

# International Moth Class Association Measurement Manual

1<sup>st</sup> Edition: John Butler, September 1984

2<sup>nd</sup> Edition: Ian Ward, June 1994

3<sup>rd</sup> Edition: Rohan Veal and Mark Robinson, May 2004

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## **1 AUTHORITY**

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This manual obtains its authority within the International Moth Class from the IMCA Council of Presidents. It may be amended from time to time as required, with immediate effect, by the IMCA Executive Committee, provided subsequent approval is granted by the Council of Presidents at the next held IMCA AGM.

## **2 INTRODUCTION**

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The purpose of this manual is to provide a consensus opinion of the acceptable approach to measurement of International Moth Class sailing dinghies. The Class Association aims to encourage a consistent and professional approach to measurement from its totally volunteer team of measurers. It is important to stress that this manual is supplementary to the International Moth Class Association (IMCA) rules, and does not replace the International Moth Class Association rules.

## **3 THE ROLE AND RESPONSIBILITIES OF THE MEASURER**

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It is the responsibility of the Measurer to ensure that an International Moth which has been measured and subsequently certified by the National Association, has undergone proper and accurate measurement in accordance with the spirit and letter of the rules of the International Moth Class.

A measurer shall not measure any boat in which he has a personal interest, ie, financial involvement, helmsman, owner, builder, designer, etc., however 'personal' or 'financial' involvement does not include the measurer's task of measurement or his fee for that measurement, if applicable. It is the duty of a Measurer, when completing a measurement form, to record only FACTS.

Measurers, in their own interests, shall not enter into any debate as to rule compliance of a particular boat. Any queries or deviations from normal should be noted on the form under 'Measurer's Remarks', and the IMCA requested to obtain a definitive ruling. The IMCA can issue a Temporary Certificate, conditional upon the correct interpretation of a particular deviation, which may be withdrawn at any time. If a measurer

is in doubt as to whether the boat complies with the 'Spirit' rather than the letter of the rules, suitable notes shall be made on the Measurement Form, or attach sketches, etc.

#### **4 MEASUREMENT EQUIPMENT**

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Measurers are expected to provide their own equipment, and are therefore recommended to prepare a measurement kit consisting of the following:

- A 10 metre steel tape, 3 metre steel tape and a steel ruler; all graduated in millimetres.
- A 600mm spirit level, Plumb Bob and 5 metres of clear bore plastic tubing.
- A large 90° set square or draughtsman's T square, Ring or template.
- A 90mm internal diameter ring.
- A reel of unwaxed Terylene whipping twine or heavy duty fishing line.
- Minimum of 6 large skewers, Minimum of 6 small skewers, 6 large 'Bulldog' clips.
- Indelible ink marking pen, Notepad, clipboard and ball-point pen.
- Calculator with a square root function, or a copy of the IMCA measurement spreadsheet.
- IMCA Measurement Manual.
- The International Moth Class Rules.
- Measurement and Calculation of Sail Area document.
- IMCA Measurement Forms.
- I.S.A.F. Racing Rules of Sailing.
- Purpose built Measurement Calliper or frame for accurate measurement of overall length and width

#### **5 INTERNATIONAL MOTH CLASS RULES**

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Upon registration as an Approved Class Measurer, each Measurer is supplied with the latest copy of the IMCA Rules, and is sent updates from the National Moth Class Association as and when changes are made. Further copies can be obtained from the IMCA.

#### **6 MEASUREMENT FORMS**

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The International Moth Class Measurement Forms comprise two parts, namely:

##### **6.1 International Moth Class Measurement Form**

This is a record of measurements taken and compliance with rules in respect of hull, mast and sails, complete with the Measurer's Declaration.

##### **6.2 Sail Area Measurement Form**

This is to justify the area of sails used with the boat, as declared on the International Moth Class Measurement Form. Points to note when filling out this form are: The Sailmaker's name must be shown on the form, together with the sail's serial number.

If a sailmaker's serial number is not evident then the measurer shall allocate one (eg, GBR4050/1) and endorse the sail accordingly with an indelible ink marker. Calculations should be carried out to 3 decimal places, with the final Total Area expressed to two places of decimals. Measurement AB must correlate with the measurement on the International Moth Class Measurement Form. Remember to sign and date the form on the reverse side!

