

Legibility of Sail Numbers for Radio Controlled Sailing.

How often have you heard the following?

“I couldn’t read the sail numbers”

“The marks of the course should not be set more than 70 meters from the bank”

“Judges need to be able to read the sail numbers to be able to perform their duty”

All common situations and comments we are faced with regularly. Radio Sailing has faced these difficulties for many years with no attempt to rectify or make change. What can be done to improve the situation?

This submission looks at the science of visual acuity, number legibility and makes suggested changes to achieve a significant improvement to sail number recognition using minor amendments to our existing sail marking rules.

1. Visual Acuity:

Measured on an eyechart at a set distance (6 meters). Most people have heard of 6/6 vision (or 20/20 for our USA friends). This means that an individual can read a letter which subtends 1/60 of a degree which is known as “1 arcminute”. Depending on which community you test, somewhere between 90% and 95% of humans can achieve 6/6 vision with visual aids (spectacles or contact lenses) and both eyes open. Many people can reach visual acuity far better than this too, so 6/6 is not 100% vision – simply a good standard.

2. Legibility:

Different to Visual Acuity because eyecharts use standard fonts, standard contrast levels and standard viewing conditions.

Legibility is especially important for Road Traffic Engineers – they want road signs to be as legible as possible for drivers and have done lots of research into what makes a sign most easily visible. There are three main factors which determine Legibility for a given visual acuity:

- Stroke width
- Gap width within the numeral
- Contrast

The combination of these variables can be summed up as the “font”.

2.1 Stroke width is critical:

Research indicates that a stroke width between $\frac{1}{5}$ and $\frac{1}{7}$ of the height of the digit provides maximal visibility.

- If the stroke is too narrow, digits blur and contrast reduces. Similar numbers become hard to distinguish: 3 and 8, 5 and 6, 1 and 7.
- If the stroke width is too wide, internal gaps close up, digits lose their distinctive shape and numbers like 8,9 and 0 are hard to differentiate. They appear as blobs.

For a numeral with a height of 100mm, the optimal stroke width for best visibility would be between 14mm and 20mm. Currently, many IOM sail numbers have a stroke width in the vicinity of 10mm to 12mm – some even as low as 8mm. Other Classes probably experience similar outcomes.

2.2 Gap Width:

Gap width inside the numeral should approximate the stroke width so as not to crowd the number. If gaps are too closed, numbers appear as “blobs” at a distance.

2.3 Contrast:

It is intuitive that a solid black mark is far more legible than a grey or faded mark. Colours are similarly lower contrast than black.

2.4 Font:

Highway signs use large thick strokes with large openings to maintain recognition at speed and distance. The Standard Alphabets for Traffic Control Devices, (also known as the FHWA Series fonts and unofficially as “Highway Gothic”), is a sans-serif typeface developed by the United States Federal Highway Administration (FHWA). The font is used for road signage in the United States and many other countries worldwide.

In France, a similarly well researched font called “Caractares” is used on road signs. This font utilises similar characteristics to Highway Gothic.

These typefaces are designed to maximize legibility at long sight distances while traveling at road speeds.

For practical signage design, elegant thin fonts are particularly poor for long-distance visibility.

3. How do existing RC sail numeral rules compare?

The IRSA Sail Number Rules require sail numbers of 100mm to 110mm in height. There are no specific requirements for the stroke width of the sail numbers. The rules specify that the numerals should be of high contrast and of a font equivalent to Helvetica (which is a family of san-serif fonts).

So if a 100mm number has a stroke width of:

- 10mm, the angular size of its strokes at 100m would be 0.5 arcminute – below the 6/6 threshold.
- 18mm, the angular size of its strokes at 100m would be 0.9 arcminute – significantly better than the visibility for the same number height of the thinner number, but short of the 1.0 arcminute for reliable identification.
- 21mm, the angular size of its strokes at 100m would be 1.0 arcminute – easily and reliably visible at 100m. However, a stroke width of 21mm may start to become clunky and start to close off some of the gaps.

4. How much could we improve the visibility of sail numbers?

If we were to introduce changes which combined a minimum stroke width of 18mm and increased the vertical height of our sail numbers to 125mm, we could achieve sail number visibility equal to our existing sail numbers at a distance equal to at least $0.9/0.5 = 1.8$ times the current distance. Therefore, sail numbers could theoretically be read at 100 meters, rather than 60 - 70 meters currently.

