

Waterline Length Measurement of 10 Rater Yachts

Some advice from ITCA Technical Chairman

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The important relevant rules concerning certified waterline length *

C.4.1 FLOTATION (OF BOAT)

With the **boat** floating in fresh water, with slack rigging, in sailing condition and dry:

- (a) the forward waterline ending shall not fall forward of the aft edge of the forward waterline **limit mark**;
- (b) the aft waterline ending shall not fall aft of the forward edge of the aft waterline **limit mark**;

C.6.2 USE (OF APPENDAGES)

- (b) No part of any **hull appendage** shall cut the datum waterplane ** outboard of the waterline **limit marks**
(important for the rudder situation)

D.2.1 LIMIT MARKS (ON HULL)

A forward and an aft waterline **limit mark** shall be placed on the outer surface of the **hull** across the centreplane, minimum size 30 mm long by 2 mm wide, and long enough to be easily visible with the boat afloat.

* *Defined as the distance between points formed by the intersection of the centreplane and the inboard edges of the waterline **limit marks**.*

** *Defined as the horizontal plane through points formed by the intersection of the centreplane and the inboard edges of the waterline **limit marks**.*

Datum waterplane – how it is used

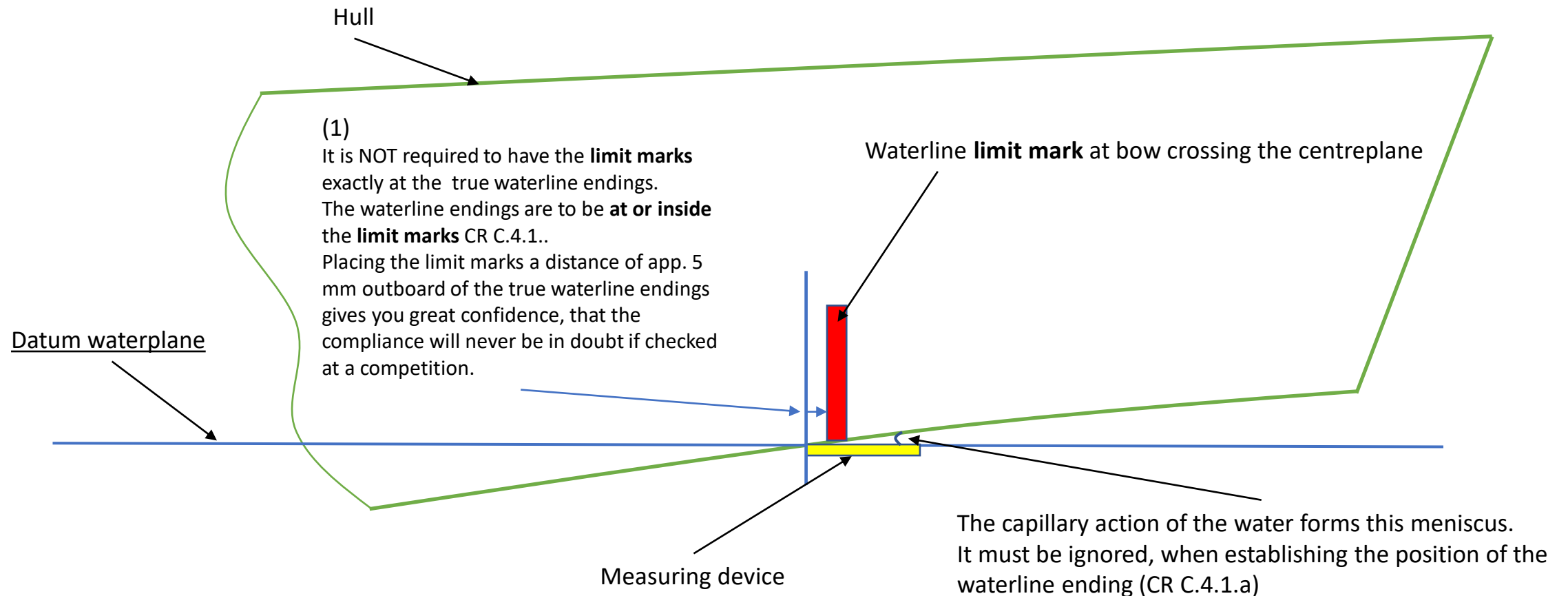
The datum waterplane is defined as ‘the horizontal plane through points formed by the intersection of the centreplane and the inboard edges of the waterline **limit marks**.’