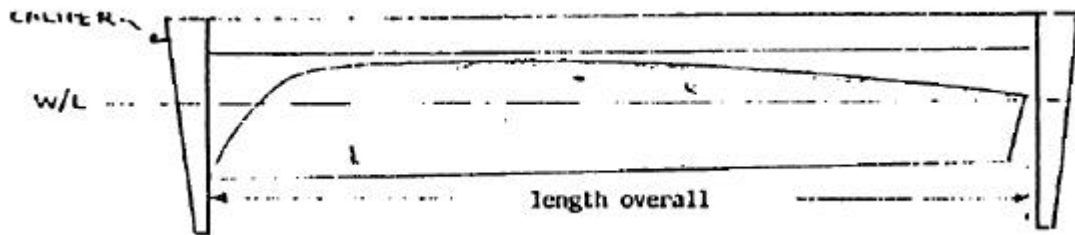
### 7.1 Preperation

Firstly, the measurer should ascertain that the boat presented for measurement is in its as-sailed condition, ie, wings with dihedral are attached and set to the position and angle encountered when sailing, and if this is not apparent, the disparity is to be noted under Measurer's Comments. Similarly, adjustable transoms must be set to the normal sailing position by the owner, prior to measurement proceeding, and if a number of positions are suggested the full range of variance shall be measured and declared on the measurement form.

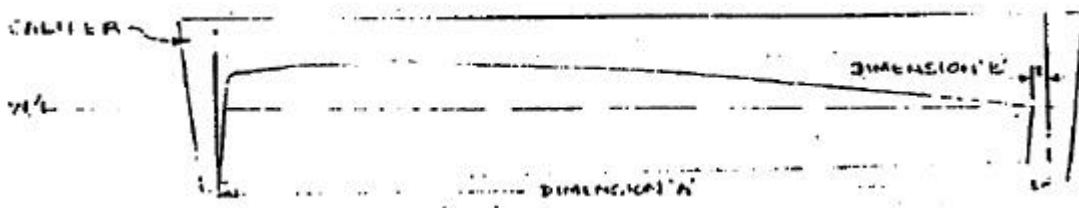
Should the measurer be in any doubt as to the owner's observance of this procedure then a sailing demonstration should be requested and the observations recorded on the measurement form. Looking at each item on the Measurement Form in turn.

#### 7.1.1. Overall Length between extremities

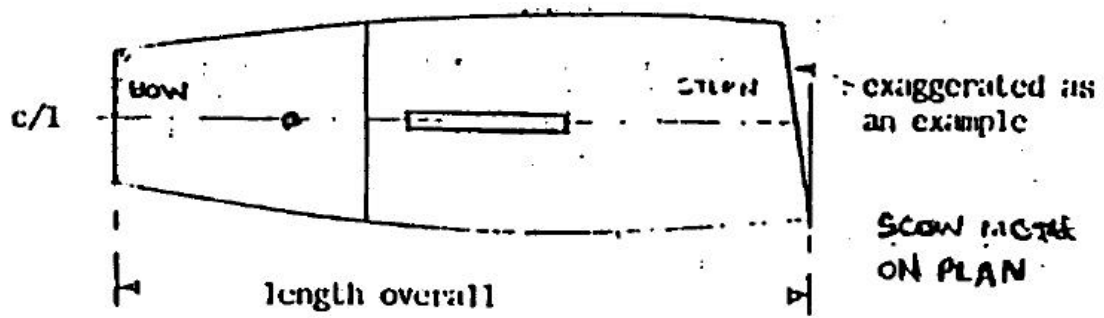
This should be measured along the horizontal waterline, exclusive of rudder and stem fittings, by the use of a calliper or frame. The measurer is to ensure by the use of a plumb line or 90° square that there is no projection, other than stem or rudder fittings, beyond the perpendiculars at either end, eg:



Should the waterline not be readily apparent then the boat shall be floated in its fully rigged condition, upright, but without crew, and the positions marked at either end. The extremities are measured perpendicular to the projection of this waterline at either end. The suggested measurement method utilising a measuring frame is as follows:

