PART B - Fundamental Measurement

B.1 Tools and Equipment

In the majority of cases, the accurate measurement of a sail may be undertaken using the following tools and equipment: -
steel tapes of good quality
micrometer
feeler gauge
batten of uniform flexibility
pencil
permanent marker pen
stamp and ink pad
Additional equipment is required to measure **ply** weight

A measurer may supplement this list with other tools or equipment that either improves the accuracy of, or the time taken on, measurement. For pre-event check measurement this is encouraged as detailed in Part C of this guide. (Appendix I gives suggestions for suitable equipment)

B.2 Sail Construction (ERS G.1)

B.2.1 What is meant by the word Ply?

A **ply** is a sheet of **sail** material made up of one or more lamina. For example a layer of film bonded to a woven fabric is a **ply**; in fact a **laminated ply**. A **sail** with its body made from one sheet of this **ply** would be a **single-ply sail**. If two sheets of the material were used next to each other this would be a **two-ply sail**. The word **ply** is both singular and plural.

If **class rules** give no restriction as to the number of **ply** that may be used it can be assumed that the number is optional.

B.2.2 What is Woven Ply?

When a **woven ply** is torn it will be possible to separate the fibres without leaving evidence of a film. Thus **ply**, (often referred to as "Mylar" a trade name for one particular polyester film), which comprises a woven base on which a plastic film has been bonded is considered to be non-woven.

B.2.3 Soft Sail

It is normally quite easy to establish if a **sail** is soft without having to fold it and risk "damaging the **ply**". However, in cases of doubt, if it is claimed that the **sail** is soft, a measurer should fold the **ply**, usually in an area of **secondary reinforcement**. If the measurer is unable to flatten the **ply** when applying pressure between forefinger and thumb or the **sail** suffers damage more than a crease line, then the **sail** is not **soft**.

B.2.4 Ply Weight

There are a number of classes which specify minimum **ply** weights. Before discussing the problems associated with such rules, it is necessary to be aware of the different units used to describe **ply** weight.

These are:
ounces (oz)
ounces per square yard (oz/sq yd)
grammes per square metre (g/m2)

When the weight is given as x ounces, this refers to the weight of one yard run of cloth 724 mm (28.5 inches) wide - this being the standard width in which the **ply** used to be woven. It is the way in which most sailcloth is described in the United States.

Figure 1a shows the comparison between the three units, and enables conversion to be made from one system to another.

A manufacturer's quoted **ply** weight may be for the material before the addition of finishes. This will not be the same as the weight of the material used in the construction of **sails**, so care should be taken to avoid confusion.

It is difficult to determine whether or not a **ply** is in accordance with a weight control in **class rules**. There are two ways of undertaking this: -

a) determining the weight of the **ply**
b) measuring the thickness of the **ply**