To comply with the **class rules** at an event the waterline endings shall be inboard of the **limit marks** that define the datum waterplane. CR C.4.1 (a) and (b).

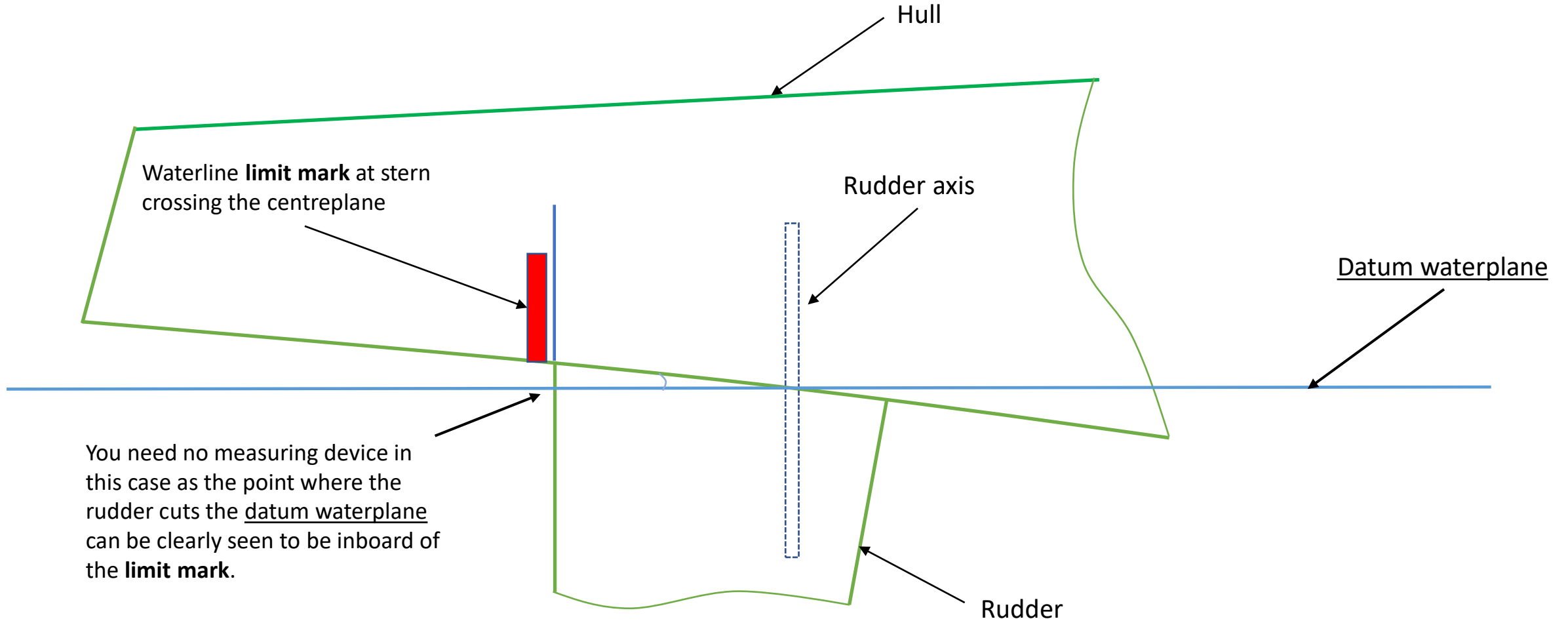
The certified waterline length used in the formula to determine the sail area is the distance between the inboard edges of the waterline **limit marks**.

Regardless of the true waterplane it is the datum waterplane that is used in several other **class rules** as it is definitively established by the position of the waterline **limit marks**.