In practice, we could potentially double the distance at which sail numbers could be read by increasing the height to 135mm and mandating a minimum stroke width of 20mm and mandate solid black numbers.

The outcome may be to change the sail number requirements to:

- Height of numbers to be between 125mm and 135mm.
- Stroke width to be between 18mm and 20mm.
- Numbers to be solid black.
- Font to be Highway Gothic or an equivalent san-serif font.

With thanks to Andrew Crocker, the following images provide some insight into the potential impact of the proposed changes:



Left sail:

Top: Helvetica 105mm, stroke = 12mm.

Middle: Highway Gothic 110mm, stroke = 18mm.

Bottom: Caracteres 110mm, stroke = 20mm

Right Sail:

Top: Highway Gothic 135mm, stroke = 18mm

Middle: Highway Gothic 135mm, stroke = 20mm

Bottom: Helvetica 135mm, stroke = 16mm.

The sail numbers viewed from 50 meters:



Existing sail numbers with narrow stroke widths already difficult to distinguish – especially top left.

The sail numbers viewed from 75 meters:



Showing the impact of greater stroke width on visibility.

The sail numbers viewed from 100 meters:



Showing that the smaller numbers have disappeared altogether, whereas there is some very faint definition remaining on the larger numbers.

The sail plans of most radio-controlled boats have plenty of room to expand the height of the sail number by 15mm to 25mm. We should retain existing gaps between sail numbers and consider introducing a maximum width for numbers. Perhaps we could introduce a rectangle into which all numerals should fit – minimum and maximum size.

We will need to consider the impact on the smaller rigs in all classes, especially for people who are required to add a third digit to their sails. More work needs to be done on the detail in this area.

I believe some simple amendments to our sail number regulations could significantly improve the quality of radio sailing globally by making sail numbers visible at much greater distance.

If required, grandfathering of existing sails could be offered, but the new sail marking requirements should be mandated at International events at which judging is used.

5. Suggested Sail Number Marking Rule Change.

I propose that the following submission be considered:

RRS E8 G1.4 is amended as follows:

1. National letters and sail number shall be in capital letters and Arabic numerals, clearly legible and of the same colour. The colour shall contrast with the body of the sail. Sans-serif fonts giving an average stroke width of 18mm or greater are acceptable. Examples of such fonts are Caracteres and Highway Gothic (FHWA Series fonts).

2. The height and spacing of letters and numbers shall be as follows:

Dimension	Minimum	Maximum
Height of sail numbers	125mm	135mm
Width of sail numbers(except “1”)	70mm	80mm
Stroke width	18mm	21mm
Spacing between sail numbers	20mm	30mm
Height of national letters	60mm	70mm
Spacing of adjacent national letters	13mm	23mm

6. How to implement the changes for radio controlled sailing events?

Sail number size and location in radio sailing is controlled by and is embedded in the Racing Rules of Sailing. I understand that IRSA have developed the capacity for International Class Associations to participate in the “Classes Committee” within IRSA.

This inclusion may provide the International Classes the opportunity to engage with each other to implement sail number dimension change on a global scale for the benefit of radio sailing worldwide. This would require each ICA to initially make the decision which supports and promotes the concept and then take the principle to IRSA.

Should the Classes Committee, Technical Committee and subsequently the Executive Committee come to an agreement, then the IRSA should be in a position to approach World Sailing and seek change.

I would not like to see individual events attempt to amend RRS E8. The change needs to be made top to bottom for the betterment of all.

7. Umpires eyesight.

At the recent IOM Worlds, it became apparent, from the comments of a few of the Umpires, that they were having difficulty viewing the boats and reading the sail numbers at what I considered was a very reasonable distance.

Additionally, the Umpire panel imposed a limitation on the Race Committee to limit the distance of any course mark to 70 meters from the shore. It does not seem appropriate that the layout of the sailing course is determined by the needs of the umpires rather than the requirement to set a course that is fair for competitors. A biased course does not provide a good outcome for an event.

I think that people engaged to perform such task should have eyesight capable to do the job. I would suggest that Umpires provide certification that their corrected, binocular visual acuity is at least 6/6 (equals 20/20 if in the USA) prior to being appointed to International Events.

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