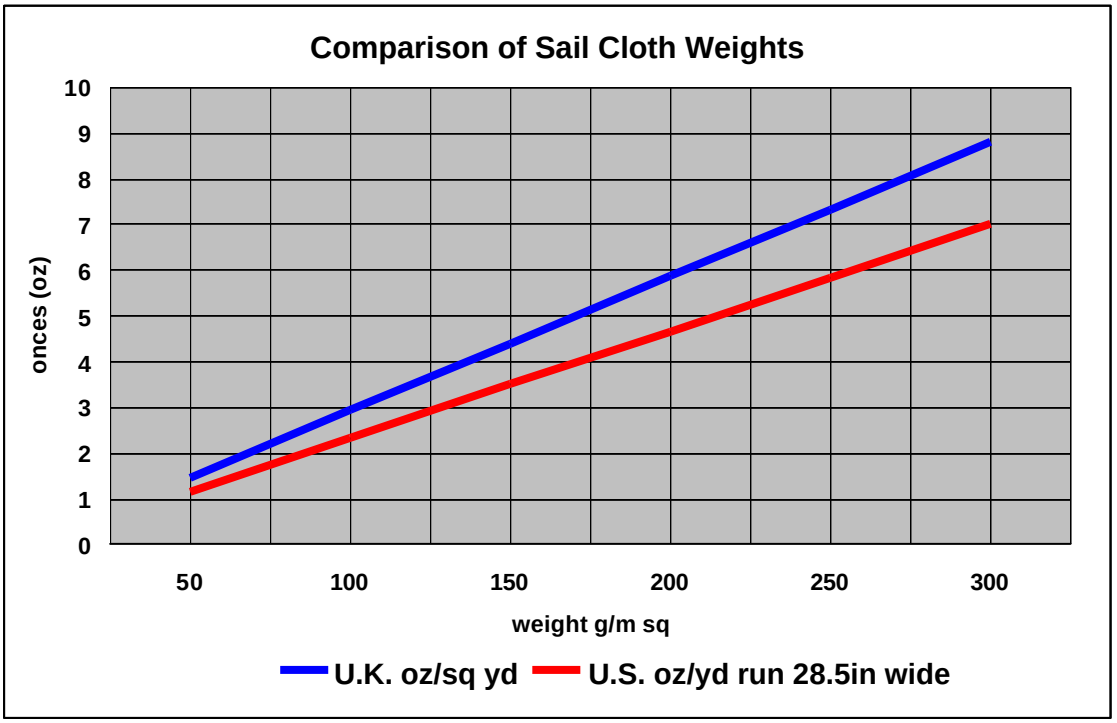

Figure 1a.

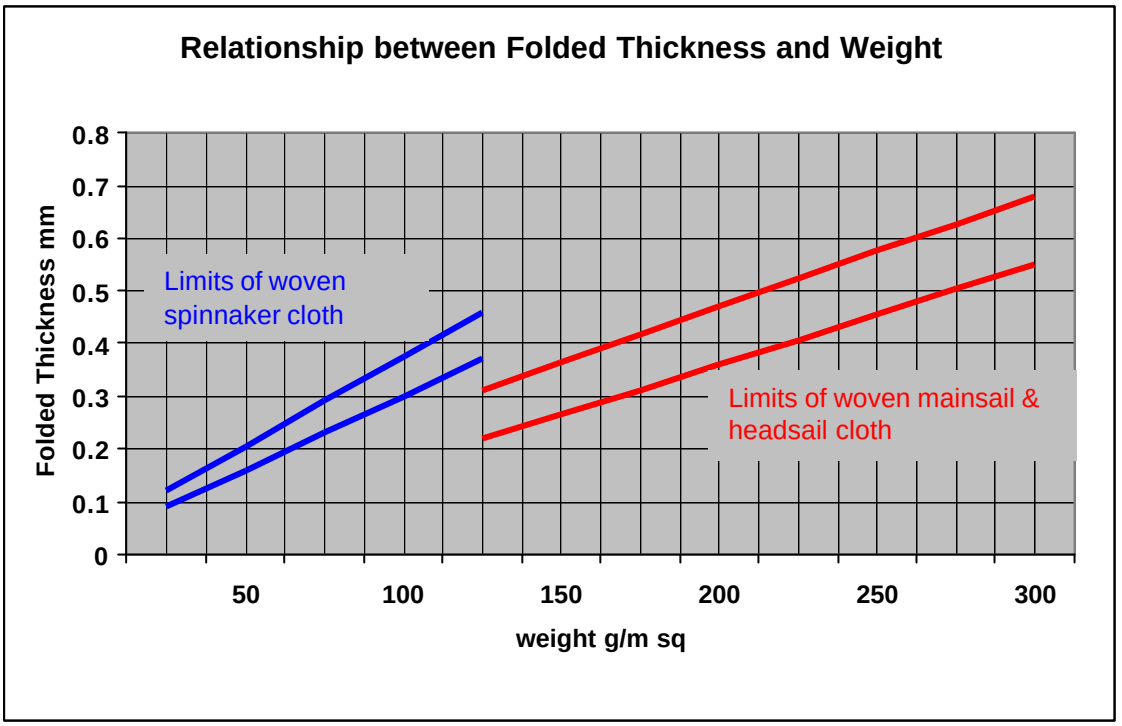

Figure 1b.

B.2.4.1 Procedure for Determining the Weight of Ply

Equipment: -
Sample cutter and scales
Details of approved equipment are given in Appendix I.

Method
Five samples of **ply** should be accurately "die-cut" from different places in the **sail**, not less than 25% of the **foot length** apart. All five samples must be carefully placed in the draught-free compartment of a levelled laboratory scale, the scale carefully balanced, and the combined weight of the five samples read off. This weight, divided by five and corrected to the units specified in the **class rules**, shall be taken as the weight of the **ply**. Great care should be taken during the scale zeroing operation.

