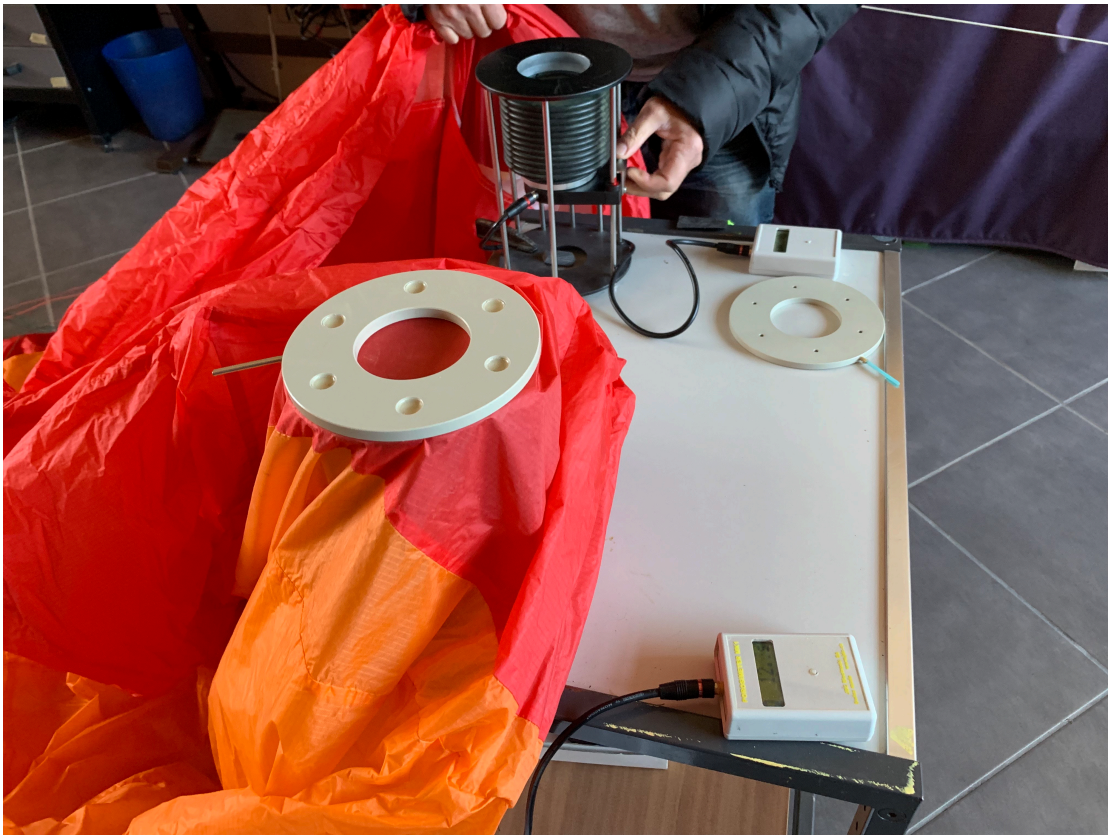
Understanding Porosity measurements.