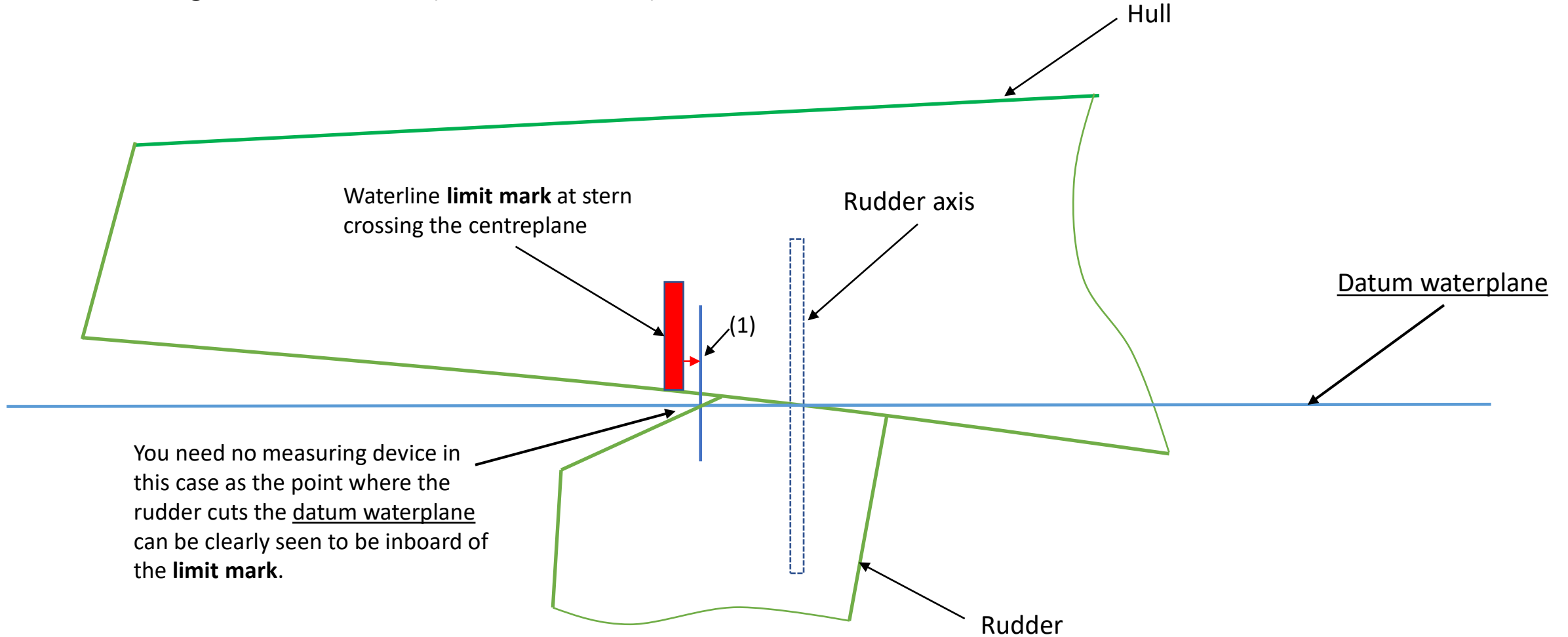
Bow region and the problem with the surface tension of the water distorting the water surface at the relevant measurement point



