International Ten Rater Class Sail Measurement Procedure

A suggested method

What is this document for? - 1

- The measurement of a boat, or its equipment, to establish that it complies with the relevant class rules is a process much like any scientific experiment. In a scientific experiment the physical measurements are taken with suitable equipment by the experimenter. Best practice demands that the measurements are **valid**, **reliable** and **credible**.
- For the measurement of a boat, or its equipment, the **validity** of the measurements is determined by the class rules and is, therefore, not determined by the the official measurer. However, the **reliability** and **credibility** are entirely under his control and both are of interest to everyone involved – owner, sailor, official measurer, certification authority and fellow competitors.
- Without good **reliability** and **credibility** in the measurement process one of the basic principles of the sport, that competitors are governed by a body of rules that they are expected to follow, breaks down. See RRS 'Basic Principles'.
- It should be self evident that it is important to establish what represents good design for the measurement equipment and good practice for its use. This document seeks to identify one example of good design of measurement equipment and the good practice of its use.

What is this document for? - 2

- The Royal Yachting Association, the World Sailing Member National Authority for Great Britain, maintains the 'RYA Racing Charter' which is included in its copies of the RRS.

- One of the objectives of the RYA Racing Charter is:

  'To provide the framework for everyone to enjoy the sport of sailboat racing in whatever capacity and to whatever level the individual desires.'

  It goes on to state Principles and Practices that support the objectives. One is:

  'Officials.... agree to provide the fairest racing possible.'

- Official Measurers play an essential and important role in helping to maintain the framework that supports sailing and, unless they carry out their tasks diligently, the fairest racing will not be possible.

- The Certification Authority should support its Official Measurers by assisting them to carry out their role effectively. Training in the process of equipment measurement is an essential part of this support.

- This document is provided by IRSA to aid that support.

References - 1

The following documents are referred to in the slides

- IRSA International Ten Rater Class rules 2018 - link
- ERS – Equipment Rules of Sailing 2017-2020 - link

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References - 2

The following documents will give valuable additional insight into the measurement process for the Ten Rater Class as well as for any other class.

- International Measurers Manual – published by World Sailing - link
- Guidance for Equipment Inspection (event measurement) – published by IRSA - link

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Contents

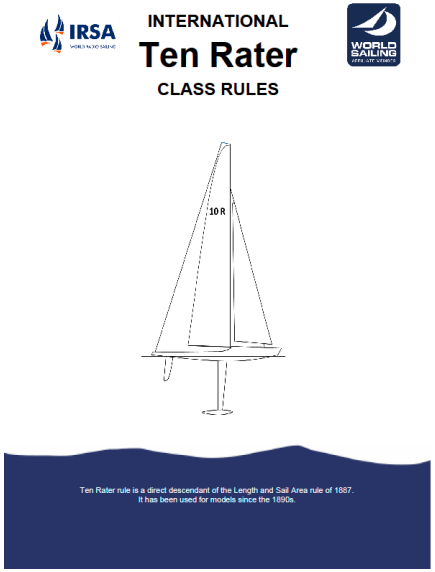
Preparation

The process of measuring the rig and sails of a Ten Rater can be carried out easily by one person.

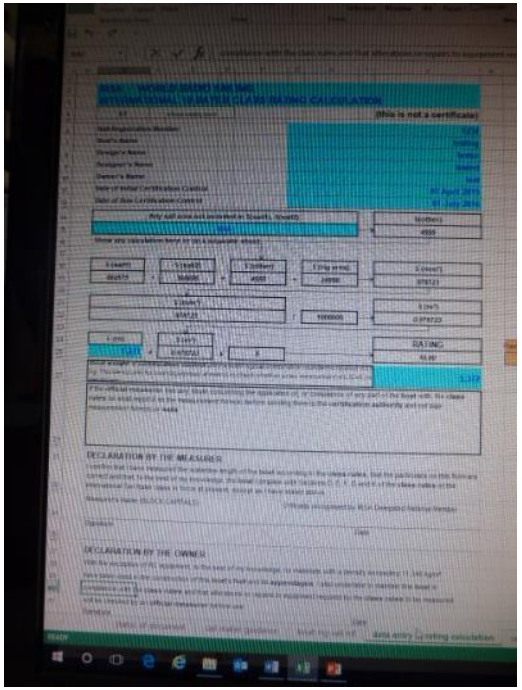
Whilst not essential at this stage, it is useful to have a full set of certification control forms printed off and set of Ten Rater Class rules.

Open a certificate spread sheet on the computer and delete all existing data. Print this blank copy to record the measurements taken.

- Set of Ten Rater Class Rules



- Set of Ten Rater Certificate & Certification Control Forms (electronic and hard copy for recording convenience) [boat data input sheet shown here]



Equipment - 1

This list should not be regarded as everything that is essential for a measuring session, nor should it be viewed as a list of the absolute minimum requirements.

- Flat surface 2500 mm x 650 mm
- Sail/spar measurement grid
- Caliper (Vernier), tape measure and straight edge rule (600 & 300 mm).
- Adhesive tapes for holding sail measurement grid to flat surface
- Pens and pencils for recording data
- Waterproof pen for certifying sails

Equipment - 2

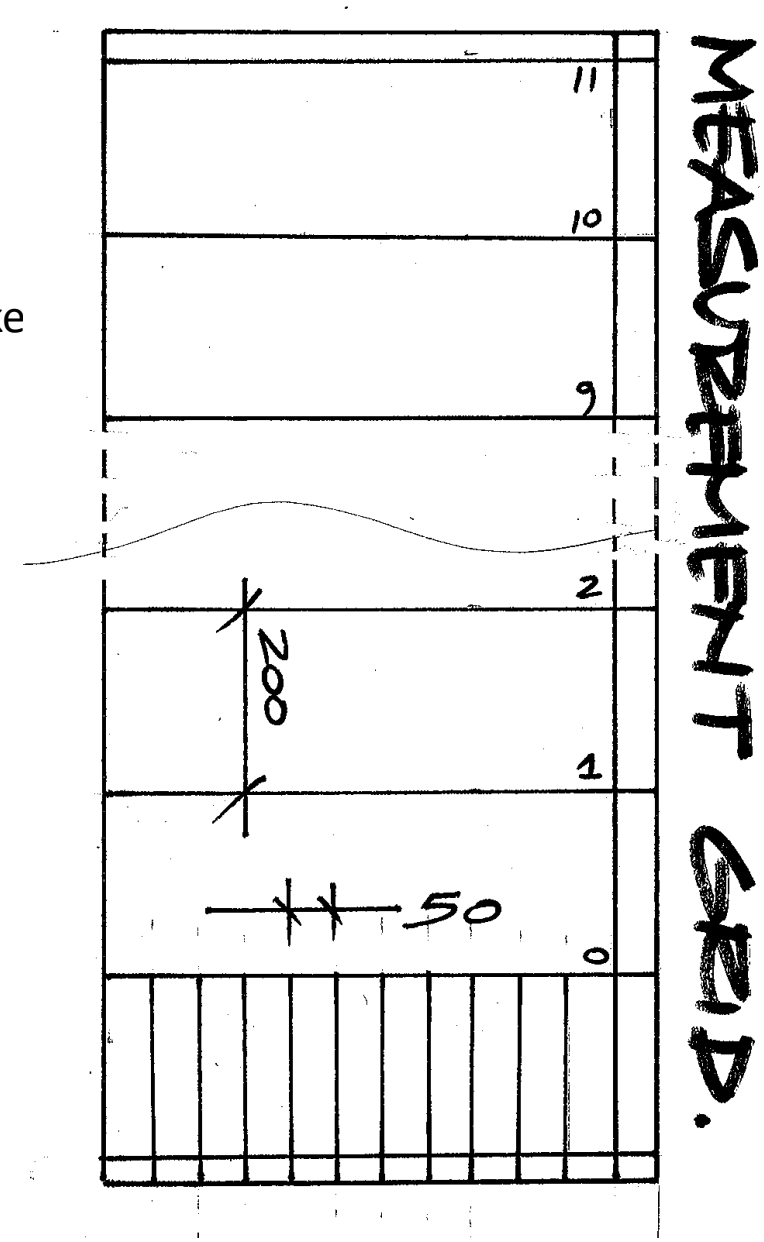
Sail/spar measurement grid

Use thick Mylar film 2450 mm x 600 mm to make the grid.

Place a vertical line 50 mm from the right hand edge.

Add grid lines at 200 mm spacing perpendicular to the first line, numbered 0 to 11.

