Evaluate your Six's rating yourself

There are a number of situations where a classic Six Metre owner may wish to evaluate the rating of his boat himself, e.g. he may wish to perform his own measurement, before an official measurement, so as to be able to check the measurer's results.

This article aims to help him. It assumes that the existing waterline is known, as shown either by the usual marks or by the traces on the hull after a season afloat. It assumes also that the boat is level on the plane of its waterline.

The measurements entail finding 22 points and measuring 19 lengths. They can be performed by one person in less than a day.

I. Reasons for wishing to evaluate the rating oneself

There are four possibilities concerning the status of a measurement certificate and waterline marks on the hull:

		Certificate exists	
		Yes	**No**
Marks exist	**Yes**	Case A	Case C
	No	Case B	Case D

For each case, an owner might wish to measure his boat:

Case A: if the boat no longer floats on her marks, so as to see if she will still measure as a Six,

Case B: so as to see where the original marks should be and if the boat will still measure,

Case C: so as to fill out a preliminary measurement certificate which corresponds to the marks. If the boat no longer floats on her marks, to see if she will still measure as a Six – and, if so, how much sail area is allowed,

Case D: so as to see if the boat measures as a Six and how much sail area is allowed.

A. Case A

In this case, one must simply measure the vertical distance between the triangular mark and the existing waterline. If the distance is less than 50 mm., the boat will still measure (see Class Rule, Appendix A, rule A3.h.ii)

B. Cases B, C & D

In practice, each of these cases involves performing the full measurement as outlined in this article.

II. Excel tables provided for the calculation

The calculations used in this article are those described in the 2007 version of the Class Rule (the Third Rule) available at:

http://www.sailing.org/tools/documents/6m2007_CR_080607-[4259].pdf

Usually, boats which measure under the Second Rule also measure under the Third Rule.

Those parts of the Rule which concern the spars and sails are not covered by this article.

Insofar as possible, all the cells in the tables contain a reference to the article in the Class Rule on which they are based (see the three columns entitled "Sources from the Class Rule"). In some cases, the references specify the paragraph and line numbers.

The tables used for the calculation are in the form of an Excel notebook available at http://www.classic6mr.info. They are:

1. ***Codes used in the tables which follow***

   It explains the colour codes assigned to all the cells of the tables.

2. ***Points on the hull used for the rating***

   It is only at the time of an official measurement that the permanent marks are placed on the hull – and on both sides of the hull.

   To save time during this "do it yourself" measurement, the approach taken in this article assumes that the hull is symmetrical. The reader is instructed to place marks on only one side of the hull. This involves finding 22 points on and off the hull.

   In several places in the calculation of the rating, the Rule assumes that one has measured the hull on both the port and starboard sides. For these cases, the Excel tables use the same value for both sides of the hull.

   Similarly, for the bow and aft chain girth measurements, this article instructs the reader to only measure the chain girth on one side, i.e. half the complete chain girth. The Excel tables double these half chain girths as necessary.

3. ***Lengths and displacement for calculating the rating***

   One must next measure 19 lengths (in metres) based on these points – and, if possible, weigh the boat (in metric tons).

   It is also possible to use Imperial measures (ft., sq. ft. & cu. ft.), expressed as decimals. In this case, the rating is "19.67" (3.2809 feet per metre x 6) rather than "6".

   Once thesemeasurements have been entered in this table, all your work is done! The Excel tables take over and perform all the necessary calculations

4. ***Two pass or fail tests***

   This table performs the two tests which are pre-requisites for a boat to rate as a Six. Both concern L 2, whose position is denoted by the aftmost rectangle and circle on the hull.

5. ***Calculation of the L term of the rating formula***

   This table produces the value for the "adjusted length" (L). It involves three principal calculations, followed by those for 5 penalties. They extend over four pages:

   i. Extended waterline length

   ii. Bow chain girth difference

   iii. Stern chain girth difference

   iv. Possible girth difference penalty (P_1)

   v. Possible penalty for insufficient beam for yachts built after 1937 (P_2)

vi. Possible penalty for excess tumblehome (P_3)

vii. Possible penalty for excess draught (P_4)

viii. Possible penalty for insufficient displacement (P_5)

The resulting value for L is then carried forward to the next table.