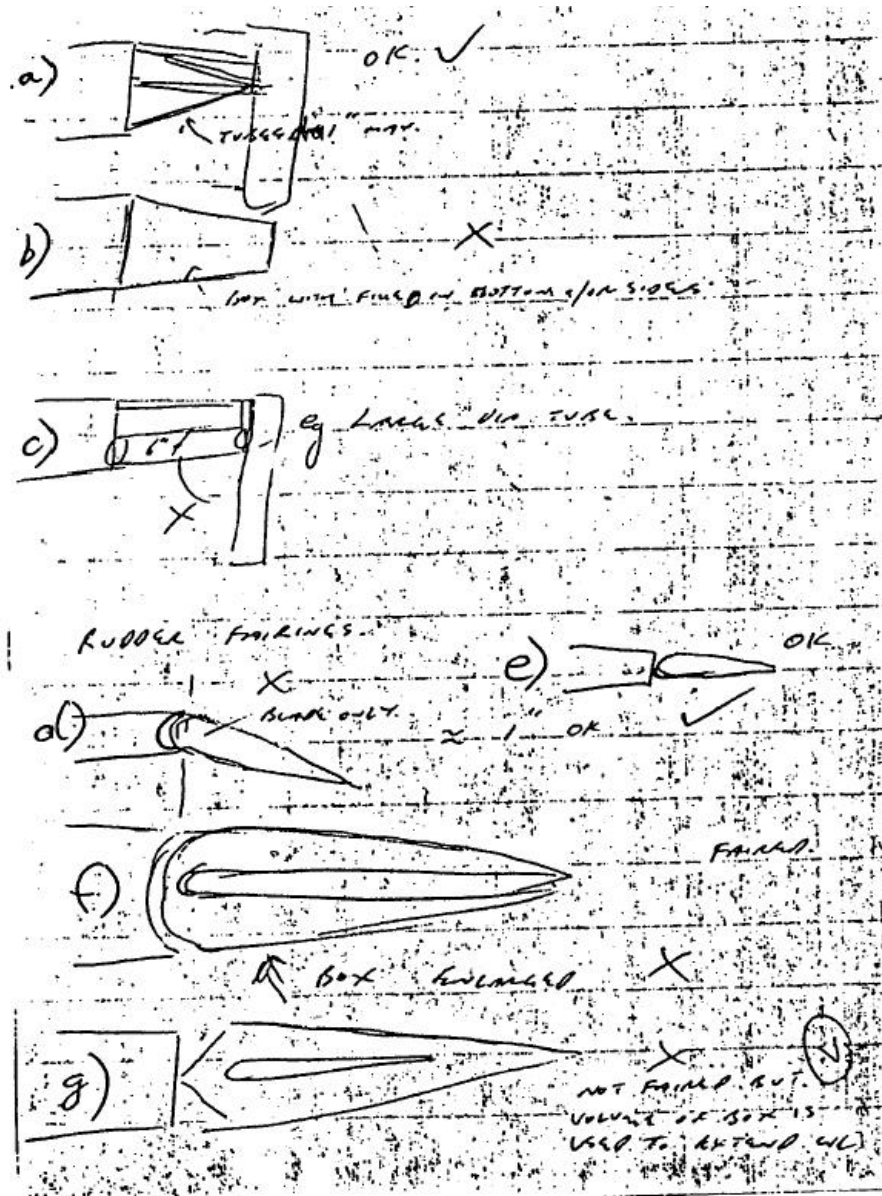


Due to callipers varying in length according to their materials of construction, ambient temperature, etc., the overall dimension between uprights, (Dimension 'A') can be measured using a steel tape at the precise moment of measurement. Measuring back from one end using a steel rule will give Dimension 'B'. Subtracting Dimension 'B' from Dimension 'A' will give the overall length, eg, Dimension 'A' (3380mm) minus Dimension 'B' (27mm) = 3353mm. Points to note with Scow type Moths in particular, are that asymmetrical bows and transoms shall be measured to their extremities.



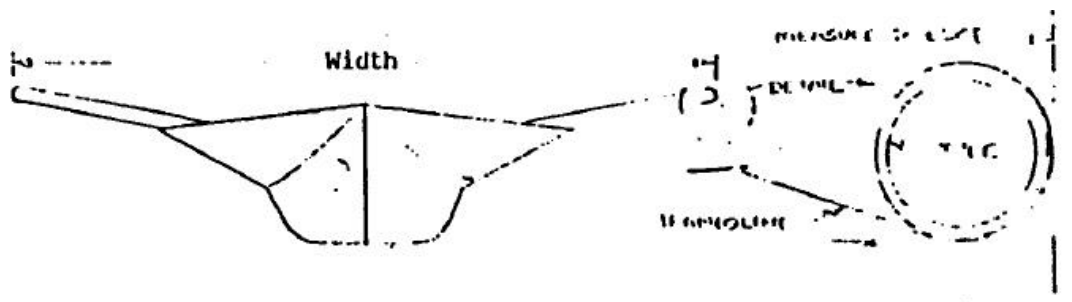
### 6.1.2 Rudder Fittings

Rudder and Fixtures External rudder supports are allowed, provided that no attempt is made to increase the effective sailing water line.