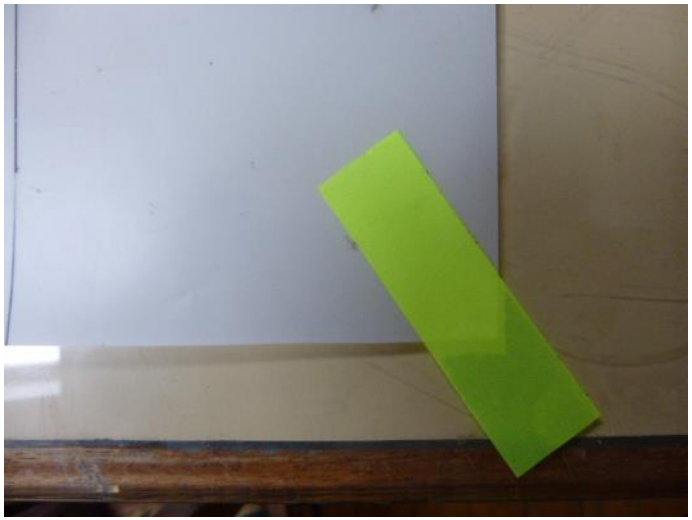
Add vertical lines at 50 mm spacing below the lowest grid line and perpendicular to that grid line, numbered 0 to 11.

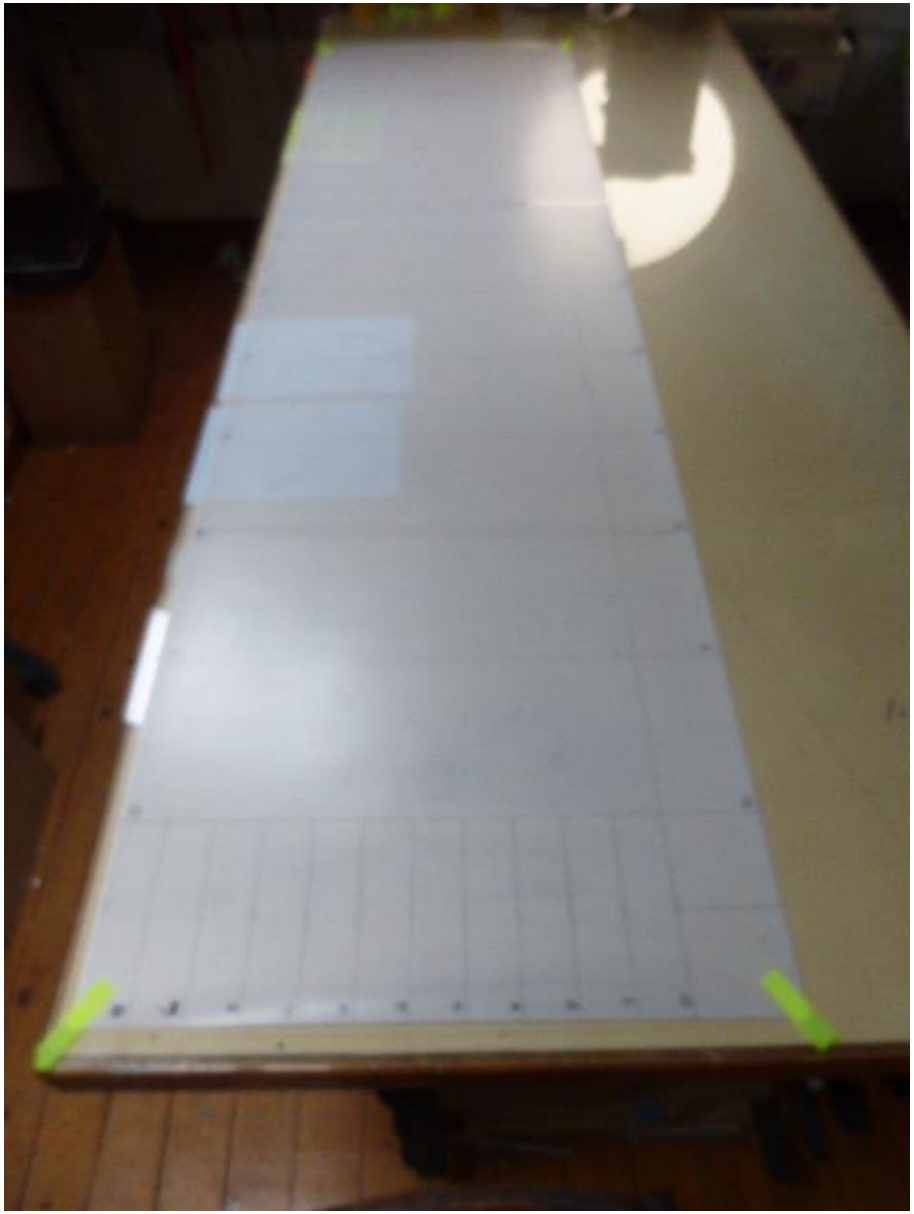


Setting Up

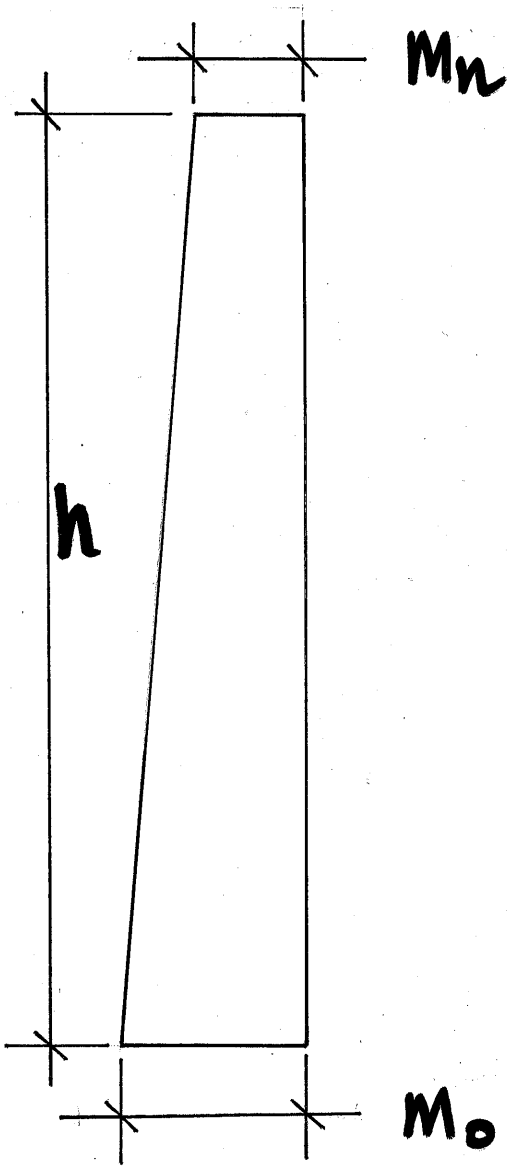
Prepare grid

Tape the sail/spar measurement grid to the flat surface using tabs of tape at the four corners.





Mast spar measurement – constant & evenly tapered profiles



Many **mast** spars are of constant cross section or are evenly tapered along their length.

In these cases the area of the spar, Am, is calculated as:

$$Am = h \times (m_0 + m_n) / 2$$

where:

h is the length of the spar above deck,

m_0 is the **fore-and-aft mast** spar **cross section** or **vertical boom** spar **cross section** at one end,

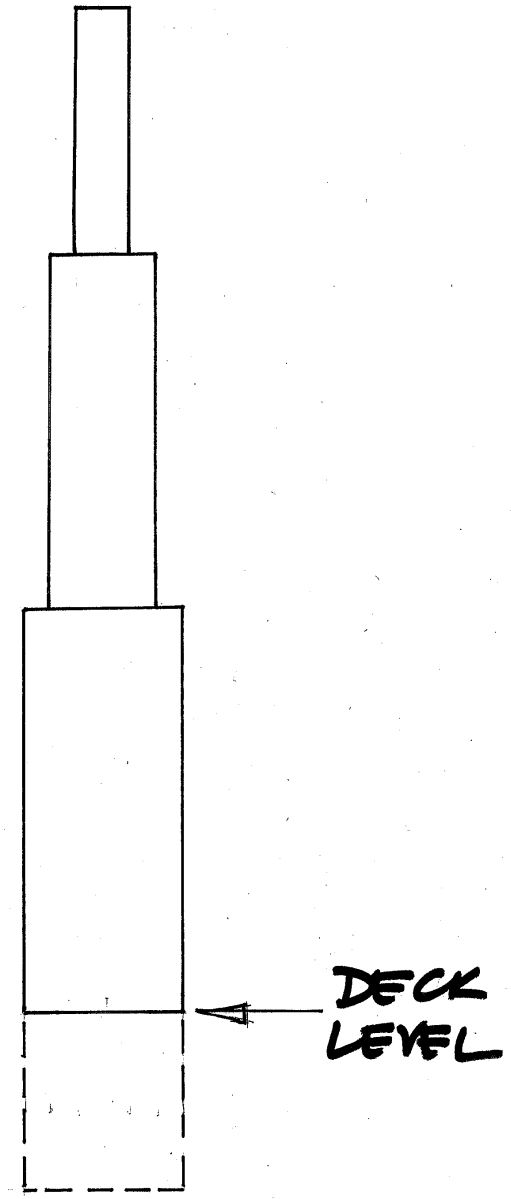
m_n is the **fore-and-aft mast** spar **cross section** or **vertical boom** spar **cross section** at the other end.

Mast spar measurement - other profiles – 1

Many **mast** spar have an irregular taper. They are measured on the sail/spar measurement grid.

Mast spar shall be placed over the sail/spar measurement grid perpendicular to the grid lines and with a grid line at deck level.

