## Beating in strong winds

In these conditions we are trying to reduce the heeling forces by flattening the sails as much as possible. Move the fairleads back one notch (10-15mm) to allow the leach of the jib to twist open and at the same time to flatten the foot of the sail. Progressively tighten the kicker, which tightens the leach and bends the mast. Ease the mainsheet in the gusts to spill wind. You may have to sail with the mainsheet permanently eased but let it out so far that it flaps. This almost doubles the heeling force and can capsize a boat. As long as the leach is setting, things are ok but to depower further, flatten the sail some more by tightening the cunningham.

## Off-wind Sail Trim

Off-wind courses can be split into reaching and running. Many of the ideas behind sail trim on the reach are the same as on a beat although the emphasis is on creating as much power as you can handle to coax the boat onto the plane.

## Reach

On a reach the sails are being used to create a driving force as the wind passes from the luff to the leach over their curved surface. Instead of sailing by the jib telltales as you would on a beat you will have to steer the boat in the direction you want to go and set the sails accordingly.

### Jib Trim for the Reach

The crew's job on the beat did not require too much concentration as they only had to pull the jib in hard and hike out. On the reach the jib must be set to get the lower two pairs of telltales to fly horizontally. The jib sheet will need constant trimming to achieve this as the wind shifts, as the boat accelerates or slows and as the helm heads up or bears away. The set of the jib has a big impact on the power developed by the whole rig so don't underestimate the crew's role.

Jib trimming can be approximated to:

- If the telltale on the windward side of the sail lifts- pull the jib in.
- If the telltale on the leeward side lifts or falls- ease the jib out.

With an inexperienced or young crew the helm can ask them to trim the jib to a certain position and then the helm steers to get the telltales to fly correctly. Unless the wind is shifty this will be more successful (and less confusing for the crew) than continuously asking them to 'pull the jib in' or 'let the jib out'.

As you bear away from a close reach a correctly trimmed jib becomes very full in the foot and the slot between the jib and the mainsail becomes closed. These effects slow the boat down and increase the heeling forces. To overcome this you need to push the clew of the jib to leeward by with the jib stick (or pole). The class rules allow a minimum and maximum length jib stick and the minimum length one should be used on a beam to broad reach while the maximum length pole is kept for the run. Once the sail is set on the pole, trim it to the telltales as before.

### Mainsail Trim on a Reach

As on the beat you will need to trim the mainsail continuously to get the best out of it. On the reach, the kicker is used to control the twist in the sail and the mainsheet is used to control the angle of the boom from the centreline. Watch the leach telltale next to the top batten and keep it flying however don't let the sail twist too much that vertical wrinkles form by the mast. By keeping an eye on these two points you will have achieved the most efficient mainsail trim. On a reach the sail is pulling the boat along instead of trying to heel it over, so we can use more power and go faster. To do this we ease the outhaul and the cunningham.

### Sail Trim on the Run

This is really as simple as it looks and once set we don't need to adjust anything.

Let the main out until the boom is next to the leeward shroud and ease the kicker until the top of the sail is at 90 degrees to the boat's centreline. The outhaul should be set tight to spread the sail out and catch more wind. In moderate conditions set the jib with the jib stick on the windward side. With the sails goose winged in this fashion you will have to keep a good look out for other boats in front of you but also keep an eye on your burgee for changes in the wind direction.

In strong winds you may not want to use the jib stick but setting the jib to windward will balance the boat. The helmsman can pull the windward jib sheet around the outside of the shroud and pull the jib across balancing the mainsail and making the boat easier to control. In the same conditions ensure that the top of the main sail does not twist forward of the mast. This can require a lot of tension on the kicker but it will stop the boat death rolling.

In light conditions when the wind will not fill the jib, set it to leeward. You may use the jib stick but the jib will not be providing much power, so this will have only a small benefit.