B.2.5 Ply Thickness

Some classes control **ply** thickness and as there is a loose relationship between the thickness of **woven ply** and its weight, some classes use this to approximate **ply** weight by thickness measurement. There are, however, a number of factors, including closeness of the weave, the nature of the filaments and the types of finish applied, which make this relationship less than precise. This is shown by Figure 1b which compares of **woven ply** weight with upper and lower limits of the folded thickness.

Measurers should also be aware that sail material from a single roll might vary in thickness by up to 10%.

B.2.5.1 Measuring the Thickness of Ply

Where **class rules** control **ply** thickness, this is usually the minimum thickness. It is thus important that measurement is taken at the thinnest area, particular if the **sail** is lofted from a laminated **ply** with open weave scrim. If the micrometer measuring surfaces permit, thickness measurements should be taken between the scrim. The measurer should take as many thickness measurements as necessary to be satisfied that a **sail** is in compliance with **class rules**. The dimensions recorded shall be absolute and not averaged.

Figure 2. Measuring the thickness of **Ply**

A micrometer and, if the **ply** has no scrim, a feeler gauge will be needed.

Before taking any measurements carefully clean the micrometer measuring surfaces and zero or calibrate it using the feeler gauge.

Always bring the measuring surfaces together slowly and uniformly using the micrometer ratchet when checking zero and when taking measurements.

Do not scrape the sail cloth with the micrometer while positioning for a measurement or during removal, as this may result in a resin build up on the measuring surfaces, which can cause erroneous readings.

When taking double thickness measurements, which will be necessary to measure in the body of the **sail**:

a) fold but do not crease the **sail**.
b) open the micrometer wide enough to enable the jaws to pass over the doubled roll without scraping.
c) If the **ply** has no scrim, place the feeler gauge between the two **ply** layers. This prevents the surface of one layer meshing with the other. Subtract the feeler gauge thickness from the micrometer reading.

Stiff cloth may require two or more padded clamps carefully placed near the point of measurement to hold the two layers together.

Re-check for clean measuring surfaces and zero or re-calibrate frequently, especially before re-checking measurements close to or outside specified class limits.

B.2.6 Reinforcement

Check **class rules** for the permitted limits and material of **primary** and **secondary reinforcement**.

B.3 Measurement Points (ERS G.4, G.5 & H.4.2)

B.3.1 Corner Measurement Points and Aft Head Point (ERS G.4 & G.5.5)

To find a **corner measurement point** or the **aft head point** may require the extension of the line of the **edges of the sail** adjacent to the **point**.

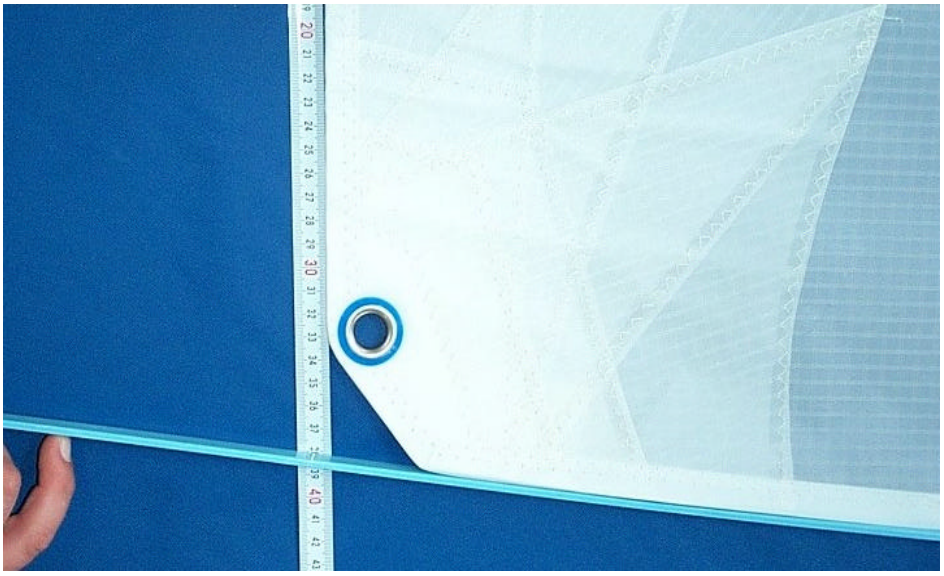

Figure 3. Headsail **Clew Point**

Where the line of the extension of the edge is obvious, it should be used. Placing a batten along the edge can often help to give a true extension line continuing any curve (see Appendix 1).