See Figure L.1.1 and L.1.2 of the class rules.



Mast spar measurement - other profiles - 2

Mast spars shall be placed over the measurement grid perpendicular to the grid lines and with a grid line at deck level.

See Figure L.1.1 and L.1.2 of the class rules.

In this example there is a fitting (the grey tube) on the **mast** spar at deck level.

Mast spar measurement - 3

Mast spars shall be placed over the measurement grid perpendicular to the grid lines and with a grid line at deck level.

See Figure L.1.1 and L.1.2 of the class rules.

The leading edge of this **mast** spar is on the vertical line.

Mast spar measurement - 4

The fore-and-aft **mast** spar **cross sections**, m_0 to m_n, shall be measured at and along all the grid lines that the spar cuts.

In the example on the right a fitting occurs at the grid line – the measurement required is of the spar **cross section** (the main structural part of the **mast**) so ignore the fitting when taking the measurement.

Mast spar measurement - 5

The area of spar above the uppermost gridline cutting the spar, At, is calculated as:

$At = 0.7 \times m_n \times E$

where E is the height of the spar above the uppermost grid line and m_n is the uppermost width.

Ignore any fitting that is not faired into the **mast** spar. E in this example is 130 mm.

Mast spar measurement - 6

Fittings not faired into a spar and no bigger than is reasonably required for their purpose shall not be considered to be part of the spar.

Fittings faired into a spar and/or bigger than reasonably required for their purpose shall be considered to be part of the spar.

If the backstay crane had been faired into the spar, or was bigger than necessary, it would be included in the E measurement.

Boom spar measurement

One **boom** with a maximum **boom** spar **cross section** not exceeding 22 mm may be used to extend the **tack** and/or **clew** of each **sail** without being included in the measured rig area.

Most rigs have only two **boom** spars of less than 22 mm cross section. In this case there will be no need to measure any boom spars.

A swing rig will normally have more than two **boom** spars so will require the area of additional spar area.

Any **boom** spar that shall be included in the measured rig area shall be measured as for **mast** spars.

Sail area measurement – 1

Some general points in the Class Rules that vary the approach required by the Equipment Rules of Sailing:

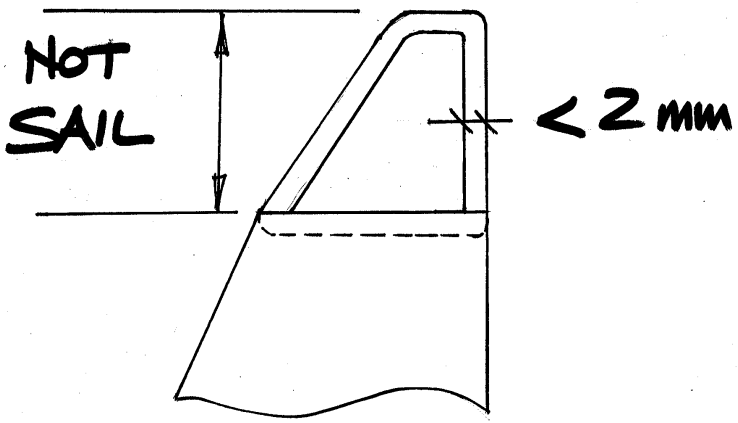
- Battens need not be removed from sails
- Sails can be left on the spars – but it will be easier if they are removed
- Stays inside luff tabling that are less than 2 mm in diameter need not be removed
- Tell tales overlapping sail edges shall be ignored.

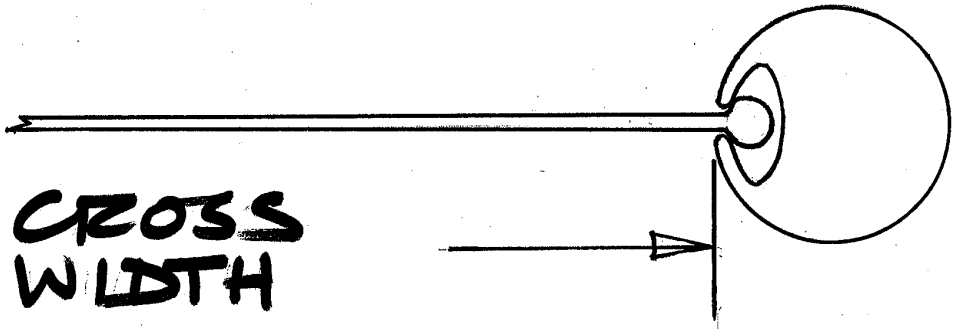
Sail area measurement - 2

Some general points in the Class Rules that vary the approach required by the Equipment Rules of Sailing:

Parts of a headboard that are less than 2 mm in diameter and not covered by sail material shall not be taken as parts of the **sail**.

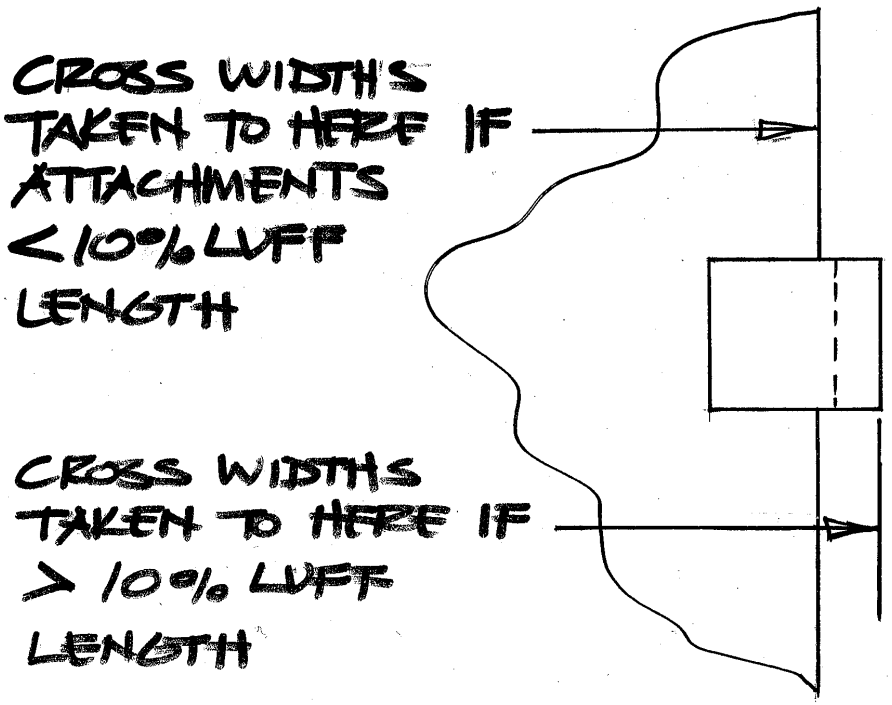
Where a **sail** has a luff rope the cross widths shall be taken to aft edge of the **spar**.





Sail area measurement - 3

Discontinuous attachments on the **luff** shall be disregarded for the purpose of measurement provided that their total length, measured along the **luff**, does not exceed 10% of the **luff** length and that the longest attachment is no more than twice the shortest.

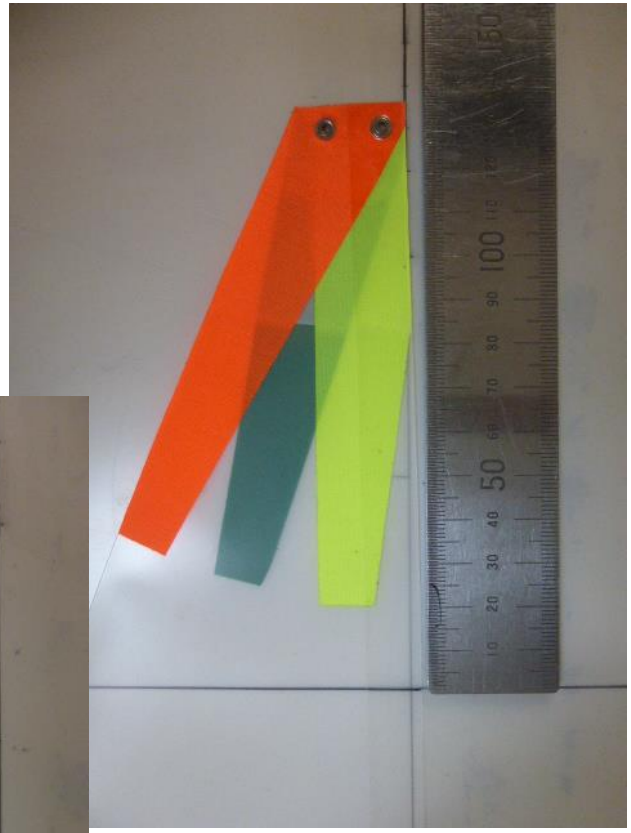


Sail area measurement - 4

The **sail** shall be placed over the measurement grid with the **clew point** on the datum grid line (below left)and with the **head point** (right) and **tack point** (below right) on a line perpendicular to the grid lines. See Figure L.2.1.