6. ***Calculation of the maximum allowable sail area as a function of the hull parameters***

This table calculates two other terms (d and F) and then relates them, along with L, to the rating of "6". Based on this relation, it then calculates S, the maximum allowable sail area, as its final result (see sample table below).

The calculation of the sail area starts with the equation for the Third Rule:

$$(1) \qquad 6 = \frac{L + 2d + \sqrt{S} - F}{2.37}$$

The diagram in Table 6 presents the equation as individual fractions.

$$(2) \qquad 6 = \frac{L}{2.37} + \frac{2d}{2.37} + \frac{\sqrt{S}}{2.37} - \frac{F}{2.37}$$

The measurements and the ensuing calculations will have provided values for all the terms except $\frac{\sqrt{S}}{2.37}$. Table 6 then re-writes the equation in terms of $\frac{\sqrt{S}}{2.37}$, so as to be able to eventually solve the equation for S, thus arriving at the maximum allowable sail area:

$$(3) \qquad \frac{\sqrt{S}}{2.37} = 6 - \frac{L}{2.37} - \frac{2d}{2.37} + \frac{F}{2.37}$$

Multiplying both sides of the equation by "2.37" gives:

$$(4) \qquad \sqrt{S} = (2.37 * 6) - L - 2d + F$$

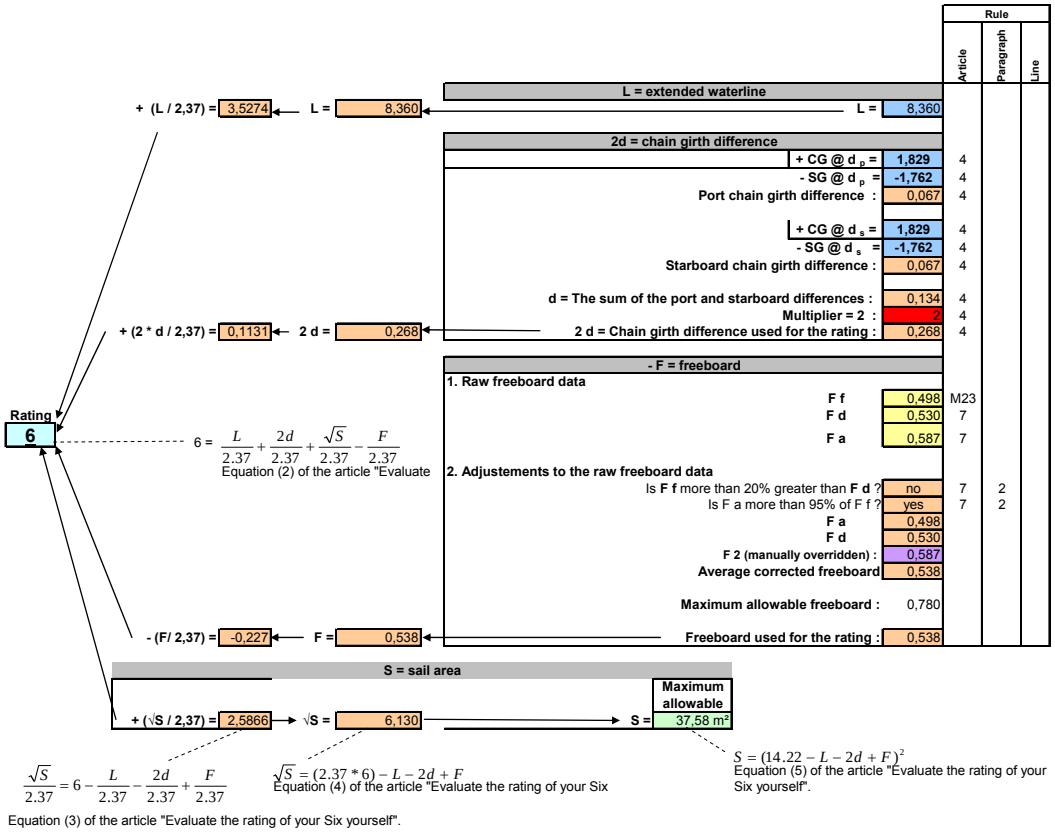
Multiplying out the term (2.37 * 6), gives:

$$(5) \qquad \sqrt{S} = 14.22 - L - 2d + F$$

Finally, both sides of the equation are squared, thus yielding a form which gives the value of *S*:

$$(5) \qquad S = (14.22 - L - 2d + F)^2$$

which is the calculation used to arrive at the maximum allowable sail area.