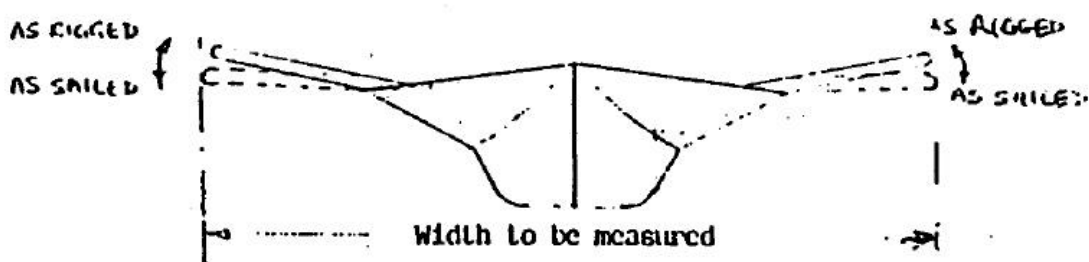


### 7.1.3. Overall beam including Wings

Principles of measurement are similar to those with overall length, although the use of callipers is not normally required. Where wings are encountered, the outer projection of any material, including trampoline cloth, foam or air bags, should be measured, not purely the aluminium tubes.



If flexible wings extend the overall width when bent, this should be taken into consideration, eg,



Remember to press down on both wings simultaneously when measuring, whether the wings appear flexible or not, and check for the maximum dimension at both ends as well as the middle of the tube. Please note that there is no stipulation as to maximum distances from the centreline, so asymmetrical hulls are not penalised.

#### 7.1.4. Wings

The measurement rules refer only to maximum length and beam of the hull. No reference is made to the form or type of construction. Hence 'wings' are considered to be an integral part of the hull and are typically only be detachable for the purpose of transport.

#### 7.2 Longitudinal Air Gap

This generally only applies to scow type Moths in order to restrict the possibility of producing a multi-hull configuration. The air gap can normally be ascertained by visual inspection using a long straight-edge spanning the 'tunnel'. If a 'tunnel' underwater shape is continuous almost to the transom, this can only be tested by a flotation test as described in Rule 6.3 (i).

#### 7.3.1 Hollow in the Hull

The intent of this rule is to provide a restriction on scows becoming catamarans. It also applies to all other hull designs.

#### 7.3.2 Static Water Plane

The static water plane is the waterline of the hull when fully equipped without crew. A hollow is allowed as per the IMCA rules throughout the hull when measured transverse to the hull, to a point 2700mm from the transom. Forward of that point no restrictions apply. Two catamaranbows are allowed.



The hollow measurement is made with reference to a taught stringline from the waterline on one side, under the hull to the waterline on the other side.

#### **7.4 Is boat equipped with adequate buoyancy?**

There shall be not less than two adequate buoyancy tanks or bags (securely fixed) which by either inspection or flotation testing should be adequate to float the boat's own weight plus 75kg when capsized or with the cockpit full of water. This shall only be taken to mean with buoyancy arrangements unpunctured. Additionally, with any one tank flooded, buoyancy must be sufficient to float the boat's own weight plus 10kg.

#### **7.5 Are buoyancy tanks effective?**

It is not always possible to test the capacity of a buoyancy tank. It may be necessary to measure the tank volume by taking the density of water as 1.0. Eg: The volume of a tank 1,000mm x 500mm x 200mm is 100 litres, which should provide approximately 100 Kg of buoyancy.

#### **7.6 Are buoyancy compartments watertight?**

Watertightness within buoyancy tanks can only be fully proved by a capsized buoyancy test. However, a visual inspection can circumvent this if properly carried out. Check for gaps at joints, cracks, proper fitting of inspection covers, bung fittings and rudder pintles, etc. Other items requiring special attention are joints within cockpit wells, unfilled staple holes and deck/hull joints near the centreboard case and gunwhales.

#### **7.7 ISAF Plaque**

The ISAF plaque should be positioned as per the IMCA rules.

### **8 MEASUREMENT OF SPARS**

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The mast should be measured straight unless it is permanently pre-bent. It is not possible to make effective measurements of the mast whilst the sail is rigged.

Where masts or booms will not pass a 90mm ring, those parts exceeding 90mm shall be measured as extra sail area. A typical example of this is a wingsail, or a wishbone mast, eg,



The overall length of a mast includes sheave blocks at the head, and also the step or socket plug at the foot of the mast. Measurement bands on the mast are to be contrasting in colour to the mast, and also permanent, eg: painted bands are accepted. Plastic adhesive tape is not acceptable. Measures should note for sails that enclose the mast, upper measurement bands are not required.

## 9 MEASUREMENT AND CALCULATION OF SAIL AREA

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Prior to setting out the sail for measurement of area it is important that the following essential criteria have been satisfied.