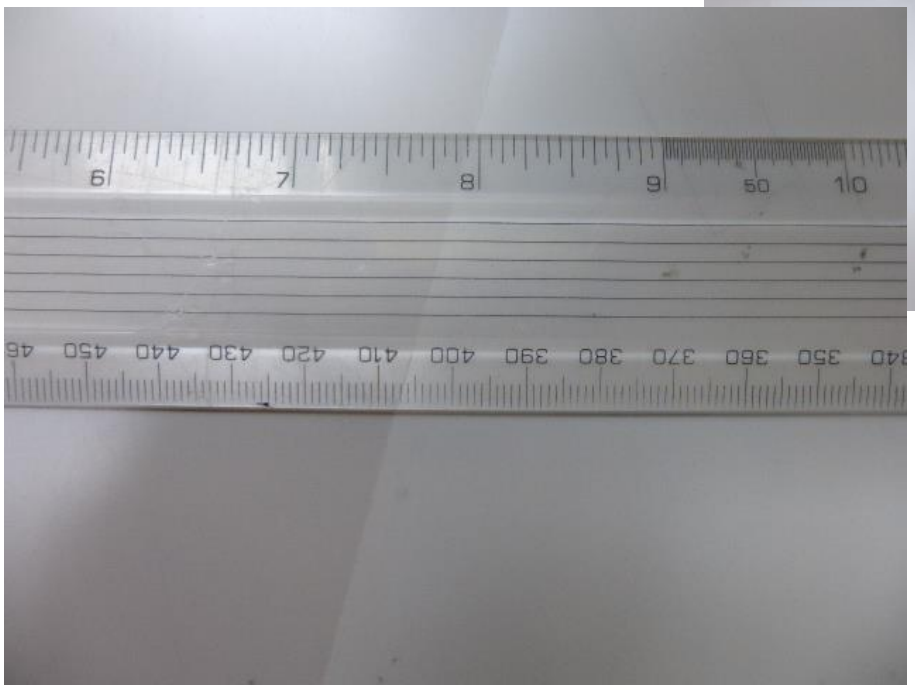
Sail area measurement - 5

The upper limit of area A1 shall be marked at the **luff** and **leech** where they pass over the grid line. See Figure L.2.3. The illustration to the right shows the sail correctly positioned on the grid. The illustration below shows the sail (moved) after marking.



Sail area measurement - 6

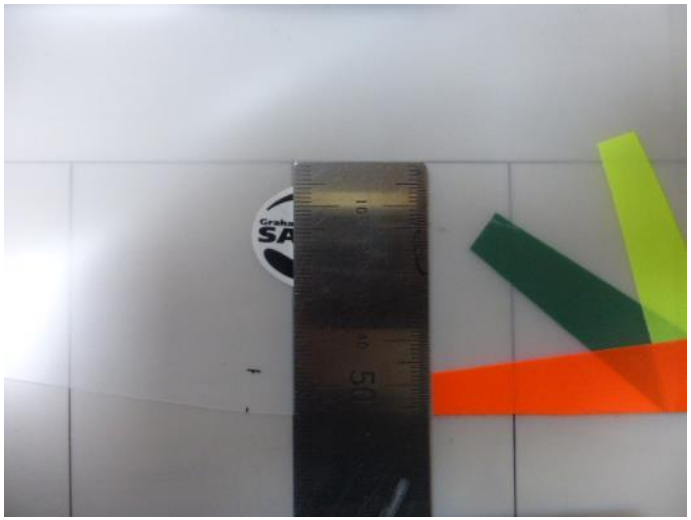
Cross widths, c_0 to c_n, shall be measured from the **leech** to the **luff** at and along all the horizontal grid lines which the **sail** cuts. See Figure L.2.4

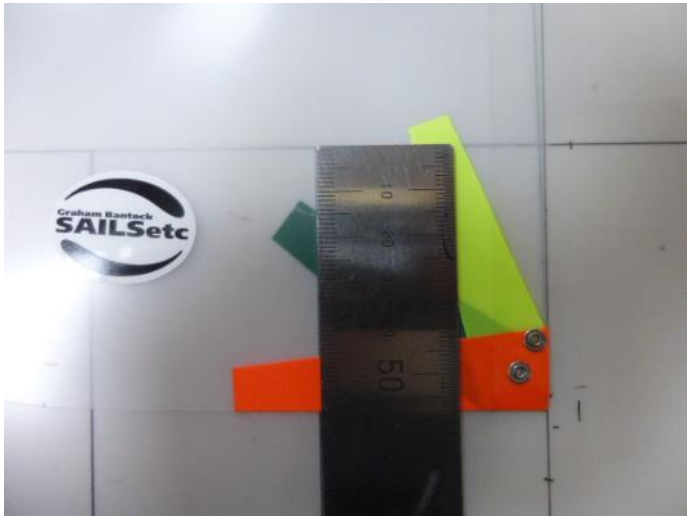


The cross width is 408 mm.

Sail area measurement - 7

Heights, h_0 to h_n, shall be measured from the datum grid line to the **foot** at and along all the vertical grid lines which the **sail** cuts. See Figure L.2.4.





Data entry - 1

The cross widths c_0 to c_n, heights h_0 to h_n and the extensions at the head of each sail, E, are entered into the spreadsheet for the two sails and the area of each sail is found from those measurements.

- The uppermost cross width is always entered into the box marked c_n
- The aftermost height is always entered into the box marked h_n
- Whole number values only – no decimal places.

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IRSA 10 RATER CLASS SAIL CERTIFICATION CONTROL FORM

89	official validity check

Sail 1	Hull registration number	2345

E	50		
cn	55	c_{n-1}	118
c10			
c9	118		
c8	167		
c7	212		
c6	265		
c5	295		
c4	329		
c3	361		
c2	392		
c1	316		
SUM1	2455	+	
c0	435		
hn	9		
h10			
h9			
h8			
h7	19		
h6	27		
h5	34		
h4	40		
h3	45		
h2	45		
h1	35		
SUM2	245	h0	12

Guide measurements for sail makers and Equipment Inspectors :	
Luff length	2062
Leech length	2096
Luff perpendicular	435
Foot	435
NB : These dimensions are approximate and for guidance only	
To maximise sail area	
Either	
Delta Sail 1 LP	18
Equivalent to Sail 1 LP	453
Or	
Delta Sail 2 LP	24
Equivalent to Sail 2 LP	428

Warning box

Warning box

A1 :	$c_0 + c_n$	490	x	100	49000	+	491000	A1	540000
	SUM1	2455	x	200					
A2 :	0,5 x E (c_n x (2 + E / 200) - E x c_{n-1} / 200)							A2	2356
A3 :	$h_0 + h_n$	21	x	25	525	+	12250	A3	12775
	SUM2	245	x	50					
								S (sail1)	555131

DECLARATION BY THE MEASURER

I confirm that I have taken the measurements on this form, that they are correct and that to the best of my knowledge, the **sail** complies with the **class rules** in force at present, except as I have stated below.

The measurer may report anything here.

Name of Official Measurer (BLOCK CAPITALS) | Stamp (Certification Authority)

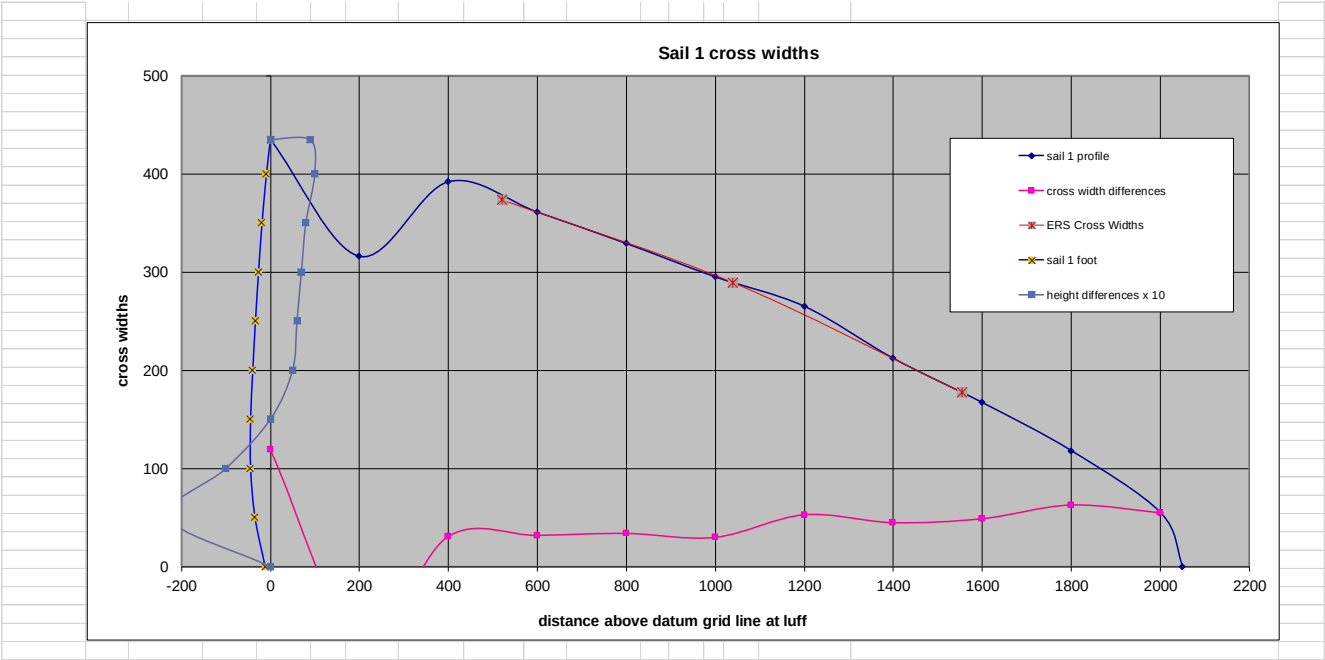
Signature | Date

Effective: 1st April 2018 | *V 18-2* | *© 2018, IRSA*

IRSA Ten Rater Class Sail 1 CCF - Certificate page 2 - ***not valid without pages 1, 3 and 4.***

Data entry - 2

To the right hand side of the data entry area and below it are graphs that show the sail profile.