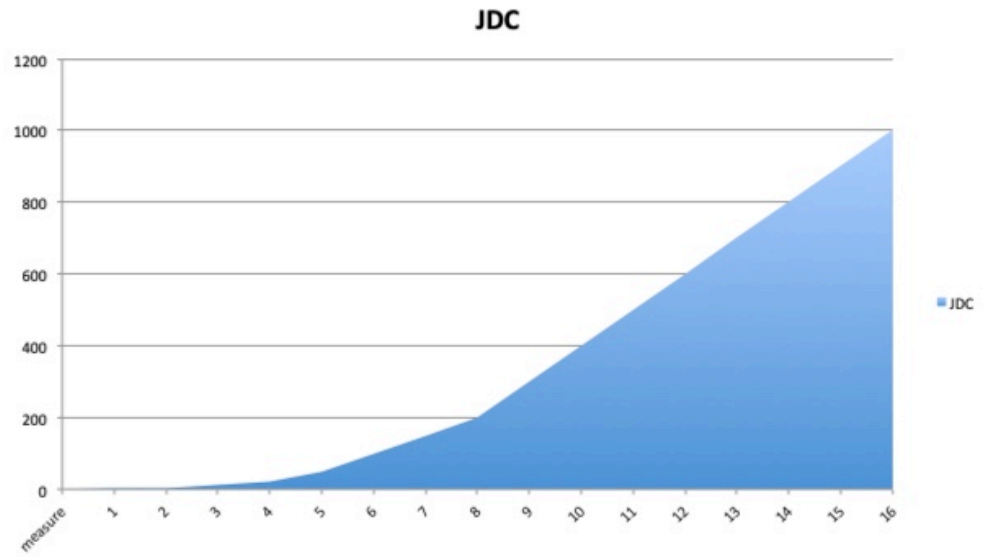


Nearly all Service centers check the porosity of gliders using a JDC porosity meter. This instrument does not directly measure porosity but instead measures the time for a fixed volume of air to pass though a circle of cloth. Provided in the users manual is a conversion formula to show how to convert the seconds measurements of the JDC to real porosity values. This formula is Porosity = 9/(JDC reading in seconds).

This is an inverse relation, and you can see below some typical values for porosity readings from a JDC and the conversion.

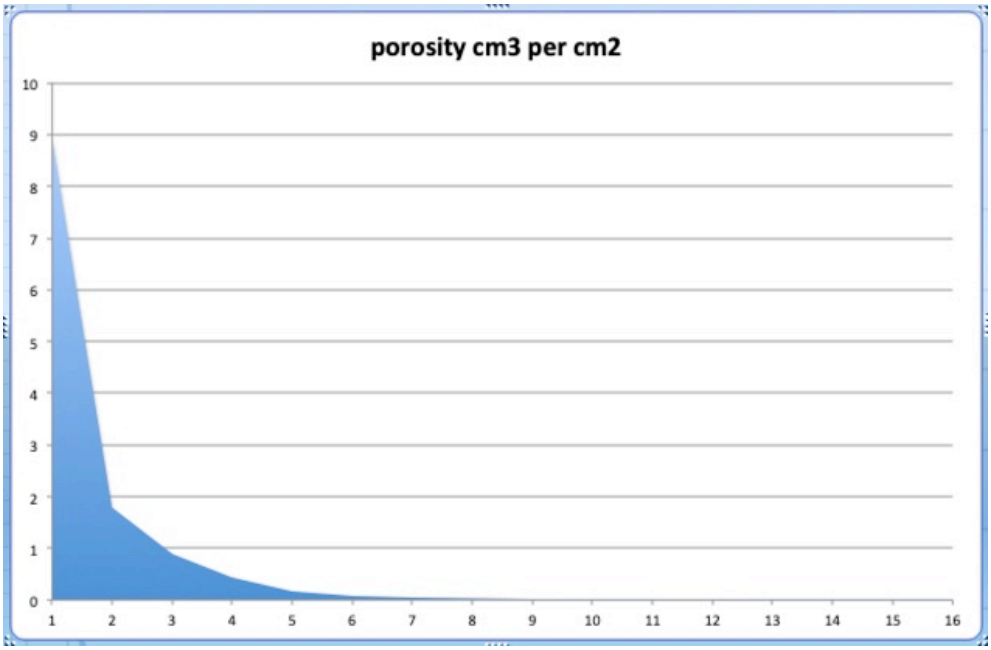
measure	JDC sec	porosity cm3 per cm2
1	1	9
2	5	1.8
3	10	0.9
4	20	0.45
5	50	0.18
6	100	0.09
7	150	0.06
8	200	0.045
9	300	0.03
10	400	0.0225
11	500	0.018
12	600	0.015
13	700	0.012857143

14	800	0.01125
15	900	0.01
16	1000	0.009



When you plot these JDC values on a graph for all these typical reading this is what it looks like. You can see that the natural human tendency is to look at the large area of the graph to the right hand side and think that this is the main significance. But this would be incorrect, however is unfortunately what a lot of service centers have been doing.

Now lets plot the same graph for the same values, but this time we will plot the actual porosity values after conversion.