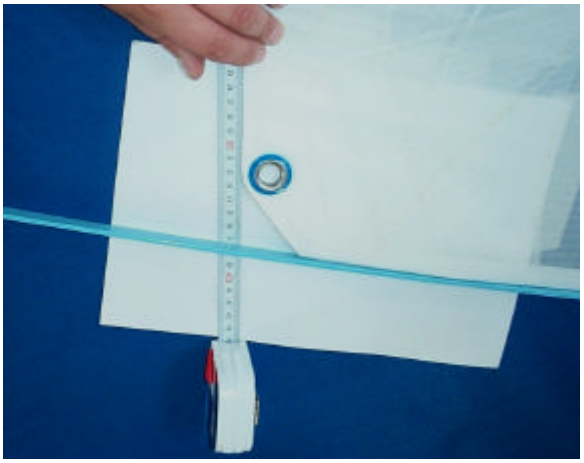

Figure 3a.

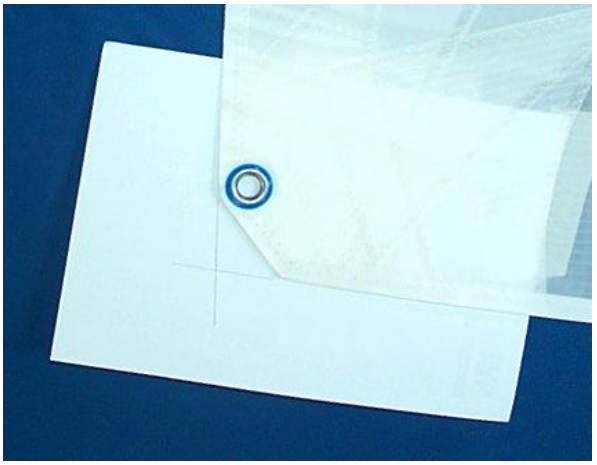

Figure 3b.

Marking the extension lines on paper taped to the underside of the sail helps to retain the point during measurement

Where the line of the extension of the edge is uncertain and not repeatable leading to inconsistent measurement points, the measurement of the sail should be refused.

B.3.2 Leech Points (ERS G.5.1 to G.5.4)

Note: hollows may affect the position of leech points. See B.3.4

The **half leech point** is found by folding the **head point** to the **clew point** and equally tensioning the two halves of the **leech** so formed. The **half leech point** is the intersection of the fold and the **leech**. See figures 4 and 5.

Figure 4. Finding a Mainsail **Half Leech Point**

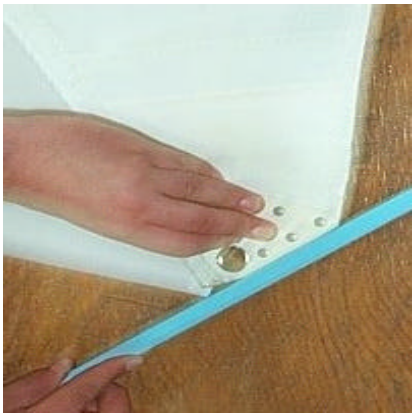

Figure 4a.
Place the **head point** over the **clew point.**

Figure 4b.
Marking the edge of the sail in the fold at the **leech point**.

Figure 5. Finding a Spinnaker **Half Leech Point**

The **quarter** and **three-quarter points** are found similarly by folding the **clew point** and the **head point** respectively to the **half leech point**. The **points** are the respective intersections of the folds and the **leech**. See figures 6, 7, 8 and 9.