- The leech profile is shown by dark blue diamonds and a dark blue line.
- The foot profile is shown by red crosses on yellow squares and a bright blue line.
- The pink squares and a pink line show the changes in cross widths.
- The pinks squares on a blue line shown the changes in foot heights.

Two errors in the data entry for the cross widths are obvious from the leech profile line. The cross width at 200 mm (C1) is probably 100 mm too small. The cross width at 1200 mm (C6) is probably 10 mm too large.

Large irregularities appear at those places in the ‘change in cross width’ line.

Data entry - 3

To the right hand side of the data entry area are tables in yellow that check for hollows in the sail leech and foot profiles.

Because the data entry for C1 was 100 mm too small the word ‘check’ appears against C1.

Because the data entry for C6 is 10 mm too great it appears there are hollows each side of C6 i.e. the word ‘check’ appears at C5 and C7.

The word ‘check’ also appears for h2 and h3 for the foot profile. A visual check of the graph shows this may not be the case.

Check the sails to establish the correct dimensions and for any hollows where indicated.

	Hollows check :		
	Measurer - Please check for hollows where noted		
C11	0	0	
C10	55	55	**ok**
C9	118	111	**ok**
C8	167	165	**ok**
C7	212	216	**check**
C6	265	254	**ok**
C5	295	297	**check**
C4	329	328	**ok**
C3	361	361	**ok**
C2	392	339	**ok**
C1	316	414	**check**
C0	435	158	**ok**
hn	9		
h10	0	28.5	
h9	0	40	
h8	0	42.5	
h7	19	39.5	
h6	27	33.5	
h5	34	26.5	
h4	40	18	
h3	45	9.5	**check**
h2	45	4.5	**check**
h1	35	0	
h0	12		

Data entry - 4

Checking the sail reveals 316 was entered instead of 416 at C1 and 265 was entered instead of 256 at C6. When these corrections are made the sail profile appears shown here.

The ‘change in cross widths’ and ‘change of foot heights’ lines are now smooth.

Note that there are three data points (orange/red on a red line) that show the estimated ERS quarter, half and three-quarter cross widths for the sail. Not used for measurement but used for the sail maker guidance page.

Data entry - 5

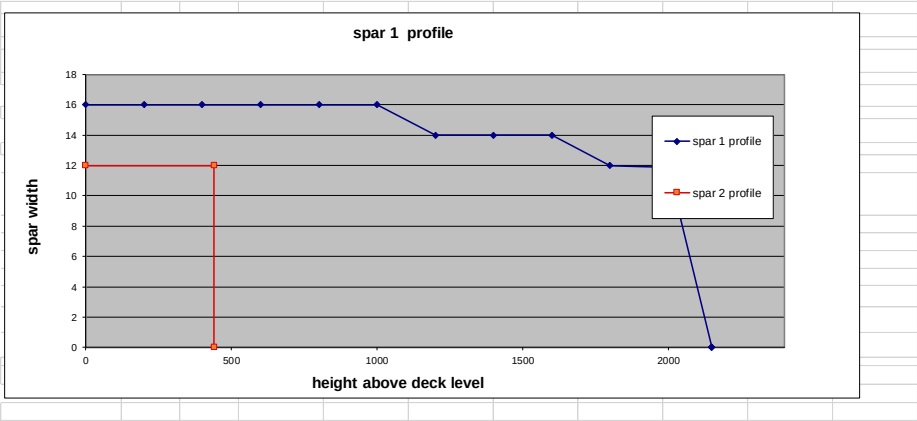
Mast spars that are of constant diameter, or have an even taper, are measured by measuring the width at the **heel point** (m0) and the **top point** (mn) and the distance between those (h).

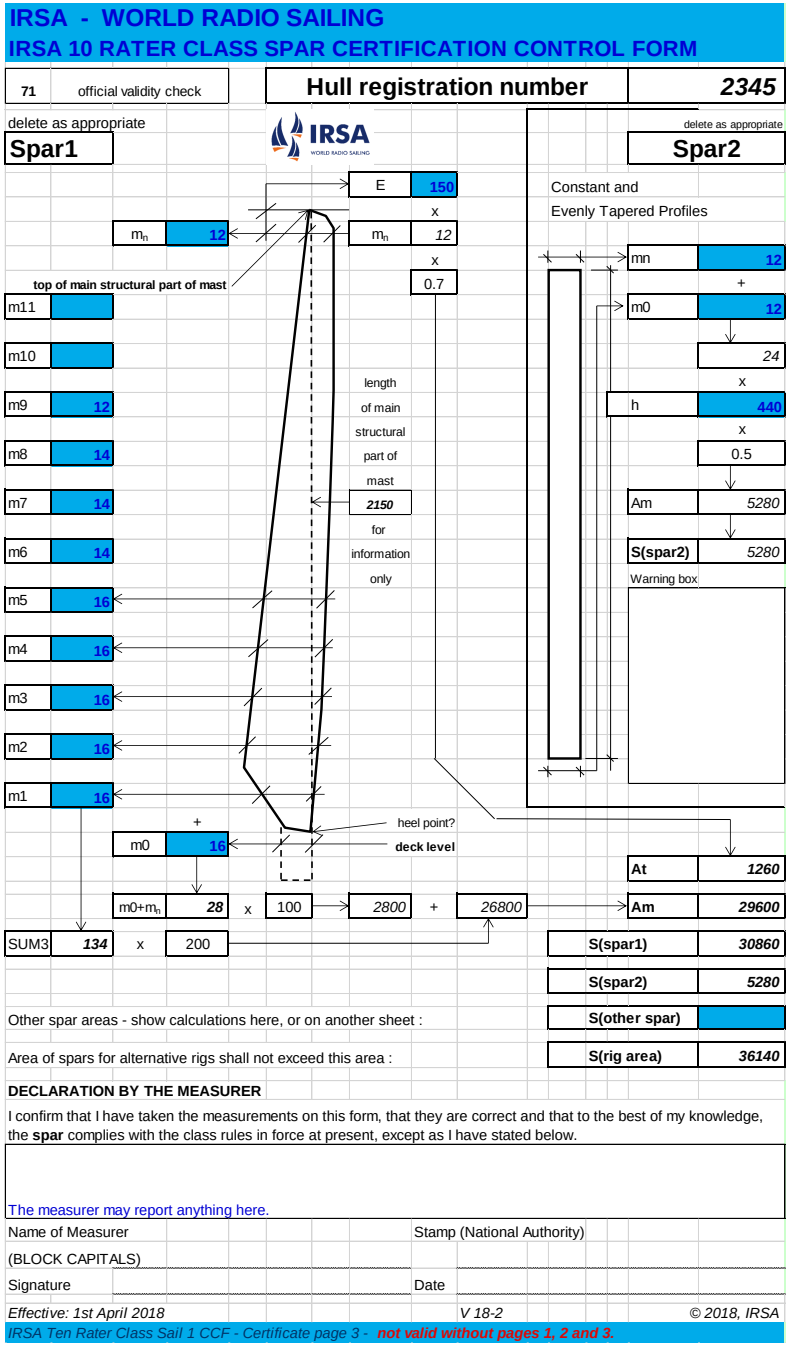
See the Spar2 area to the right hand side of the spar – page 4 sheet.

In the example here this calculation is used to find the area of a **boom** spar that is part of a swing rig that uses three **boom** spars in total. It is 440 mm long and 12 mm deep.

Masts that have an irregular profile are measured in the same way that sails are measured.

This includes any spar that is made with a step 'taper' using tubes of different diameters. This mast is made of 16, 14 and 12 mm tubes.



