MEASUREMENT AND CALCULATION OF SAIL AREA

1   GENERAL

1.1   The intention is to establish a reliable and simple method of measuring the whole driving area of the sail plan, including the spars, foils, and flaps (or wing sails).

1.2   It is not possible to frame methods to deal with every eventuality and therefore in the case of unique or different shapes of rig the measurer may need to use his judgement in dividing the rig for measurement in order to calculate the area accurately. **Combination** rigs such as a soft trailing edge on a heavily shaped wing spar of a rig where the camber and shape is produced by tensioning when it is on the yacht, may be more conveniently and equitably measured in an **assembled for sailing** condition, rather than in component parts. In these cases the measurer shall record the method used.

1.3   Elements of the sail plan which are vertical, or nearly so, when the yacht is not heeled shall be measured. Elements of the sail plan which are horizontal or nearly so when the yacht is not heeled, such as fences and end plates, are not measured provided that:

(i)   The surfaces of such elements are not able to make an angle, measured at right angles to the fore and aft axis of the yacht greater than 10 DEG to the horizontal when the yacht is not heeled, and

(ii)   the total area or their surfaces does not exceed ten percent of the measured sail area excluding such surfaces.

For the purpose of calculating the area of horizontal, or nearly horizontal surfaces, only the area of one side of each fence and the surface of an end plate, which is adjacent to the sail, shall be included in the area.

1.4   A soft sail is any sail made up of cloth or other material which is flexible and can be rolled up or folded.

1.5   For the purposes of measurement of **sail** area the term sail shall be deemed to be that part of a soft sail outside the spars and includes the headboard, tabling and battens, which extend beyond the edge of the sail. It shall not include cringles, which are wholly outside the sail or bolt or footropes, which are inside the spars.

1.6   The area of any hole in the sail, the maximum dimension of which does not exceed 50mm, shall not be deducted from the measured area.

2   SPARS AND WING SAILS

2.1   The guiding principal is paragraph 1 (general). Except as provided below, the area of that part of any spar (including the luff spar of a headsail) or wing sail, which projects above the sheerline, shall be measured.

2.2   Devices of fairing added to a spar or wing sail shall be measured as part of that spar or wing sail.

2.3   If the mast, spar, flap or sail is of constant section throughout its length then the area shall be its length multiplied by the mean half girth.
         If the mast, spar or sail is not of constant section, and its profile forms a fair curve or curves, it shall be divided into a suitable number of equal lengths and **Simpson's rule** used to calculate the area, using the half girth measurements (see below) as offsets.

         Simpson's rule

         AREA = L/3 (a + 4b + 2c + 4d + 2e... 2x + 4y + z)

         Where L is the uniform distance between offsets and a, b, c, d, e,... x, y and z are offsets. Note: there has to be an odd number of offsets.

         If the mast, spar or sail is not of constant section and its profile is not a fair curve, it shall be considered as a number of trapeziums and half girth measurements shall be found at the end of each. The sum of the areas of all the trapeziums is then the area of the mast, spar or sail.
         The girth measurement shall be taken as the distance from the centreline round the surface of the spar or wing sail to the same point on the centreline. The resultant dimension shall be divided by two, to give the half girth measurement.
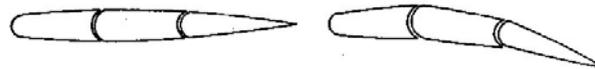

Figure (1)   Figure (2)

2.4   An articulated wing sail, such as that shown in fig. 1, shall be measured as described above except that the skin girth shall be taken over all the sections when they are in the position that gives the greatest girth.

Note: the greatest girth may occur when the sail is at maximum camber (see fig. 2).

2.5   A spar which supports the rig on which no sail is set directly, (e.g. a bipod straddling the hull, a structure fore and aft to support a main staysail or boom from which a loose footed sail is set) shall not be included in the measured sail area provided the maximum vertical or fore and aft dimension of the spar does not exceed one and a half times the maximum horizontal or transverse dimension.

2.6   The measured area of a boom shall be taken as its overall length multiplied by its mean depth in the vertical plane.

3   SOFT SAIL SET ON SPAR(S)

3.1   When the sail is set on spars and between measurement bands the distance between the bands is used to obtain the primary dimensions of the main triangle.

3.2   Area using measurement bands:

(i)   With battens set in their pockets the sail shall be pegged out on a flat surface with just sufficient tension to remove waves or wrinkles from the edge rounds and to spread the sail, as far as possible, substantially flat. Once the sail has been pegged out in this way all the required measurements shall be taken and no alterations to the tensions shall be made.