Figure 6. Finding a Mainsail **Quarter Leech Point**

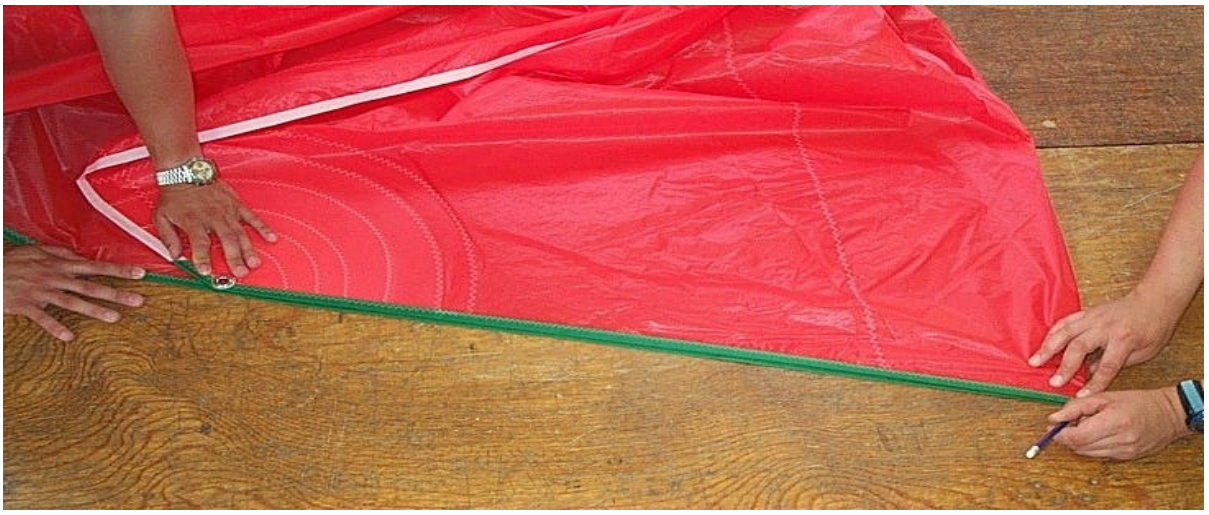

Figure 7. Finding a Spinnaker **Quarter Leech Point**

Figure 8. Finding a Mainsail **Three-quarter Leech Point**

Figure 9. Finding a Spinnaker **Three-quarter Leech Point**

The set distance of the **upper leech point** from the **head point**, when specified in **class rules**, is measured in a straight line across the **sail** as defined.

B.3.3 Mid Foot Point (ERS G.5.6)

The **mid foot point** is found by folding the **tack point** to the **clew point** or, with a spinnaker, one **clew point** to the other **clew point**, and equally tensioning the two halves of the **foot** so formed. The **mid foot point** is the intersection of the fold and the **foot**.

Figure 9a. Finding a Spinnaker **Mid Foot Point**

B.3.4 Hollows (ERS H.4.2)

The presence of a hollow shall be determined with the **sail** flat in the area between the items referred to in ERS H.4.2.

Where a hollow exists in the vicinity of a **measurement point**, e.g. on the **edge of a sail** at the end of the **half leech point**, the **sail** shall be flattened out in the area of the hollow, the hollow bridged by a straight line, and the shortest distance from the measurement point to the bridge line shall be added to the measurement being taken.

B.4 Condition of Sail During Measurement (ERS H.4.1)

B.4.1 General

The **sail** shall be as required by ERS H.4.1 and be at ambient humidity and temperature.

B.4.2 Shape of the sail edge (ERS H.4.1)

To check the shape of the **sail edge** the **sail** shall be flat in the area being checked. This is achieved as follows: -

a) lay the **sail** out on a flat surface. Figure 10
b) fold or flake the **sail** as shown in Figure 11.
c) work any wrinkles near the edge into the fold.
d) Without pulling out the fold, apply just sufficient tension to the edge to ensure it is flat.

The shape of the edge, which should now be flat, can be gauged against a straight line produced by a string, or the edge of a measuring tape, stretched along the edge of the sail.