### 9.1 Emblem

The International Moth Class emblem shall conform to the shape held in template form by the IMCA and are available on the IMCA web site. Emblems can be affixed back to back on either side of the sail but must be solid, and not in outline only.

### 9.2 Numbers and National Letters

Check that these comply with IMCA rule 5 and I.S.A.F. RRS Appendix G, and particularly that numbers are grouped above half height, the starboard side letters and numbers uppermost and the distance between is as laid down in the IMCA rules.

### 9.3 Special Sail Designs and Allowances

It is important to note that the International Moth Class does not have sail design restrictions like other classes; in particular:

- Moth sails are not subject to restrictions on materials, thickness or reinforcements, including the use of wingsails.
- Rounds which are not a fair curve are not further subdivided for accurate measurement.
- Sleeve luff sails have special allowances.
- Spars are measured where they exceed 90mm diameter (ie. wing masts).

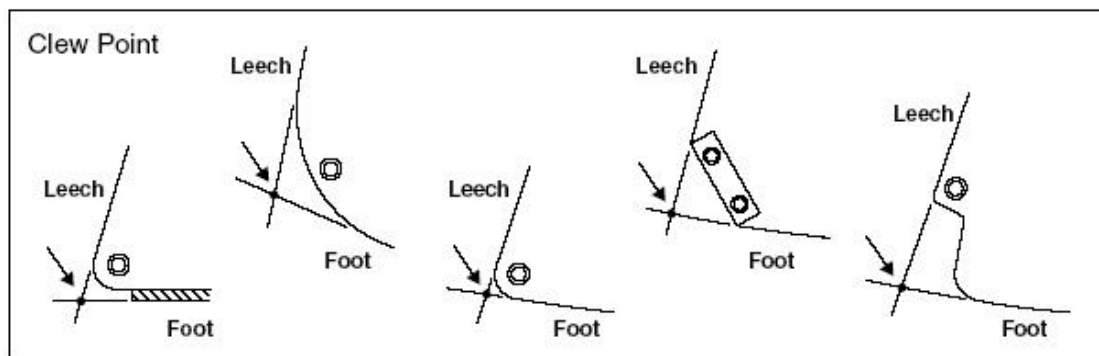
### 9.4 Pre-Measurement

Luff and foot bolt ropes are not included in the sail area measurements. Sleeve luff sails are allowed a deduction (after calculation of total area) of luff length  $AB \times 50\text{mm}$ . International Moth Sails are not covered by stiffening or reinforcement restrictions. The intention is to measure the entire sail area when extended to its limits.

The measurement of sail area is probably open to the greatest variance unless consistent methods are adopted. Sails to be measured do not necessarily need to be dry, but it is preferable that they are for accuracy. With battens tensioned in their pockets, they shall not extend more than 150mm from the leech tabling.

The sail should be pinned out on a flat level surface with sufficient tension to remove wrinkles and waves in the sail material. Skewers should be placed at the head (A) and clew (C) of the sail and a tape run from each of these points until they cross at a point (B) near the tack where the dimensions of AB and BC intersect.

The sail must have a luff, leech and foot.



## 9.5 Sail Area Calculation

### 9.5 a ISAF Rules for Sail Calculation

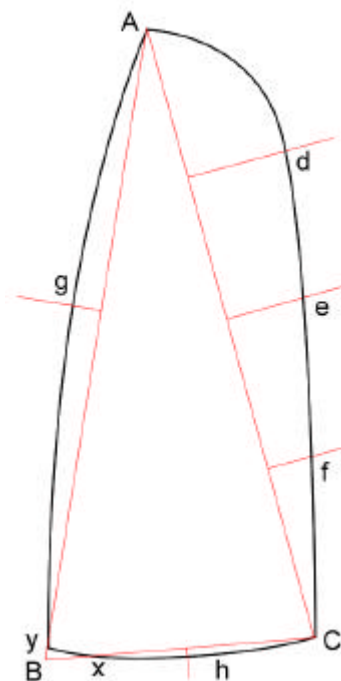
This method is valid for sails measured until 31.12.2004. After that date only the triangulation (chapter 9.5 b) may be used.

If a sail has not a triangular shape including a smooth curve for the leech the triangulation has to be used also because the formula for the leech does not cover unusual leech curves.

The twine should be stretched around these points (A, B and C) and tensioned until they revert to the same position once 'twanged'. Foot, luff and leech rounds should then be secured by bulldog clips fastened to short skewers, to prevent any transfer of areas.