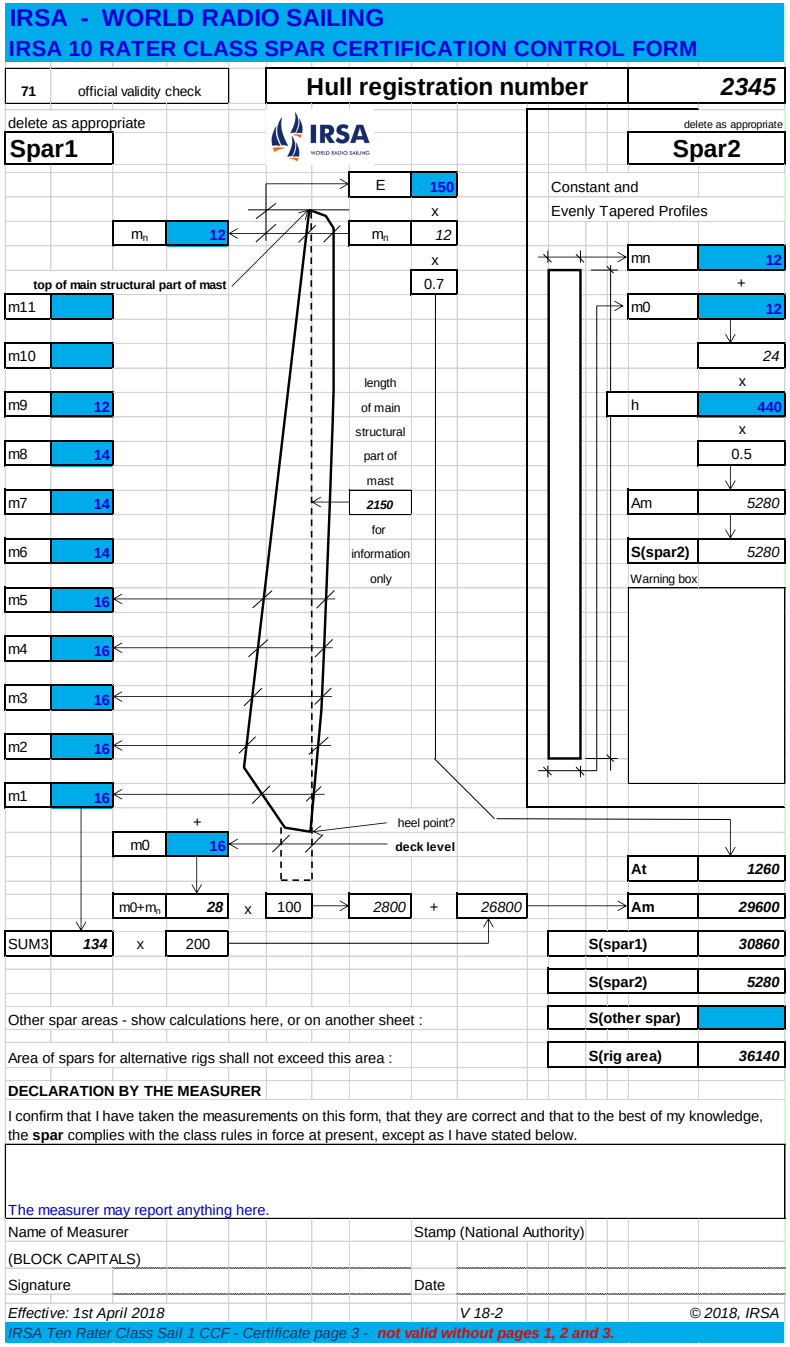


Data entry - 6

The length of the **mast** spar is calculated from the data and is shown near the middle of the page shown here.

It is useful to make a quick check by measuring the approximate length of the mast. This ensures no data entry is missed out.

The **mast** spar length is compared with the **mainsail luff length**. If it is shorter than the **mainsail luff length** a note to that effect is shown in one of the 'warning boxes'.



Round measurements correctly

Always round up to the next whole number

“Linear measurements shall be taken in millimetres and rounded up to the nearest whole number….”

For example, a value judged to be just over 208.0 mm, say 208.1 mm, shall be rounded to 209 before being used on the certificate.

Comparing dimensions with limits

Limits are not flexible.

*"Maximum and minimum values of limitations in the **class rules** or **certificate** shall be taken as absolute limiting values."*

For example, a boom with a cross section judged to be just over 22.0 mm, say 22.1 mm, is over the 22 mm limit above which its area shall be included in the measured rig area.

Certification of the largest sails

Usually the largest sails and mast spar are measured first to establish the rating of the boat. After completing this…

The **official measurer** shall **certify sails** ….

- this means he adds a **certification mark** (usually his signature)

…. and add the following marks at the **tack**:

- the date of **certification control**, (usually today's date)
- the area of each **sail** ….,(look on the spreadsheet for the relevant sail – in square metres to 3 places of decimals e.g. 0.644)

Certification of smaller sails - 1

Other sails shall comply with the dimensions of their ‘parent’ sail recorded on the certificate.

Their dimensions are found in the same way as for the parent sail with one exception:

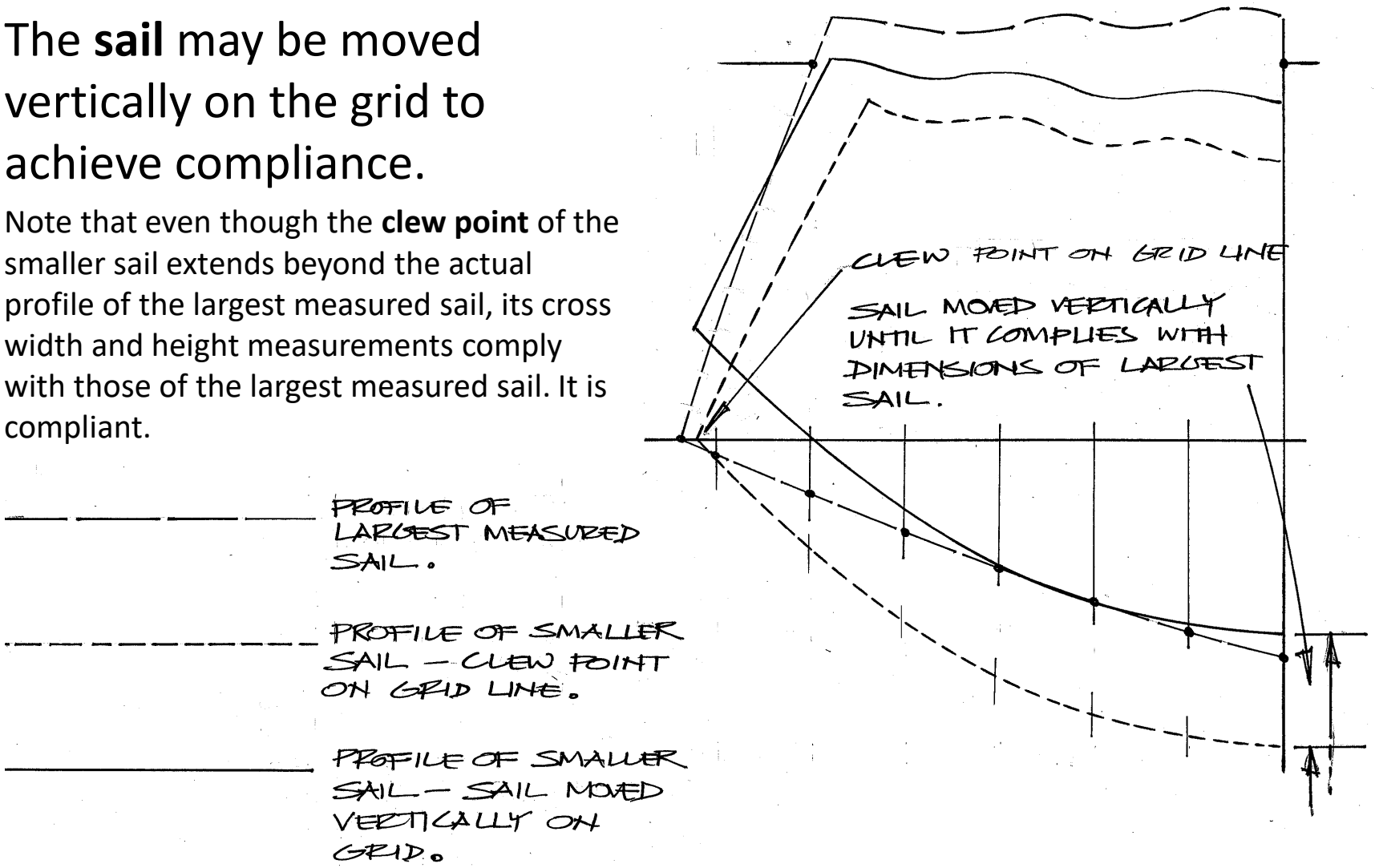
- The **sail** may be moved vertically on the grid to achieve compliance.

This is because the **tack point** (especially for headsails) will usually extend below the h_0 dimension when its **clew point** is placed on the grid line. In this case the sail is moved up the vertical grid line until the **tack point** is at the dimension recorded on the certificate (or further if necessary). Then the cross widths and heights can be taken and compared with the certificate values.

Certification of smaller sails - 2

The **sail** may be moved vertically on the grid to achieve compliance.

Note that even though the **clew point** of the smaller sail extends beyond the actual profile of the largest measured sail, its cross width and height measurements comply with those of the largest measured sail. It is compliant.