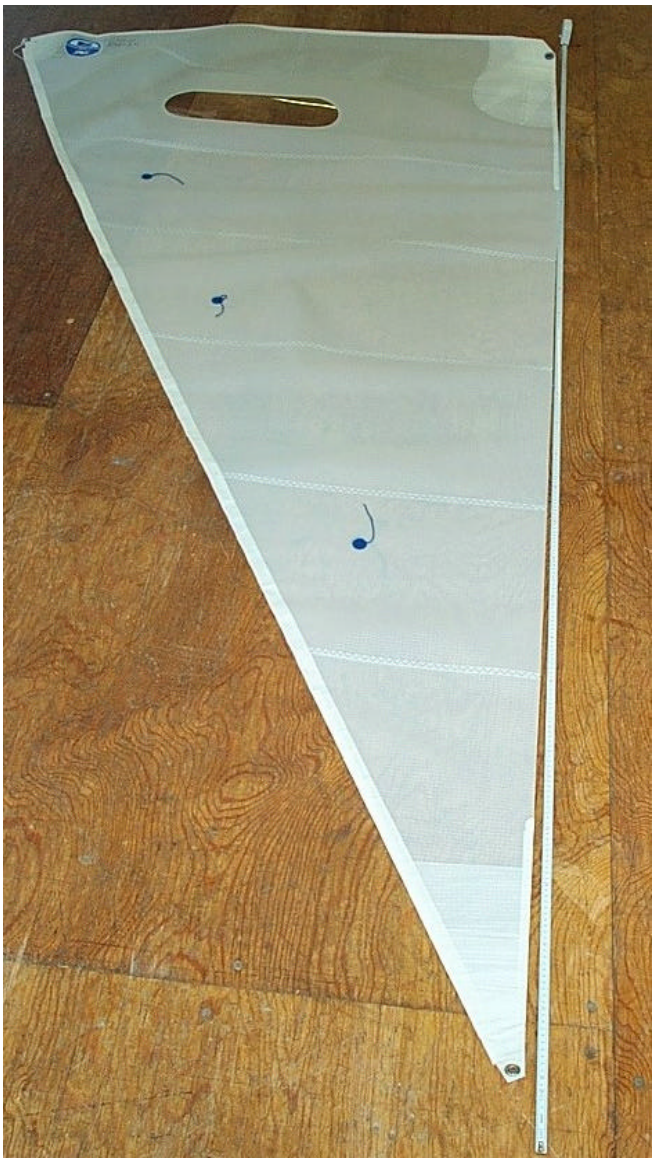

Figure 10. Sail before flaking

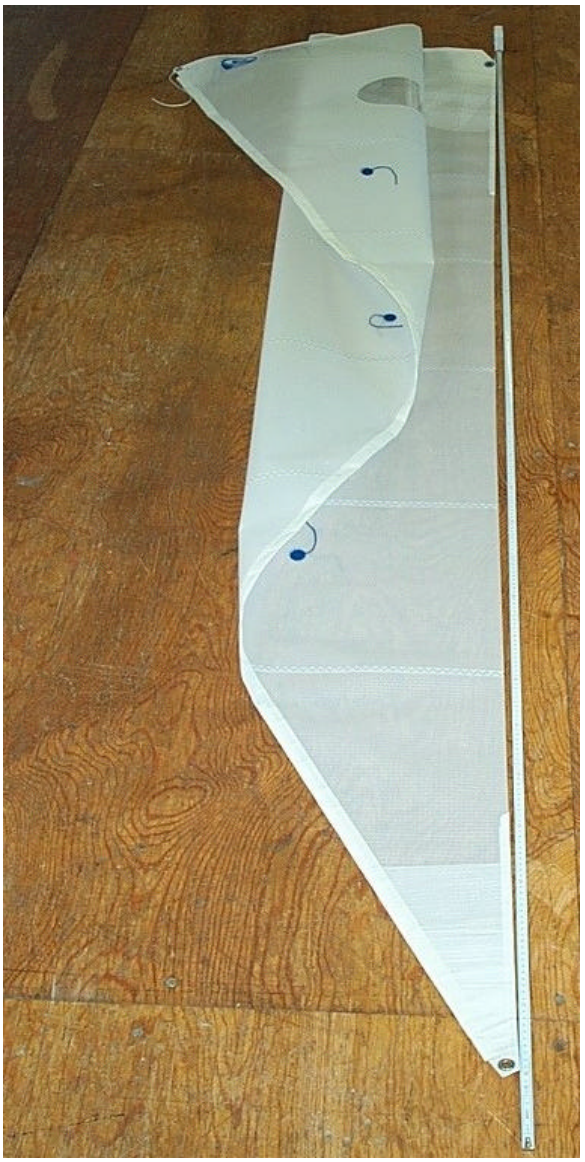

Figure 11. Sail after flaking

B.5 Lengths (ERS G.7)

B.5.1 Foot, Leech & Luff Lengths, Diagonal and Foot Median (ERS G.7.1, G.7.2, G.7.3, G.7.9, G.7.10)

All lengths shall be measured as the straight line distance as defined. Lengths shall be measured with the **sail** laid out with the tension applied as required by ERS H.4.1. **Corner reinforcements** which cannot be "straightened" at the head of the spinnaker may necessitate the taking of two part measurements to an intermediate point, with the sum of these giving the dimension of the defined measurement. See Figures 12 and 13.