7. *ISMA Measurement Certificate format*

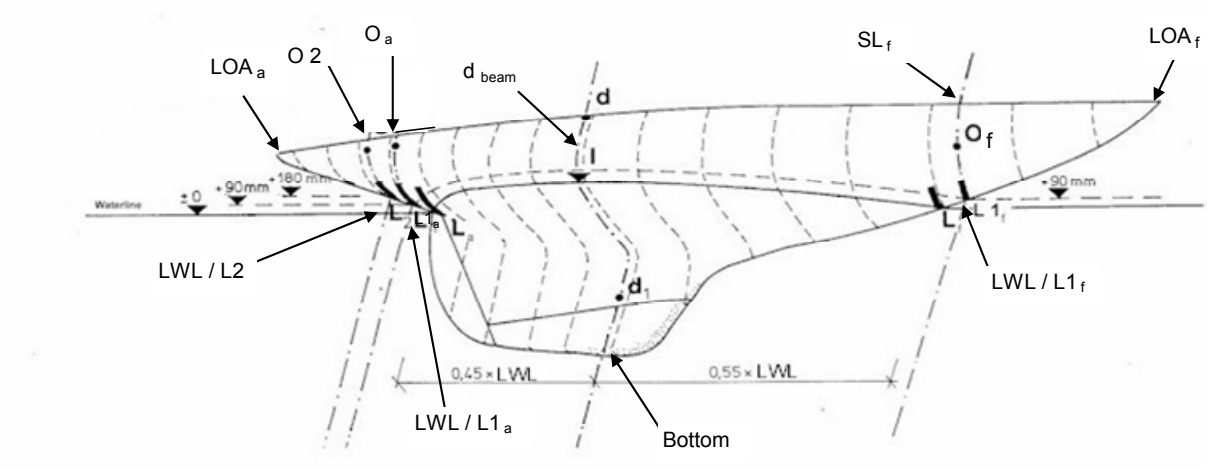
This table presents the measurement data in the format defined at article M29 of the Class Rule.

Name of yacht :		**Michel Selig**		
Year :		1935		
Designer :		Reinhard Drewitz		
Measurement year :		2008		
Units :		Metres		
	Overall length		10,178	
Add	Overhang Forward to L_1	0,665		
Add	Overhang Aft to L_1	1,993		
Subtract	Total Overhang		2,658	
	Measured Length		7,520	
Subtract	Girth at Bow	0,760		
Subtract	Twice Vertical Height at Bow	0,600		
	O. at Bow	0,180		
Add	1½ O. at Bow		0,270	
Subtract	Girth at Stern	2,194		
Subtract	Twice Vertical Height at Ste	-0,994		
	O. at Stern	1,200		
Add any penalty at O_2		0,000		
Add	⅓ O. at Stern		0,400	
Add	Penalty (Beam)	0,000		
Add	Penalty (Tumblehome)	0,000		
Add	Penalty (Draught)	0,000		
Add	Penalty (Displacement)	0,000		
	Penalties		0,000	
CORRECT LENGTH, L.				8,190
Subtract	Skin d to d_1 Port	1,829		
Subtract	Chain d to d_1 Port	-1,762		
	d Port		0,067	
Subtract	Skin d to d_1 Starboard	1,829		
Subtract	Chain d to d_1 Starboard	1,762		
	d Port		0,067	
Add	*d*		0,134	
2*d*				0,268
Add to find sum of Measurements				8,458
		Actual	Adjusted	
Add	Mean Freeboard Bow O	0,498	0,498	
Add	Mean Freeboard Midship d.	0,587	0,530	
Add	Mean Freeboard Stern O	0,530	0,504	
	Sum of Freeboards		1,532	
Subtract (⅓ sum) FREEBOARD, F.				-0,511
	Sail area (m²)			39,344
√S				6,273
Total of Measurements				14,220

III. Visualising the points and distances

Of the 19 points required to measure, the diagram below[1] shows those that are used to measure the 14 distances.