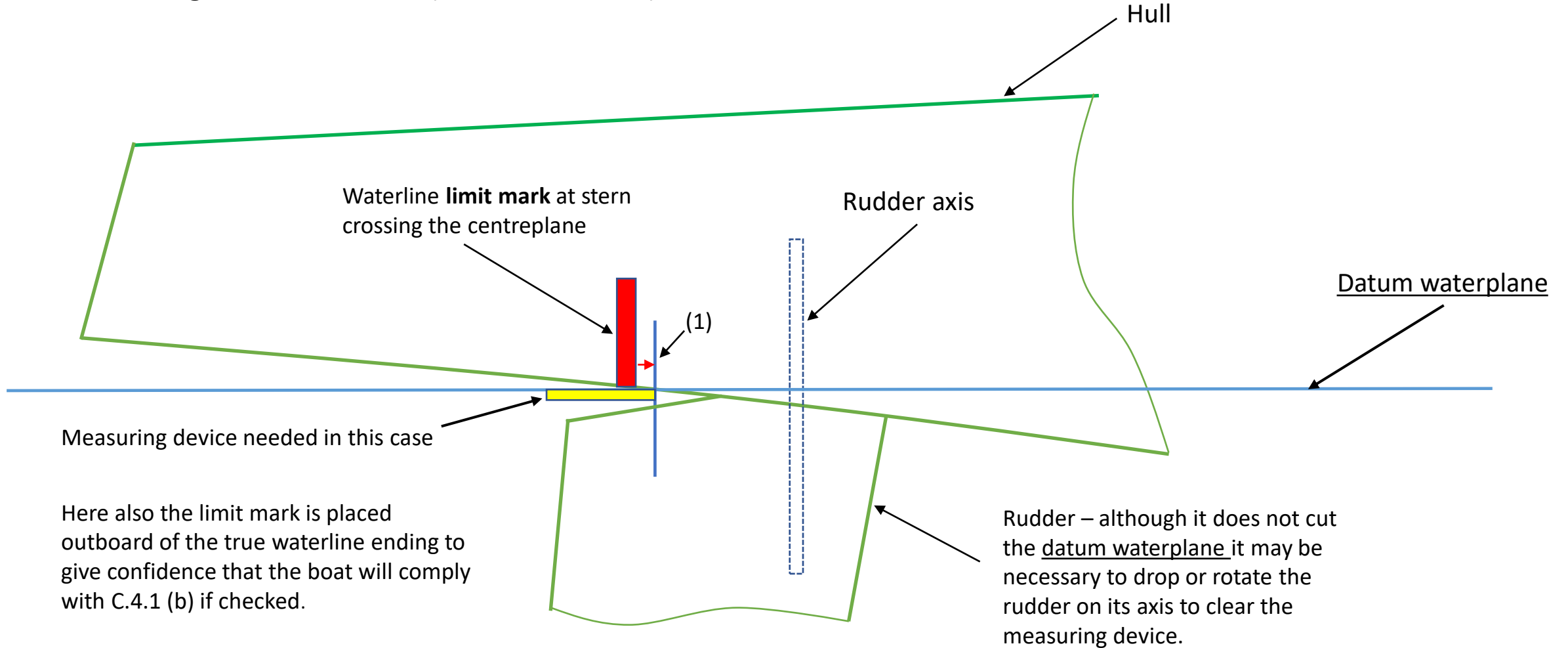
The stern of the hull and the position of the waterline **limit mark** in the region of the rudder (Version 1 / C.6.2)



The stern of the hull and the position of the waterline **limit mark** in the region of the rudder (Version 2 / C.6.2)



The stern of the hull and the position of the waterline **limit mark** in the region of the rudder (Version 3 / C.6.2)



Examples of different devices to measure the

- certified waterline length (the distance between the waterline limit marks) and
- establish the waterline endings.

The tank used in Germany

This is only one example how to build a tank. Such a tank may be built from other materials, however it can be **useful** to have one side of the tank from plexiglas.

It is also not necessary to have such a full volume tank. Small rectangular box-like extensions for dunking the keel and the rudder are possible.

The walls of this tank have 10 mm thickness - necessary due to the water pressure. Note the steel girders each side of the tank and their restraining bars to prevent the sides bending outwards.