Here follows an example using hypothetical measurements, of how to measure the sail using the ISAF-Rule method:

- AB has been measured from the spar as 5.185m twine set to this dimension.
- BC (say 2.000 m) is determined by measuring the foot length from Point C to the tack of the sail.
- Look along the luff to where the twine intersects the inside of the bolt rope or luff on a pocket luff sail at point (X).
- Take measurement AX (say 4.900m).

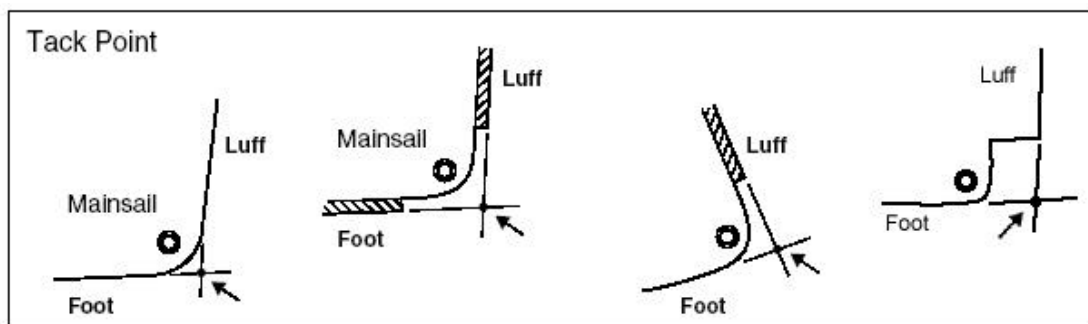


- Measure the maximum perpendicular offset (g) to the inside of the bolt rope or luff on a pocket luff sail at this point, using a tee square and small tape (say g = 0.150m).
- Similarly find where the twine cuts the foot of the sail at Y and measure CY (say 1.900m). Measure the maximum perpendicular offset (h) along CY (all as described for the luff round) (say h = 0.080m). Where the foot has a shelf or a substantial amount of shape so that when the foot is extended there is loosed or bulging material above it, a measurement shall be taken from the straight line joining the tack to the clew, in the way of the greatest fullness, to an arbitrary point where the sail does lie flat. A second measurement is then taken from the arbitrary point of greatest fullness following the folds or bulges or material. The difference between the two measurements represents the offset of the rounded foot.
- Next measure AC (say 5.200m).
- Divide this by four to give you the measuring intervals (eg,  $5.200 / 4 = 1.300\text{m}$ ), measuring stations are therefore at 1.300m, 2.600m and 3.900m from either A or C.
- Mark with a cross on the sail where each one of these stations occurs (on the line of the stretched twine) and using the twine as a base line project perpendicular offsets to the leech at each station and mark where this crosses the leech.
- Measure each offset with a square in turn d, e, f. (say 0.600, 0.500, 0.400). Your measuring should now be complete, assuming the sail does not exceed 8.00m<sup>2</sup>, but you are advised to leave it pegged out until the areas has been verified.
- The main triangle ABC is calculated using the half circumference  $S = (AB+BC+AC) / 2$  with the formula:  $\text{Area} = \sqrt{S(S-AB)(S-BC)(S-AC)}$   
[in the example:  $S = 6.193\text{ m}$  and  $\text{Area} = 5.095\text{ m}^2$ ]
- The foot area is calculated by:  $\text{Area} = 2/3 BC * h$  [in the example 0.101 m<sup>2</sup>]
- The luff area is calculated similar:  $\text{Area} = 2/3 AY * g$  [in the example 0.490 m<sup>2</sup>]
- The leach area is calculated by:  $\text{Area} = AC/4 * (1.16d + e + 1.16f)$  [in the example 2.158 m<sup>2</sup>]
- The total area is summarized by main triangle, foot area, leach area and luff area [in the example 7.84 m<sup>2</sup>]
- All calculations have to be carried out to the 3rd decimal, which is rounded between 4 and 5
- The final result will be rounded down to 2 decimals.