Figure 12. Measurement of head part of **Foot Median**

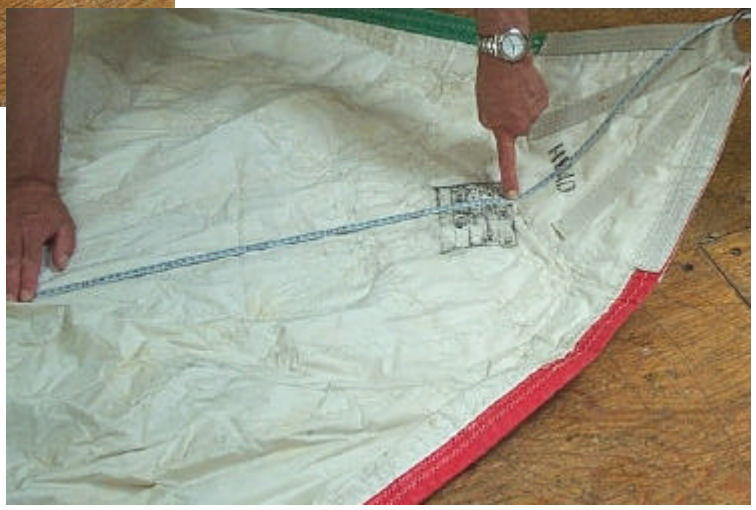

Figure 13. Measurement of remainder of **Foot Median**

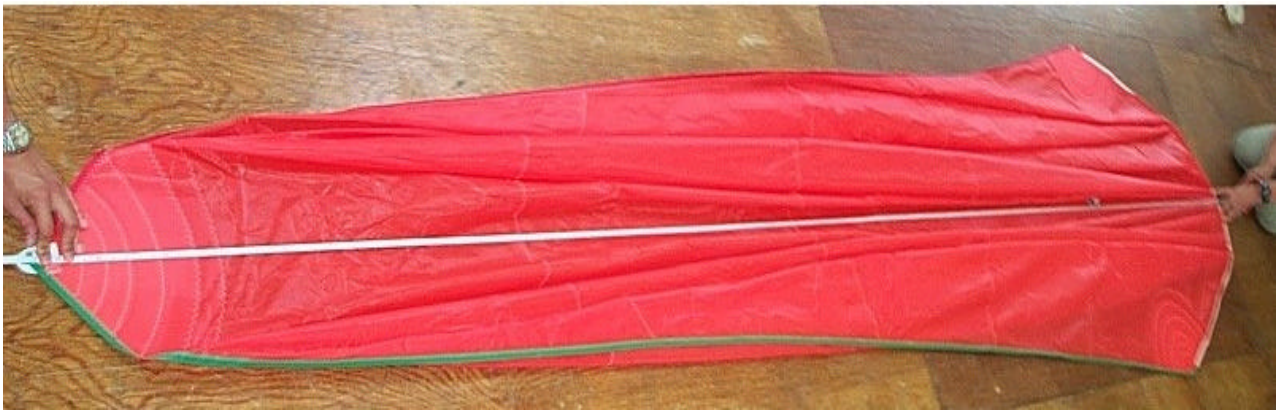

Figure 12a. Measurement of spinnaker **Foot Median**

B.5.2 Luff Perpendicular (ERS G.7.11)

The **luff perpendicular** shall be measured as the shortest straight line distance swung across the **sail** by a tape from the **clew point** to the **luff** as appropriate, including bolt rope if any, as illustrated in Figure 14. The measurement shall be taken with the **sail** laid out with the tension applied as required by ERS H.4.1.