This leads to a completely different type of graph. The porosity values that are measured indicate the amount of air that leaks though the cloth to the top surface. It is this that can cause a safety problem on paragliders and is the reason

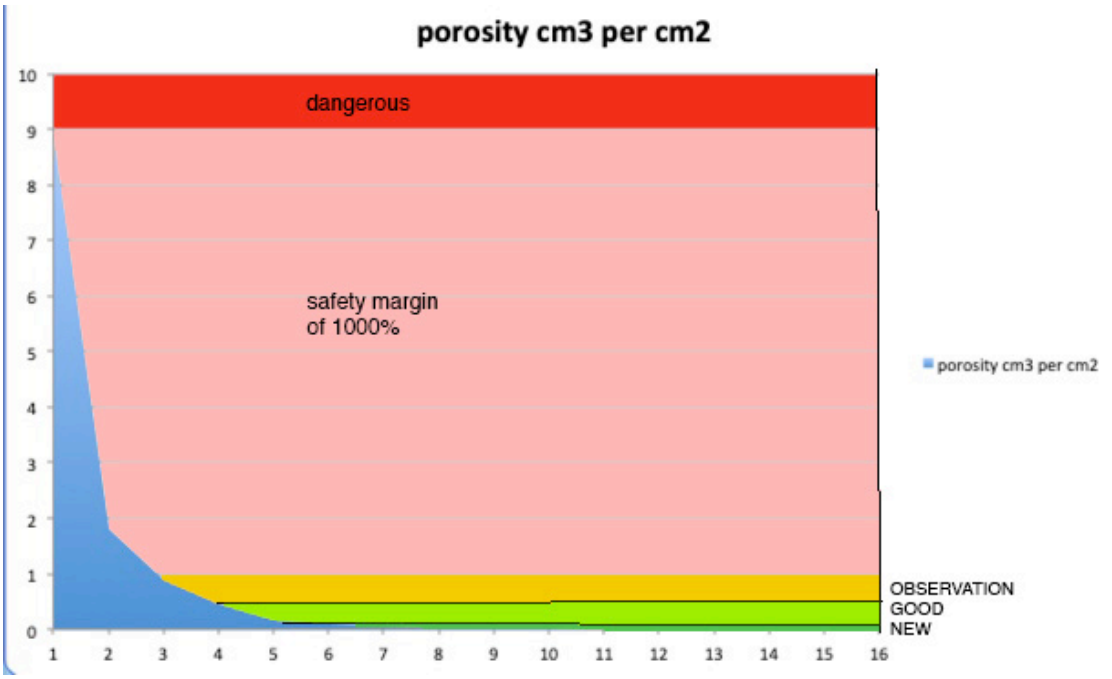
we measure cloth porosity, so this is the value that we should be looking at when setting the scales of porosity values.

It is therefore logical to use the porosity graph to establish the safety limits for porosity.
From my own extensive experience I set the following limits:

1) RED AREA.
   Flight tests show that gliders below 1 second can suffer from deep stall problems. As glider design has improved paragliders with readings below 1 second are often safe to fly, but lets fix this limit as the real safety limits and the red line.
2) SAFETY MARGIN.
   Next we have the safety margin. This margin is up to 10 seconds or 0.9cm3/cm2. This is the very generous safety margin that is 1000% above the actual red line.
3) OBSERVATION area. This is from 10-50 seconds on the JDC, and is gliders that are getting closer to the safety margin. But it is important to remember how far these gliders are from the red line, for instance a glider with a value of 20 seconds still has a porosity 20 times less than the value of the red line.
4) GOOD
   Next is good readings 50-200 seconds. Values around 100 times better than the red line.
5) AS NEW >200sec.