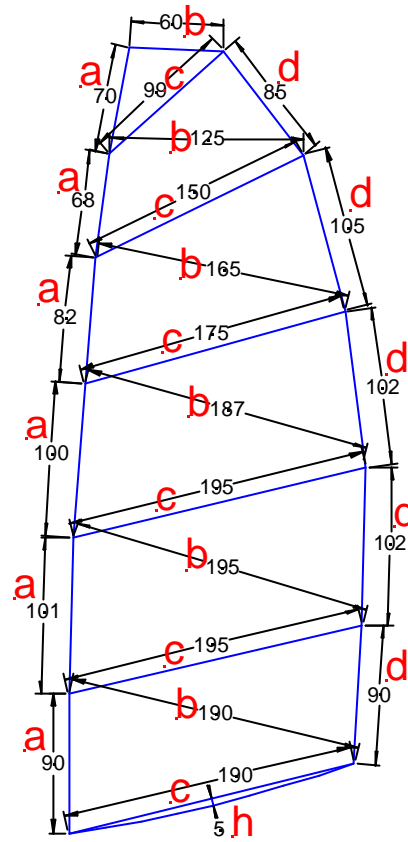
### 9.5b Triangulation

Any sail measured after the 31.12.2004 has to be measured using the triangulation. Also sails with unusual shape, which are measured before 1.1.2005 have to be measured by triangulation.

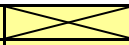
For the triangulation the sail has to be divided into a number of suitable triangles. Any arrangement of the triangles on the flattened sail is possible. For a common moth sail the subdivision according to the diagram is recommended, because a computer-spreadsheet is available to calculate the area of the triangles.



- Here follows an example using hypothetical measurements, of how to measure the sail using the addition of triangle areas method: Determine head point "A", tack point "B" and clew point "C" as described above. (The tack point "B" is **not** identical with the Point "B" used in the ISAF method. It is the real tack point as described in the diagram above.)
- Mark the sail with crosses at both ends of the intersection centerline batten / sail. At the luff use either the inner side of the luff rope or prolong the centerline of the batten to the forward edge of the sail, if it is around the mast.
- The area between the battens (BC is treated as batten) is divided into two triangles by a diagonal, which always starts at luff segment top and ends at leech segment bottom.
- Each quadrilateral consists of the bottom "c", the 2 sides (luff "a" and leech "d") and the diagonal "b". The top is used as bottom for the upper quadrilateral.
- The top of the sail has only 3 lines, because the leech segment is the diagonal [b].
- Measure all distances "a" along the luff curve, all diagonals "b", all battens "c" and all leech segments "d". At the top of the sail the leech segment "d" is omitted, because the diagonal represents that part of the leech.
- Measure the foot offset "h" as biggest perpendicular offset of the foot curve from the line BC if applicable.
- Put all values into the spreadsheet and choose the additional calculation options for luff round or foot round sails.
- For the manual calculation the formula for the main triangle (ISAF-rule) can be used, using the distances a, b and **lower** c for the first triangle and the distances b, **upper** c and d for the second triangle.
- Example using the rows 10 and 9 for the lowest quadrilateral:  
 $S = 1/2 * (a_{10} + b_{10} + c_{10})$  and  $A1(10) = \text{Square root} [ S * (S - a_{10}) * (S - b_{10}) * (S - c_{10}) ]$  for the first triangle and  
 $S = 1/2 * (b_{10} + c_9 + d_{10})$  and  $A2(10) = \text{Square root} [ S * (S - b_{10}) * (S - c_9) * (S - d_{10}) ]$
- The foot area is calculated in the same manner as in the ISAF-rule:  $\text{Area} = 2/3 BC * h$
- If the sail encloses the mast, a value of  $0.05 * \text{the sum of all segments "a"}$  has to be subtracted.
- If the sail encloses the boom, a value of  $0.09 * \text{the lowest segment "c"}$  has to be subtracted.
- The sum of all triangles and the foot area (subtracted by the luff pocket and the boom pocket if applicable) is the sail area, rounded mathematically to 2 digits.



Numerical example using the spreadsheet:

<b>Triangulation</b>	<b>Area:</b>	<b>7.68</b>	m <sup>2</sup>		<b>Version4</b>				
<b>Luff round -&gt;</b>	<b>x</b>	0.256	Measurements in meter !						
<b>Foot round -&gt;</b>		0.000	<b>h</b>	0.050	Foot area 0.063				
		<b>Luff</b>	<b>Diagonal</b>	<b>Batten</b>	<b>Leech</b>				
	No.	<b>a</b>	<b>b</b>	<b>c</b>	<b>d</b>	S1	A1	S2	A2
<b>Top</b>	1					0.000	<b>0.000</b>		
	2					0.000	<b>0.000</b>	0.000	<b>0.000</b>
	3					0.000	<b>0.000</b>	0.000	<b>0.000</b>
	4					0.000	<b>0.000</b>	0.000	<b>0.000</b>
	5	0.700	0.600	0.990		1.145	<b>0.207</b>	0.000	<b>0.000</b>
	6	0.680	1.250	1.500	0.850	1.715	<b>0.421</b>	1.545	<b>0.419</b>
	7	0.820	1.650	1.750	1.050	2.110	<b>0.671</b>	2.100	<b>0.772</b>
	8	1.000	1.870	1.950	1.020	2.410	<b>0.919</b>	2.320	<b>0.880</b>
	9	1.010	1.950	1.950	1.020	2.455	<b>0.951</b>	2.460	<b>0.960</b>
<b>Bottom</b>	10	0.900	1.900	<b>1.900</b>	0.900	2.350	<b>0.831</b>	2.375	<b>0.841</b>
	Luff ->	<b>5.110</b>	Foot						