[1] By the kindness of its authors, the diagram is reproduced from page 20 of the first book to be written about Sixes: Ingvard Liewendahl, Harald Aftan and Pekka Barck, ***Sexornas Jakt*** (Finlands 6mR – förbund r.f., Heldsinki 1994). It is in Swedish.



IV. Tools & supplies:

The tools and supplies needed depend partly on the type of floor on which the boat is stored. This may be dirt, rough concrete or smooth concrete.

The tools common to all three types of surface are quite simple:

- masking tape and ball point pen,
- tape measure and, if possible, a laser measure,
- bubble levels : one @ 20 cm. and one @ 80 cm.,
- electrical tape,
- plumb bob,
- 2 straight edges, one 1.5 m. long and the other 3 m. long,
- a big right angle, at least 60 cm. on a side
- some small rectangular pieces of cardboard,
- -- something to stand on to reach the top of the covering board

The tools and supplies that vary have to do with marking points on the floor.

A. Concrete floor

If the floor is smooth enough so that masking tape or electrical tape will stick to it, you will only need a fast drying liquid to clean the small area where each strip of tape will be applied. Acetone should work.

If the concrete is too rough for tape to stick, one solution is to use the white liquid formerly used to correct errors on a page of typescript. First clean the spot with acetone, then apply the "white-out", but make sure that it has hardened before placing the mark.

B. Dirt floor

It's impossible to sink a nail at a precise point on a dirt floor. Pebbles in the soil will deflect the nail.

To set a string on a dirt floor, one needs to form an "**I**" with three strings and four nails**.** The strings corresponding to the top and bottom of the "I" do not need to be placed accurately. The third string, corresponding to the vertical portion of the "I", loops

around the other two, thus permitting accurate positioning. And use rolling hitches to adjust the tensions of the strings.

For working on a dirt floor, you'll need a hammer, a box of 5 cm. long nails, several tens of metres of string and scissors.

You'll also need straight pins which you'll stick through the string to mark a position.

To measure from a point on the hull, the easiest way is to drive a small nail into the hull at the point. If you wish to avoid doing this, you can use electrical tape and cardboard, for example, to:

- establish a point on the hull, against which you can push the straight edge,
- fix the plumb bob string on the covering board,
- and even hang the plumb bob from the bottom of the hull.

V. Precision and accuracy

A Six Metre rating is expressed with a precision of three decimals, which implies an accuracy to the nearest millimetre of each length measured. This is pure fantasy. With the variety of conditions under which Sixes are measured, this level of precision is illusory.

First, it doesn't much matter. One less millimetre in the rating amounts to a reduction of the sail area by the equivalent of a square 14 cm. x 14 cm.

Second, with variations in temperature and humidity, the boat's dimensions vary by more than a millimetre and so does the measuring tape.

Accuracy is expressed as a margin of error, e.g. ± 4 mm. As one goes through a step of measurements, the margin of error becomes cumulative. The margin of error of the first step needs to be added to, or even multiplied by, that of the second, etc. To be accurate to a millimetre, one needs to measure in microns and then achieve an accuracy of at least ± 500 microns.

Accuracy also depends on consistency. This implies comparing multiple measurements. For a Six, one would need to have different people doing the measurements several times over at least a year under different conditions of temperature and humidity. The accuracy would be the range of their results.

Independent of the quality of the person doing the measuring, the inherent accuracy of a Six's rating is perhaps ± 0.005, i.e. from 5.995 to 6.005.

Despite all this, it's still worth trying to be very careful. Be precise and record the measurements to the nearest millimetre, but don't be fooled by your precision.

VI. Finding the points and measuring the lengths

Because of the hull's curves and the fact that the boat is resting on its keel, it is necessary establish a line parallel to the boat along which the measurements are taken. Measurements made on the boat then need to be projected out to the parallel line on perpendiculars.

When actually measuring, one has to juggle a bubble level, a straight edge and the string of a plumb bob.

Both tasks are tricky. Here are some hints on how to do both of them.

A. Perpendiculars

To establish a perpendicular, you must define a rectangle, alongside the hull, parallel to the centreline. The forward and aft corners of the rectangle must be equidistant from the centreline. For the rectangle to be correct, its diagonals must be equal.

The figure below shows what not to do.