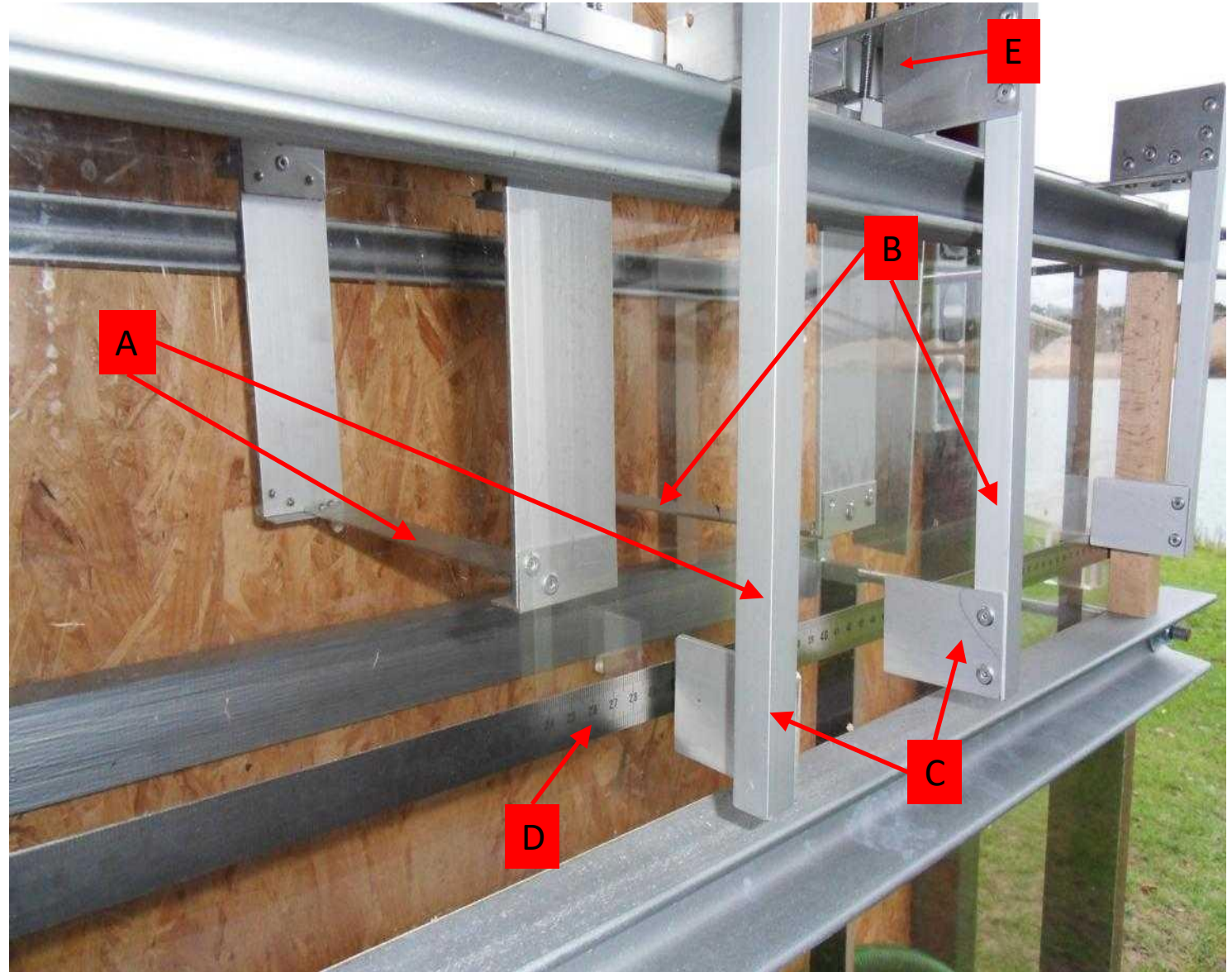
One more picture, which shows the equipment to measure the certified waterline length.

A = Metal measuring device for the bows.
B = Metals measuring device for the stern.

The devices A and B are combined with external vertical arms C which allow noting the waterline **limit mark** positions on the rule D fitted on the outside of the tank.

Both parts A and B can be shifted on the upper edge of the tank.

Screw (E). One provided each side of devices A and B to adjust the height of the measuring devices level with the surface of the water remote from the hull.



A tank used in the UK

A simpler device can be used to establish the waterline endings with a tank.

Similar in that there is a screw on each side to adjust the bar to the water level. However they are different in two fundamental ways i.e. the way they are used and their orientation. They are used to determine the waterline ending positions on the hull – this is done by placing a self adhesive printed strip with markings at 1 mm intervals where the waterline ending is expected to be.

At the bow they are positioned just off the centreline so the thickness of the strip does not affect the position of the bar on the hull. At the stern it is usually impossible to avoid that effect but the effect is small and only increases the certified waterline length. When the boat is pushed very gently towards the bar it is possible to read and note the position of the bar on the strip when the boat stops. This is done at each end.