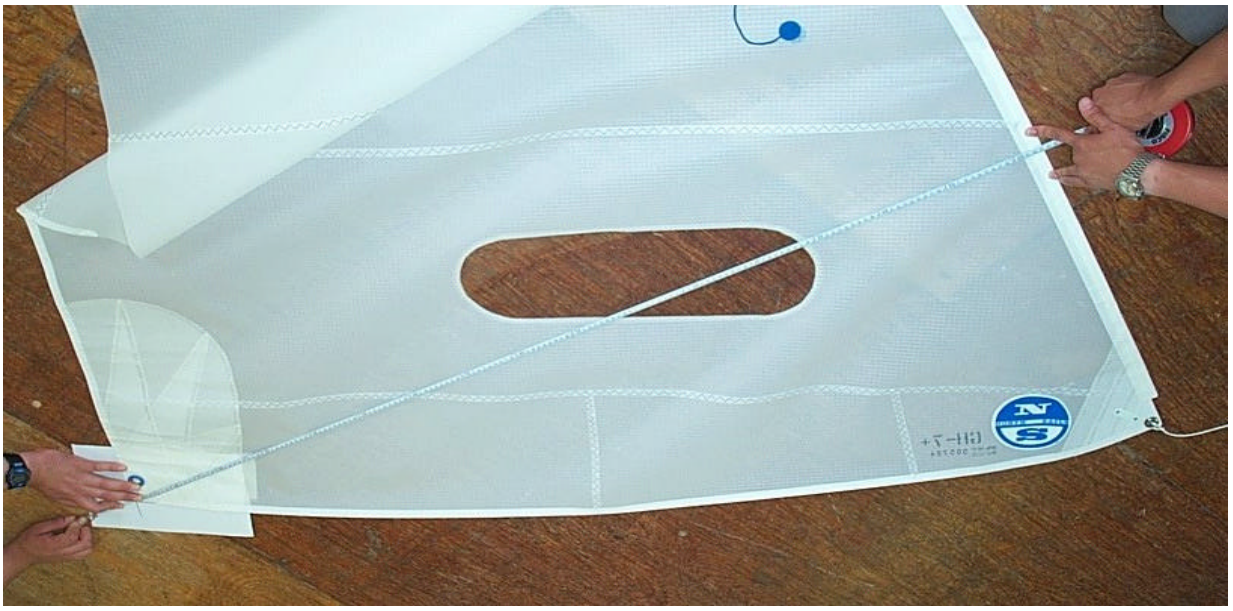

Figure 14. Headsail **Luff Perpendicular**

B.6 Widths (ERS G.7)

B.6.1 Mainsail and Headsail Quarter, Half, Three-quarter and Upper Widths (ERS G.7.4, G.7.5, G.7.6, G.7.7)

Mainsail and headsail widths, except **top width**, shall be measured as the shortest straight line distance swung across the **sail** by a tape from the **leech point** to the **luff** including bolt rope if any, as illustrated in Figure 15. The measurement shall be taken with the **sail** laid out with the tension applied as required by ERS H.4.1.

Figure 15. Mainsail **Half Width**

B.6.2 Spinnaker Quarter, Half, Three-quarter and Upper Widths (ERS G.7.4, G.7.5, G.7.6, G.7.7)

The spinnaker widths shall be measured as the straight line distance between the **leech points** as defined. The measurements shall be taken with the **sail** laid out with the tension applied as required by H.4.1. See Figure 16.

Figure 16. Spinnaker **Half Width**

B.6.3 Top Width (ERS G.7.8)

Top width shall be measured as the straight line distance as defined. It shall be taken with the **sail** laid out with the tension applied as required by H.4.1. See Figure 17.

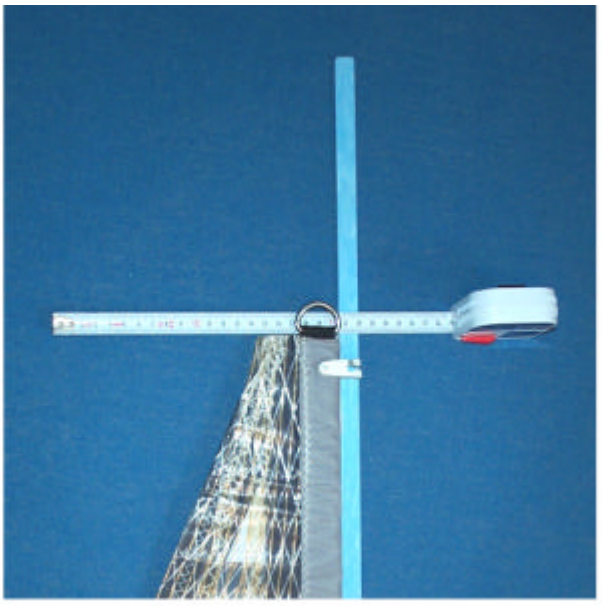

Figure 17. Headsail **Top Width**