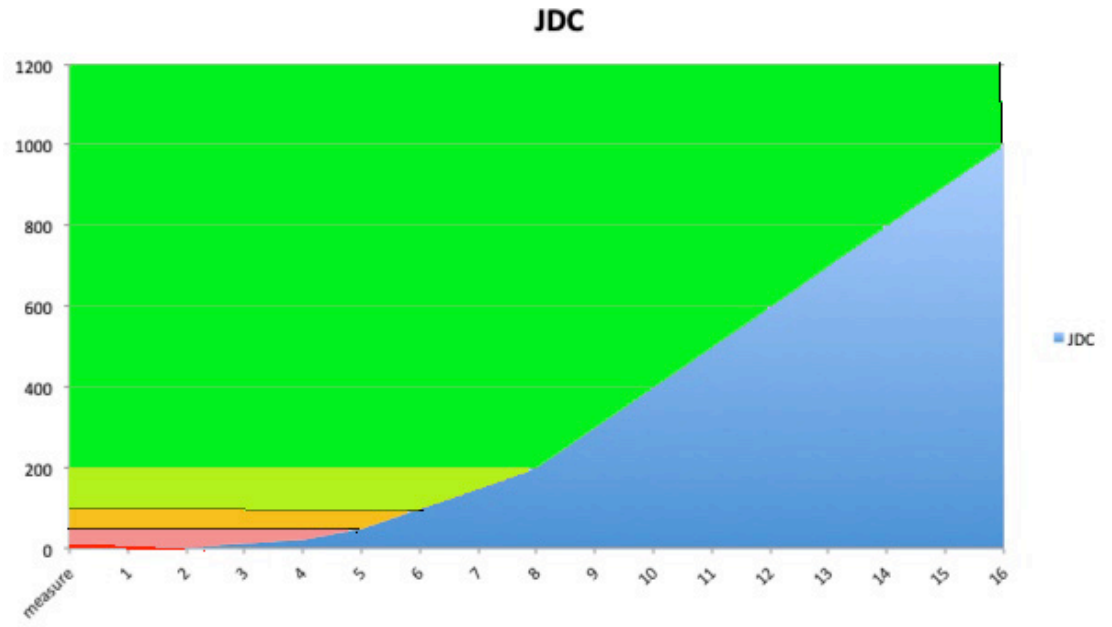
   JDC warn that values above 200 seconds can be misleading and are more likely to measure leaks in the seal than the porosity of the cloth sample being measured.

Like new in values above 200 seconds. It is recommended that no reading be taken above 200 seconds, as this is simply non-porous.
These are plotted on the Porosity graph below in color.



If we now plot these same values on the JDC we see the reason why plotting seconds can be misleading. There is a huge Green zone, which is the non-porous values, and all the area of concern is all squashed up at the very bottom of the graph.

The safety scale we have established is correctly based on porosity and not on the inverse of the porosity values.



LOWER SURFACE

It is also important to note that it is only the porosity of the top surface leading edge that is important. There is no point in measuring the porosity of the Ribs (they have holes in them) or the bottom surface. A few years ago there was a

glider designed with porous mesh on the lower surface that flew very well. Single surface gliders of course have no lower surface at all, so they fly fine like that, so measuring lower surface values is a mistake.

POROUS SEAMS
I recently measured the porosity of the 3d panel shaping seam on the leading edge of some gliders. Nearly all modern gliders have these 3d panel shaping seam, and these do of course leak air.
A 10mm seam with a single row of stitching gives a porosity of 5seconds.
A 10mm seam with twin needle sewn seam gives a porosity of 12 seconds.
If you look at these numbers with the correct porosity graphs in mind they are not so alarming, as they are in the Safety Margin zone.

How many Service Centers would be very surprised if they knew this! Some Service Centers appear to be getting things wrong when measuring porosity.

RECOMMENDATIONS:
Measure only the Top surface Leading edge. Do not measure ribs or lower surface, and above all do not write reports about these values, as they are misleading to the customer.
The porosity of the center of the wing is more important than the tips.
If 80% of the LE top of the glider has good porosity the glider is good.
Recommended limits are:

1) RED AREA <1sec
2) SAFETY MARGIN. 1-10sec
3) OBSERVATION 10-50 sec
4) GOOD 50-200 sec

5) AS NEW. > 200 sec

MEASURING CLOTH AGEING.
Using porosity measures alone is not a good way to check the aging of cloth. There are 3 main factors that influence cloth ageing.

1) Strength
2) Plastic deformation
3) Porosity

The importance of these 3 factors in as listed above with strength being the most important. Modern cloths tend to age quite uniformly in all 3 factors at the same time. Looking at any one factor is a poor way to look at the ageing of the cloth. Most service centers measure strength and porosity but don't measure plastic deformation, but this is very often the most important factor in how well a glider flies and ages.

Bruce Goldsmith