Certification of smaller sails - 3

When the smaller sails have been checked and found to comply with the dimensions of their parent sails…

The **official measurer** shall **certify sails** ….

- this means he adds a **certification mark** (usually his signature)

…. and add the following marks at the **tack**:

- the date of **certification control** (usually today's date)
- the area of the parent **sail** on each alternative **sail** (the same area that was noted on the parent sail)

Sail maker guidance - 1

This sheet is not part of the certification process but is created to log information that will be useful to the sail maker when making replacement sails to match the certificate for the boat.

Data from the data entry & rating calculation sheet appears on the sheet to identify the boat and owner.

The primary dimensions of each sail, including the ERS **quarter**, **half** and **three-quarter cross widths**, are shown.

The sail maker will also need copies of sail 1 – page 2 and sail 2 – page 3 from the certificate to ensure the sail is shaped exactly to match the certificate.

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IRSA 10 RATER CLASS SAIL MAKER GUIDANCE

Guide measurements for sail makers and Equipment Inspectors :

NB : These dimensions are approximate and for guidance only

The dimensions of sails shall not exceed the dimensions of the sails recorded on the certificate.

Hull Reg. No.	*2345*
Boat Name	*Power Point*
Design Name	*High Voltage*
Owner's Name	*A. Powers*
Sails Measured	*01 May 2018*
96	*Validity check*

Dimension	Sail 1	Sail 2
Luff	*2062*	*1575*
Leech	*2096*	*1505*
three-q *	*177*	*140*
half *	*287*	*244*
quarter *	*373*	*336*
LP	*435*	*404*
Foot	*435*	*423*

*** Use with caution**

To maximise sail area	
Rating	*9.994*
Max permitted sail area	*0.987362*
Measured sail area	*0.986809*
Deficit - m^2	*0.000553*
Deficit - mm^2	*553*
Either	
Delta Sail 1 LP	*1*
Equivalent to Sail 1 LP	*436*
Or	
Delta Sail 2 LP	*1*
Equivalent to Sail 2 LP	*405*

three quarter width
0.25 LP plus *68*

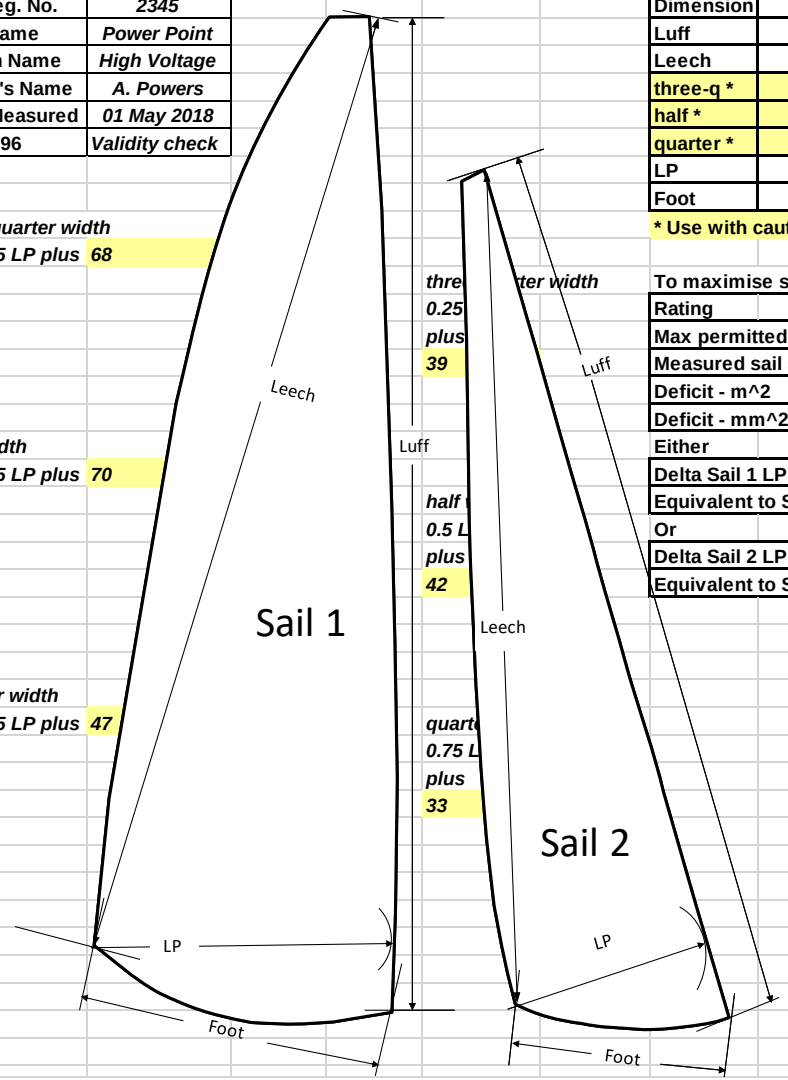
half width
0.5 LP plus *70*

quarter width
0.75 LP plus *47*

three quarter width
0.25 LP plus *39*

half width
0.5 LP plus *42*

quarter width
0.75 LP plus *33*



Sail maker guidance - 2

The difference between the measured area of the rig and the maximum permitted area (Deficit) is shown in units of square metres and square millimetres.

The deficit for this boat is 553 mm.

To assist the owner maximising his sail area for future measurement a ‘new’ dimension is found for Sail 1 LP and Sail 2 LP that will provide the additional sail area. The quarter, half and three-quarter cross widths have to be increased in correct proportion.

In this case the increase in mainsail foot length (Delta Sail 1 LP) is 1 mm. It is 553/(0.5 x 2062) = 0.54 mm. This is rounded to 1.

In practice this would create a rig area that is marginally larger than permitted.

Delta values greater than 1 indicate the possibility of having slightly larger sails.

IRSA - WORLD RADIO SAILING

IRSA 10 RATER CLASS SAIL MAKER GUIDANCE

Guide measurements for sail makers and Equipment Inspectors :

NB : These dimensions are approximate and for guidance only

The dimensions of sails shall not exceed the dimensions of the sails recorded on the certificate.

Hull Reg. No.	*2345*
Boat Name	*Power Point*
Design Name	*High Voltage*
Owner's Name	*A. Powers*
Sails Measured	*01 May 2018*
96	*Validity check*

Dimension	Sail 1	Sail 2
Luff	*2062*	*1575*
Leech	*2096*	*1505*
three-q *	*177*	*140*
half *	*287*	*244*
quarter *	*373*	*336*
LP	*435*	*404*
Foot	*435*	*423*

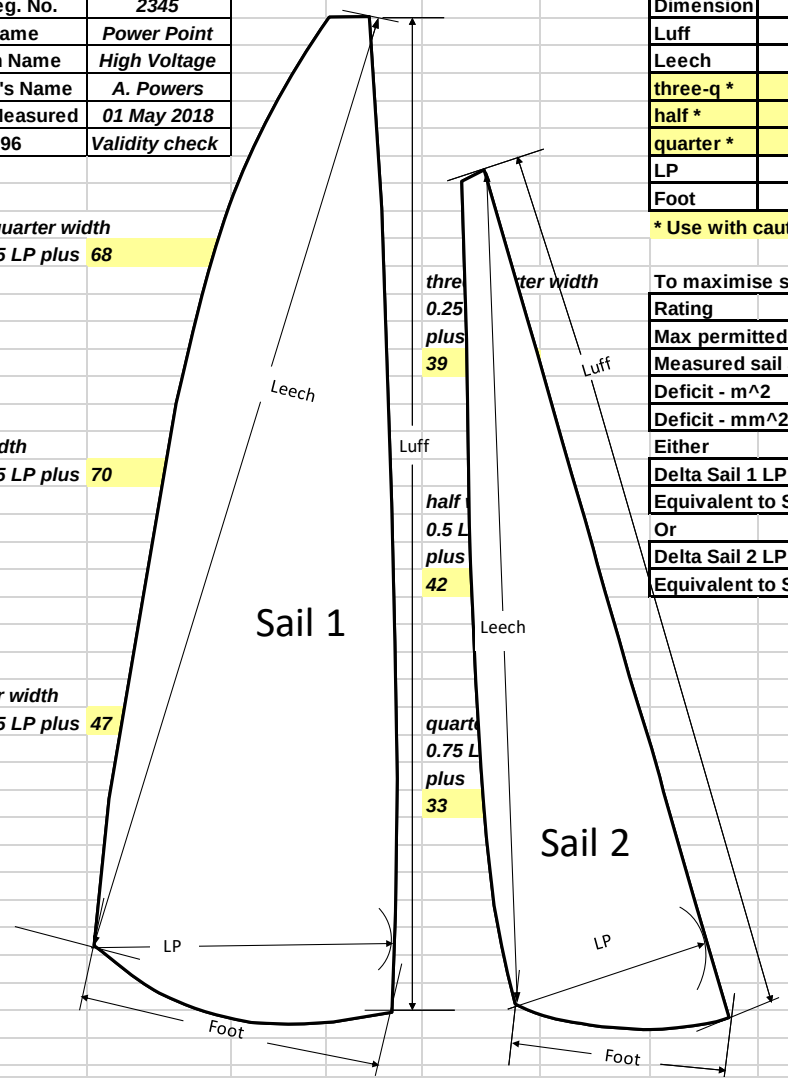
** Use with caution*

three quarter width	
0.25 LP plus	*68*
half width	
0.5 LP plus	*70*
quarter width	
0.75 LP plus	*47*