To give confidence that the boat will be compliant when checked at an event the **limit marks** are normally placed a small distance e.g. 5 mm outboard of the waterline endings found as above. The distance between those **limit marks** is then matched using a giant ‘vernier gauge’ like tool. A steel tape is then used to find the certified waterline length from the gauge. The orientation of the bar is vertical and the upper edge is sharpened (on one side only away from the hull) at 30 degrees to give a ‘knife’ edge. This makes it relatively easy to judge that the blade is at the water surface correctly.

When the edge is below the surface there is no distortion of the surface. When it penetrates the surface there is clear distortion.

Of course there is still room for differences of opinion but they are small. The difference between the two positions is very small and not likely to create an error on waterline length of more than a few mm in total.

Some pictures :

Devices to measure the Waterline Length

The overall item. The four screws in the ends allow vertical adjustment of the knife edge bar to the waterline. The beam that goes across the tank is an inverted L section.

Because the centre part of the vertical part of the L would interfere with a rudder that extends aft of the waterline ending, the central part is cut away and the added box section provides stiffness/strength.

The knife edge is made by a small L section with the vertical part pointing upwards. Two blocks of lead (at the ends of the beam) help keep the device in place.



Close up of end details.



Devices to measure the Waterline Length



The cut out allows sight of the rudder but it is there because of the radius on the metal section which would conflict with the rudder if it was near the surface. The knife edge has the angled side away from the hull.



The knife edge part from ahead and below. Cut out for the rudder visible. If the top of the rudder is closer than about 6 mm to the waterline then it would be necessary to drop it to clear the beam.



Same from centreline ahead.

A demountable tank used in the UK designed & built by Richard Uttley

The tank facilitates easier storage and enables tank to be transported.

The tank has a knife edge weir, an end dam over which the water can flow. One of the pictures of the end of the tank shows this clearly.

Essentially you use the levelling feet to level the tank and fill it with water. When it is full excess water escapes over the weir.

Place the boat in the tank (any displaced water escapes over the weir).

Push the boat towards the weir until it touches. Check water level (i.e. top up the tank and let excess flow over weir).

Hold it still and mark where it touches the weir.
The weir is a knife edge so the pencil mark can be drawn on the dry side where the boat touches.

Devices to measure the Waterline Length

The dis-assembled tank



2.Weir



Repeat process having turned the boat around. It may be necessary to swivel the rudder on some designs.

The boat can then be removed and a giant vernier and tape or ruler used to measure the distance between the **limit marks**.

The boat in the pictures has had the waterline **limit marks** fitted a few mm outboard of the waterline endings.

This is a safety feature which allows for subsequent minor increase in weight (i.e a heavier battery pack) or variations in event measurement equipment.

3. Boat in assembled filled tank



4. Bow against weir



6. Assembled tank showing weir end drainage pipes

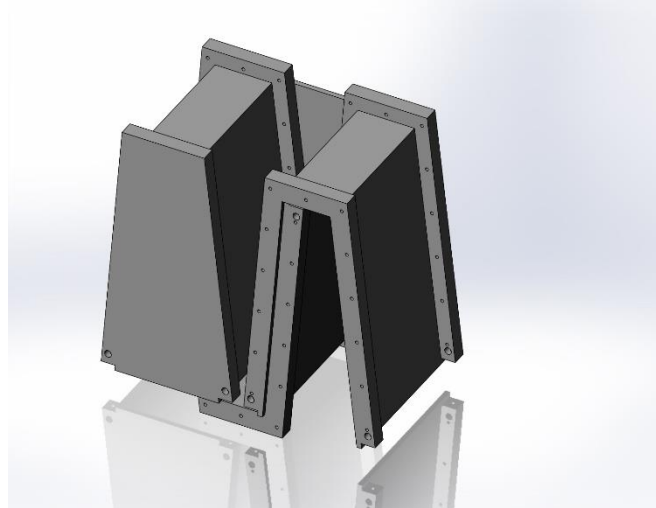
5. Stern against weir



This timber tank build by Richard was inspired by a Graham Bantock design concept for a 3 part tank.
CAD pictures on the right side.

It could be broken down for transport.
CAD drawings available from Graham Bantock.

The photo below shows a neoprene seal strip that is essential for making it watertight.



Devices to measure the Waterline Length