When measuring a sail using either the ISAF-Rule or the addition of triangle areas, the IMCA sail area calculation Excel spreadsheet will assist.

With the exception of the area reduction allowed by the rules for sails that enclose the mast or boom, small areas where there is no sail material present near the tack, head or clew should not be subtracted from the total sail area. An example of this would be where the luff pocket ends before the tack point.

When the sail area has been calculated as complying then the sail should be signed and dated in indelible ink near the tack.

If a sail calculates to 8.004m<sup>2</sup>, please remember that this does not exceed 8.00m<sup>2</sup> when rounded to two places of decimals at the final total area. Always observe that 5 rounds up and 4 rounds down when applied to the trailing decimal number.

Making a sail 'Measure' If a sail is oversized, once measured, it is the responsibility of the owner to determine how to make it measure within the 8.00m<sup>2</sup> line. This is most commonly done by trimming the foot of the sail.

## **10 ENDORSEMENT OF CERTIFICATES AND MAINTAINING VALID MEASUREMENT**

Where sails are measured subsequent to the original measurement, then the measurer concerned shall fill out a sail area measurement form accordingly. The dimensions are all added to the Measurement Certificate then signed and dated on the understanding that the sail area measurement form is sent by the owner for registration with the issuing authority.

The Class has no specific requirements for annual checks or buoyancy testing, but the owner should be reminded that it is his responsibility to maintain the boat to the standard required for full compliance with the rules, especially in respect of buoyancy.

If there have been significant alterations and changes to hull, spars and sails since the original

measurement, an owner is required to have a boat re-measured in full. Should a measurer be aware that this has not been carried out, then he is to inform the IMCA.

## **11 MEASUREMENT AT CHAMPIONSHIPS**

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All boats racing at a Championship shall possess a valid Measurement Certificate, therefore measurements at Championships do not have to be carried out 'to the full' but should concentrate on checking essential and vital areas of variance.

These may include:

1. Full Sail Area Measurement
2. Overall Length
3. Overall Width
4. Identification Marks.

Further checks may be made at random. Measuring Practice Set Up Details should be included in the Programme of the Event of times and the location where measuring is to take place. Provision shall be made for 'wet weather' measuring by the erection of tents, marquees or similar.

A separate area should be set aside for sail area calculations and 'event stamping' sails and hulls. It should be emphasised to competitors that it is their responsibility to bring hulls, spars and sails to the relevant area for measurement. The sequence in which measurements will be undertaken should be made evident to competitors eg,

Hull: Check in as sailed condition at a 'calliper' station.  
Mast: Laid out so that overall length, bands, AB can be verified.  
Sails: Pegging out and measuring areas, sufficient to allow one sail to be measured whilst another is being laid out or rolled up by the owner.

The practice of 'checking sails' by choosing a large sail, measuring it and placing smaller sails over it is condoned, provided all doubtful sails are fully measured.

Sails should then be identified, 'event stamped', and a card issued signifying compliance with the specified checks which can then be accepted by the organising club in conjunction with a Measurement Certificate.

### **11.1 Dispute Procedure**

Unless an International Jury has been convened that has authority in such events over measurement matters, then disputes have to be referred to the IMCA and the boat can sail on a 'provisional compliance' basis. Legal status can be confirmed or withdrawn at any later stage without redress.

## **12 TRAINING AND EXAMINATION OF NEW MEASURERS**

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Although dinghy classes with a solid financial base are able to offer full time 'seminar' type training and examination courses, the International Moth Class can only convene its training facilities over regatta weekends and during the National Championship.

National Championships are ideal for the observation of experienced measurers in operation, and working alongside them during check procedures invariably provides the first and best introduction possible. The measurer instructing should demonstrate to 'new recruits' the consensus methods of carrying out a full

measurement and supervise each prospective measurer through a complete measurement of the boat to ensure that it is carried out competently, with accuracy and understanding.

It shall be the responsibility of the I.M.C.A. to encourage continual maintenance and improvement in the standard of measurement techniques by recognised Class measurers.