thre	*ter width*
0.25	
plus	
39	
half	
0.5 L	
plus	
42	
quart	
0.75 L	
plus	
33	

To maximise sail area

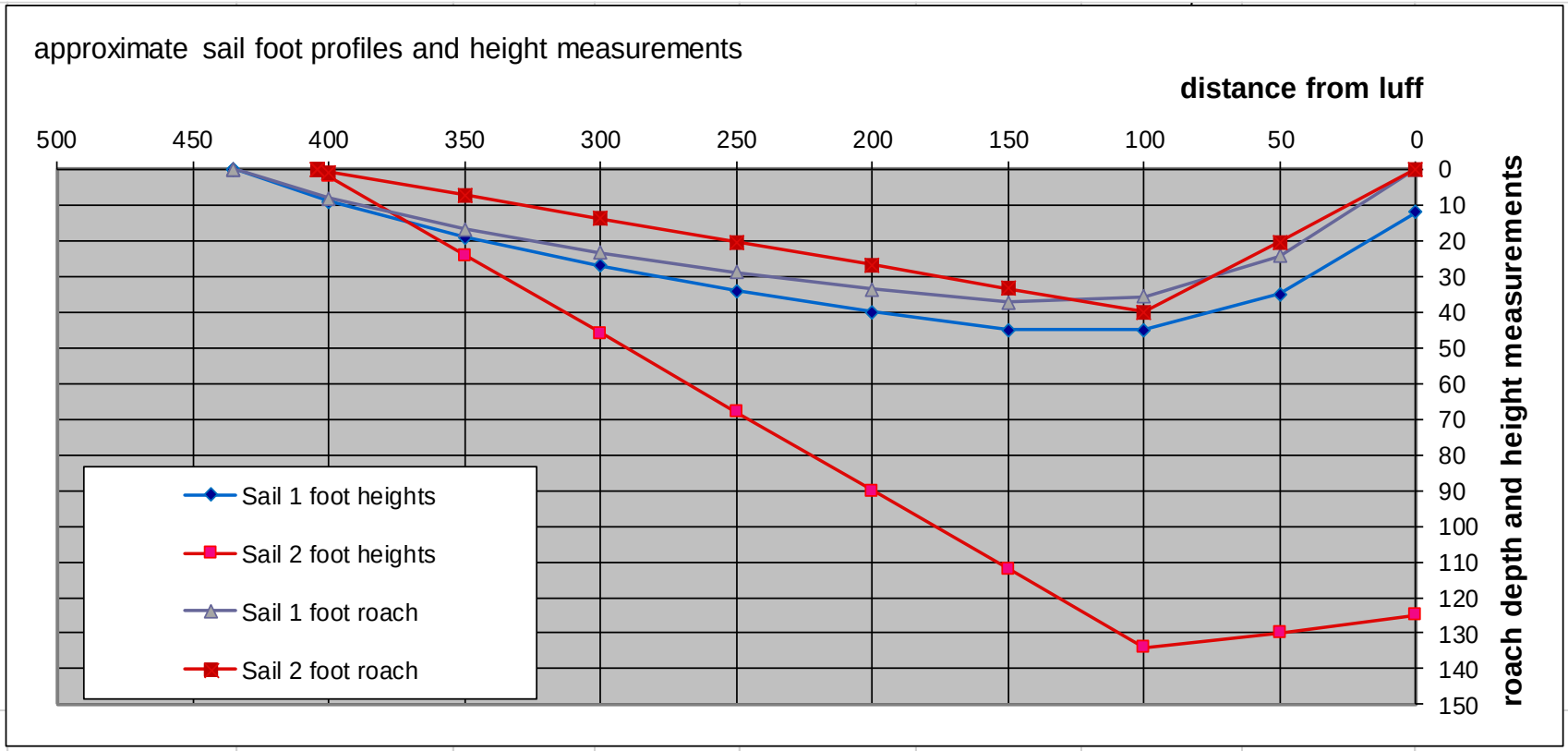
Rating	*9.994*
Max permitted sail area	*0.987362*
Measured sail area	*0.986809*
Deficit - m^2	*0.000553*
Deficit - mm^2	*553*
Either	
Delta Sail 1 LP	*1*
Equivalent to Sail 1 LP	*436*
Or	
Delta Sail 2 LP	*1*
Equivalent to Sail 2 LP	*405*



Sail maker guidance - 3

Beneath the sail diagram and associated data is a graph that shows the profile of the sail foot shapes.

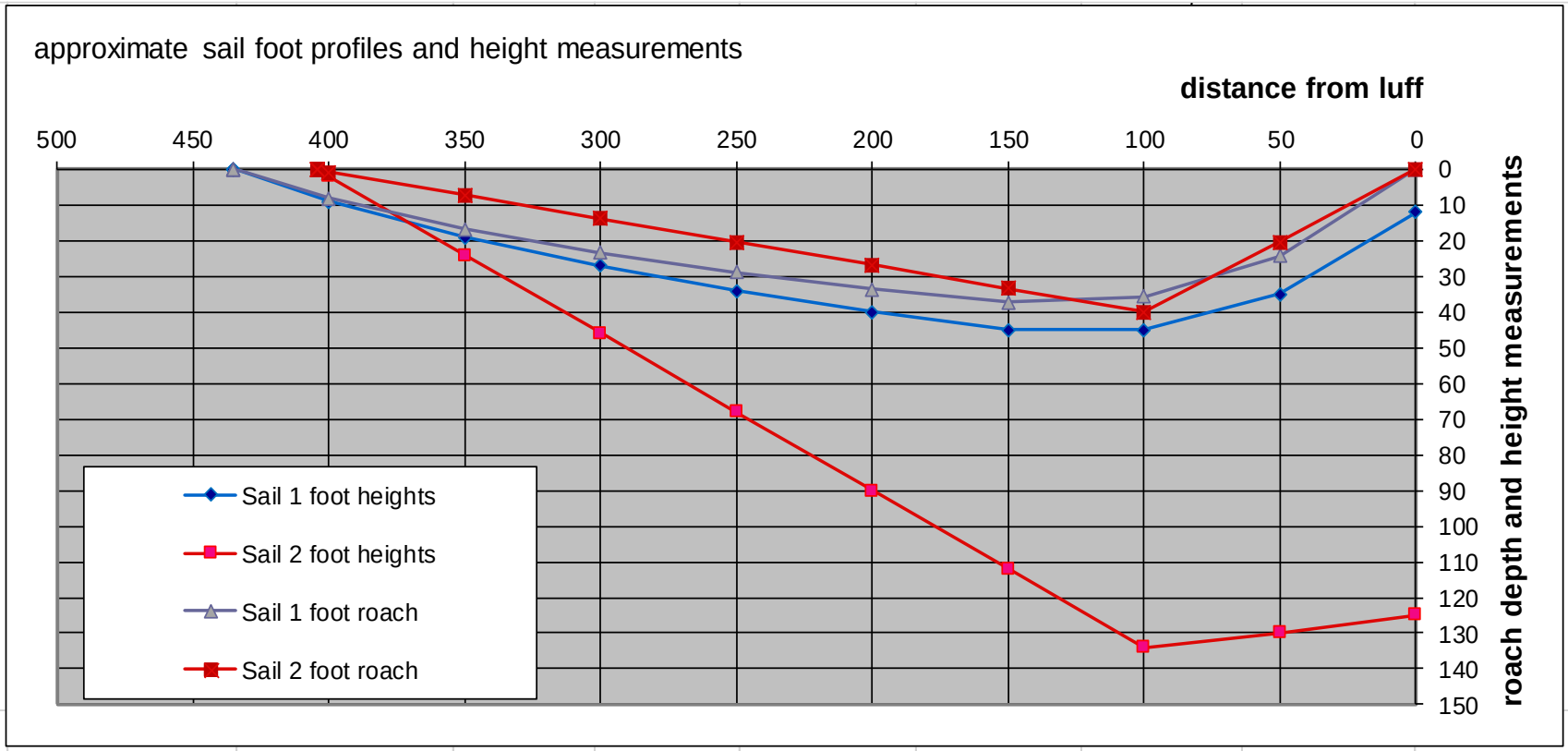
The lower line (pink squares on a red line) is the headsail foot profile – two straight lines. The upper line (red squares on a red line) is the same foot profile but with reference to a straight line between **tack point** and **clew point**. It shows the foot profile is triangular with its greatest depth of 40 mm at 100 mm aft of the **tack point**.



Sail maker guidance - 4

The curved line (blue diamonds on a blue line) is the mainsail foot profile. The upper curved line (violet triangles on a violet line) is the same foot profile but with reference to a straight line between **tack point** and **clew point**.

The upper line shows the foot roach is a maximum of 37 mm at 150 mm back from the tack point.



End

v4 – March 27th 2018