(ii)   Needles shall be fixed at the head and clew, making allowance for that part of the sail inside the spars so that the distance between the needles is the length of the leech. A third needle shall be fixed at a point so that it is the distance between the measurement bands on the mast from the head needle and also the distance of the boom measurement band from the mast from the clew needle. If the boom is shorter than the foot of the sail or if there is no boom the length of the foot shall be that found by the measurement with the sail set on the mast. A thin line shall be stretched round these needles to define the main triangle (see fig. 3).

(iii)   The area of the main triangle shall be calculated from one of the following formulae or by a scale drawing.

AREA = s (s - a) (s - b) (s - c)

where s = a + b + c / 2
and   a = length of luff
         b = length of leech
         c = length of foot

AREA = AB X CP / 2 where CP is the minimum distance from C to the thread

from A to B.

(iv)   The area of the luff round shall be calculated and added to or subtracted from the area of the main triangle. If the curve is fair and continuous its area shall be taken as two thirds of the product of the chord length and the maximum perpendicular offset to the chord. In fig. 3 above the area of the luff round is 2g (AY) / 3. The offset to the chord shall be taken as the maximum distance between the point on the sail corresponding with the aft edge or the mast, and the thread defining the main triangle.

(v)   The area of the leech round shall be found as follows:

Either - Where the leech is a continuous fair curve from point A to point C the area is taken as AC / 4 (1.16d = e = 1.16f)

Where AC is the leech length indicated; d, e and f are the perpendicular offsets between the points on the thread from A to C 1/4, 1/2 and 3/4 of the distance between the leech measurement points A and C and the edge of the sail. For the purposes of the measurement of the offsets, any hollows in the leech shall be bridged.

Or - Where the leech is not a fair curve from point A to C the area of the leech round shall be found by dividing the area into trapeziums, triangles and segments and measuring each. For the purpose of this instruction the area of a segment shall be taken as two thirds of the product of the chord of the round and the maximum perpendicular offset to the chord.

(vi)   The area of the foot round, if the sail can be pegged out substantially flat, shall be measured in the same manner as the luff round.

(vii)   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; then the area of the **flow** of the bulging material shall be determined as follows (see fig. 4):

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. The area of the foot round is taken as two thirds or the length between the tack and the clew multiplied by the offset.

(viii) The area of the shape BYTX (fig. 3) is not deducted from the area of the main triangle.

AB = Distance between mast bands

BC = Distance mast to boom band.

Figure 3

3.3   Where there are no measurement bands on the spars:

(i)   With the battens set in their pockets the sail shall be pegged out on a flat surface with just sufficient tension to remove waves or wrinkles from the edges and to spread the sail, as far as possible, substantially flat.

(ii)   Needles shall be fixed at the head, tack and clew. A thin line or thread shall be stretched tight between head, tack and clew to define the main triangle.

(iii)   The area of the main triangle shall be calculated in the manner indicated above.

(iv)   The area or the luff, leech and foot rounds shall be found in accordance with the instructions above.

4   SOFT SAIL NOT SET ON SPAR

4.1   A soft sail which is not set on a spar, such as a headsail, set on a stay or flying, shall be measured in accordance with the instructions above, except that if the leech has an offset not exceeding 5% of the leech length and is a fair curve, the area of the leech round shall be measured in accordance with the above rules.

4.2   If the luff of the sail is wired, sufficient tension shall be applied to remove bends or kinks in the wire.

5   SAIL OF UNUSUAL SHAPE

The foregoing instructions assume that the sails are essentially triangular. If a quadrilateral or multilateral sail is to be measured, the sail is to be divided into suitable triangles whose area can be measured and added. The areas of luff, foot and leech rounds shall also be added, or subtracted as the case may be. The measurer shall record the method he has used to asses the area of mainsail.

6   SPINNAKER

6.1   A spinnaker is a sail which is set: forward of the mast, with its tack in close proximity to a boom fastened to the mast and on the windward side of the forestay and on the opposite side of the yacht to the mainsail.

6.2   The area of the spinnaker shall be taken as:

SF x SL/ 2 + 2(SMG - SF/ 2) SL/ 3 where:

SF = Width of foot; measured round the edge of the sail between the lowest point on the leeches.
SL = Leech length, measured round the edge of the sail from the highest point on the sail at the head to the lowest point of the sail on the leech. If the two are not equal, SL shall be the mean of the two leech lengths.
SMG = Width at half height; shall be taken as twice the distance between the mid-point of the leech shall be determined by measuring round the edge of the sail half the length of the leech from the head.

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