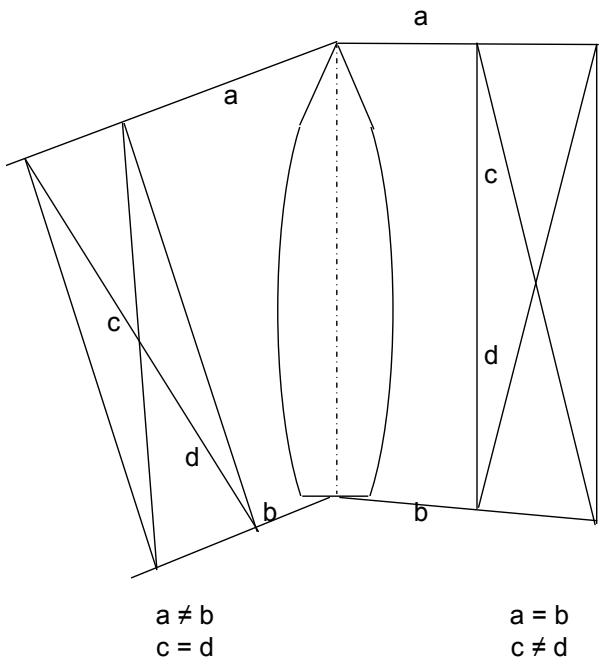


Figure 1. Two ways to get the perpendiculars wrong

B. Juggling

The trickiest measuring involves measuring both the horizontal distance and the vertical height of a point off the hull.

This entails putting a mark on two pieces of masking tape, one stuck to the straight edge and the other wrapped around the plumb bob string – while holding the straight edge level (see Fig. 2 below). This is impossible for a single person.

The trick here is to create temporary local "measuring tapes". One pre-marks the two pieces of masking tape with numbered marks about 5 mm. (1/8") apart. When everything is aligned for the measurement, one mentally notes the "mark numbers" closest to the intersection – marking the exact point on the masking tape afterwards when one's hands are free.

To get to the point of juggling a straight edge and a plumb bob string, one has to proceed by steps, answering a series of questions:

- Where do I need to place the level on the straight edge so that I can see the bubble and the masking tape at the same time? (The level is then taped to the straight edge with the electrical tape at the correct position.)
- Where do I need to place the masking tape so that it runs across the intersection?

In all there are six steps, each involving setting up and sighting and then placing the straight edge back on the ground to stick, mark or measure something.

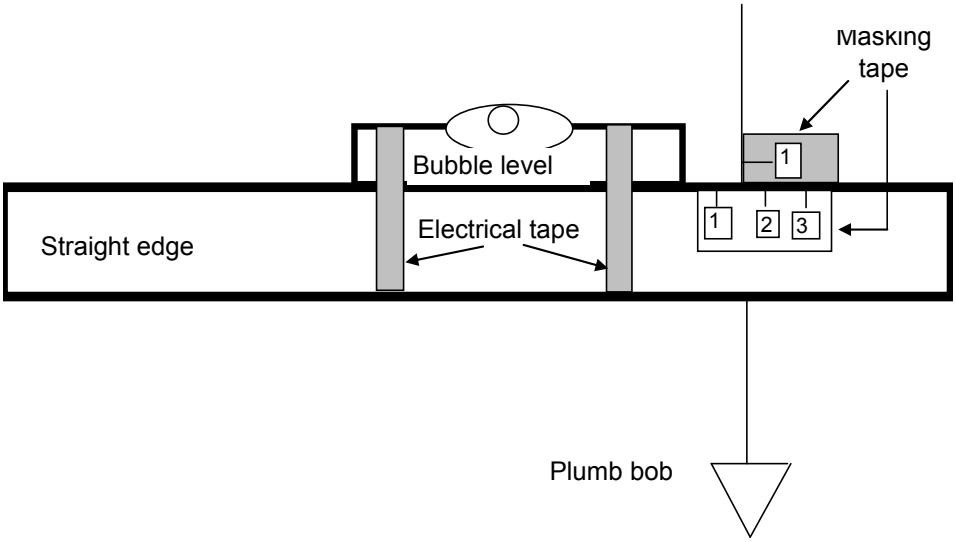


Figure 2. Juggling to measure horizontally and vertically

Good luck – and be patient and meticulous!