Bag Skirt Pattern Design

For

Model Hovercraft

Griffon 2000TDx

(With skirt designed using these notes)

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Version 5

Introduction

Fitting a correctly designed skirt to a model hovercraft can transform the models performance dramatically.

Quite often the first model hovercraft a modeller builds leads to disappointing operation. These notes will lead the reader through the stages needed to make a skirt segment pattern to make a skirt that will enable their model to show its true potential.

These notes are for a skirt having all four corners identical as in the Griffon 2000 range of craft. The standard model plan has three segments per corner but the skirt is much improved in shape if a five segment corner is used so the example shown is for such a skirt.

Equipment required

The following will be required to enable the pattern to be drawn.

Pencil

Ruler

Protractor

Compasses

French Curves

Large sheets of paper

Rubber

Calculator

Test Equipment

If the design is for a replacement skirt then a manometer will be most useful. Instructions for making such an instrument are included.

Acknowledgements
Fran Oakey – Manometer and Pitot Tube documents

Bag skirt pattern design for model hovercraft

The following is one of many methods to design a bag skirt pattern for model hovercraft

such as the Griffon 2000.

Please study the Figs 1 to 5 to help understand the process.

1) Using a manometer take pressure measurements of the bag and plenum.(See ' Inclined Manometer' and 'Pitot Tube' for instructions on making a manometer)
2) If you can't get pressure measurements because this is the first skirt then use 1.5 as the ratio required.
3) Divide the bag pressure by the plenum pressure to get the pressure differential.
4) Using the graph 'Pressure Differential to Inner/outer Radius Factor', look up the pressure differential and read of the factor required from the curve. If using 1.5, as per above, then the graph shows that the factor is 3. See 'bag design factor chart'

5) Verify the ride height of the machine and calculate the height of the deck when the model is at hover.
6) Divide this height by 2, this is the radius required for R1.
7) Multiply R1 by the factor found in step 4 to get the value for R2.

8) Take a piece of A3 size paper, the reverse of wallpaper or lining paper is good for this.
9) Refer to Fig 1 and, taking measurements from your model, draw in the cross section of the deck and side of your model. The yellow area in the example in Fig 1.
10) Mark point A which is 10mm in from the edge of the deck. The area red in Fig 1.
11) Draw the line A->E which should be twice your R1.
12) Using the centre of A->E and using a radius of R1 draw in the semi -circle A to F
13) Mark in the points A to E at 45 deg positions.
14) Draw in the line N->F. Ensure the line passes through the centre point of line E->N. The distance between E->F is the ground contact point of the skirt. Mark in point F.

15) Using the value for R2 as the radius draw in the arc F-> L. Note- the starting point for the arc should be such that the radius R2 lies along the line N->F. It may be necessary to extend the line F-> N through N to achieve the centre point of R2.
16) Mark in the points F to L at 15 deg intervals. Note the last angle if less than 15 deg for K->L.

17) Decide on the number of segments required to make the corner of the skirt. For these instructions we will assume five segments are required. This means we need four full segments and two half segments. See Fig 2 for segment layout.
18) Using the corner of the base as the point of a 90 deg angle and draw up the corner of the model on a new piece of paper. Shown outlined in red in Fig 2.
19) Divide 90 deg by the number of segments required to get the segment angle.

20) Divide the segment angle by 2 and use this result to mark in the half segments at each end of the 90 deg arc. Refer to Fig 2
21) Now mark in the remaining segments using the angle found in 19) above.
22) Keep this drawing to assist with marking out the segment positions on the model when fitting the skirt.

23) On the drawing you last worked on in step 16), mark a horizontal line across the page starting at the right hand edge of the page and ending at the left hand side of the page. The line should be parallel to the deck line at the top of the drawing. Label the line Y.
24) Next draw vertical lines down from the markers A to M so that they reach the bottom of the page. The lines should be at right angles to the line Y drawn in 23). Mark each vertical where it crosses the line Y with its corresponding letter A2 to M2. See Fig 1
25) From the horizontal line M2 to C2, plot a line using the segment angle calculated in step 20) to extend until it crosses the vertical that passes through C. Label the line Z.
26) Label the line Z with C1 where the vertical line C to line Y crosses line Z. Label in the remaining letters B1 to L1 along line Z. See Fig 1
27) Measure the distance between C1 and C2 on line Y and mark it on the drawing. Repeat for the other points B1 to L1.

28) Using the formula P1 to P2 = 2 x Pi x R1 x (angle of R1 / 360) calculate the distance of the plot points required for the skirt template. Where R1 is the value calculated in steps 1 to 6. The 'angle of R1' is the angle made by each of the points, A to F in turn, with the line P> A for the point being calculated. (Points A to F). See Fig. 1

    Start with the angle of A>P>B which is 45 deg to give **2 x Pi x value of R1 x 45 /360.** Then angle A>P>C which is 90 deg. Angle A>P> D next at 135 deg then angle A >P> E at 180 deg. Finally end with angle A >P> F at 189 deg.

    Create a table of the results. See fig 3a

29) Repeat step 28 using R2 and its corresponding angles starting with F >N> G and 15 deg, F >N> H and 30 deg, F >N> J and 45 deg, F >N> K and 60 deg, F >N> L and 64 deg. (L > M is attachment material added when cutting out the segment later).

    Add these results to the table in 28)

30) Using a long length of paper draw a vertical line down the centre.
31) Draw a horizontal line at right angles across the vertical line. Label this line A at the start and X at the end. See Fig. 3
32) Using the result from the table for A to B measure this value down line A > X and Label it B.
33) Repeat this process for all the values for R1 in the results table and end with A to F. All the measurements start at A. See Fig. 3
34) Using the result from the table for F to G measure this value down line A > X but starting at F and label the point G. See Fig. 3
35) Repeat this process for all the values for R2 in the result table and end with F to L. All the measurements start at F. See Fig. 3

36) From the drawing last worked in 27) note the measurement for A1>A2 and draw a horizontal line out to the right from line A>A1. refer fig 1 and fig 3

37) Repeat for each of the positions down A>X using the corresponding measurement from fig 1

38) Using a French curve join all the line ends just added to form the outside edge of the segment. Refer Fig 3

39) You now have a half segment, to create a full segment copy the drawing and join the lines A >L. See Fig. 3b

40) Cut out the segment pattern and glue to a piece of plywood and trim round this with a knife or band saw to give a working template which can be used to draw round on the skirt material.

41) Add attachment material (10mm) to the top and bottom of the segment and add material (5mm) outside the curved edges of the segment for stitching when cutting out the material.

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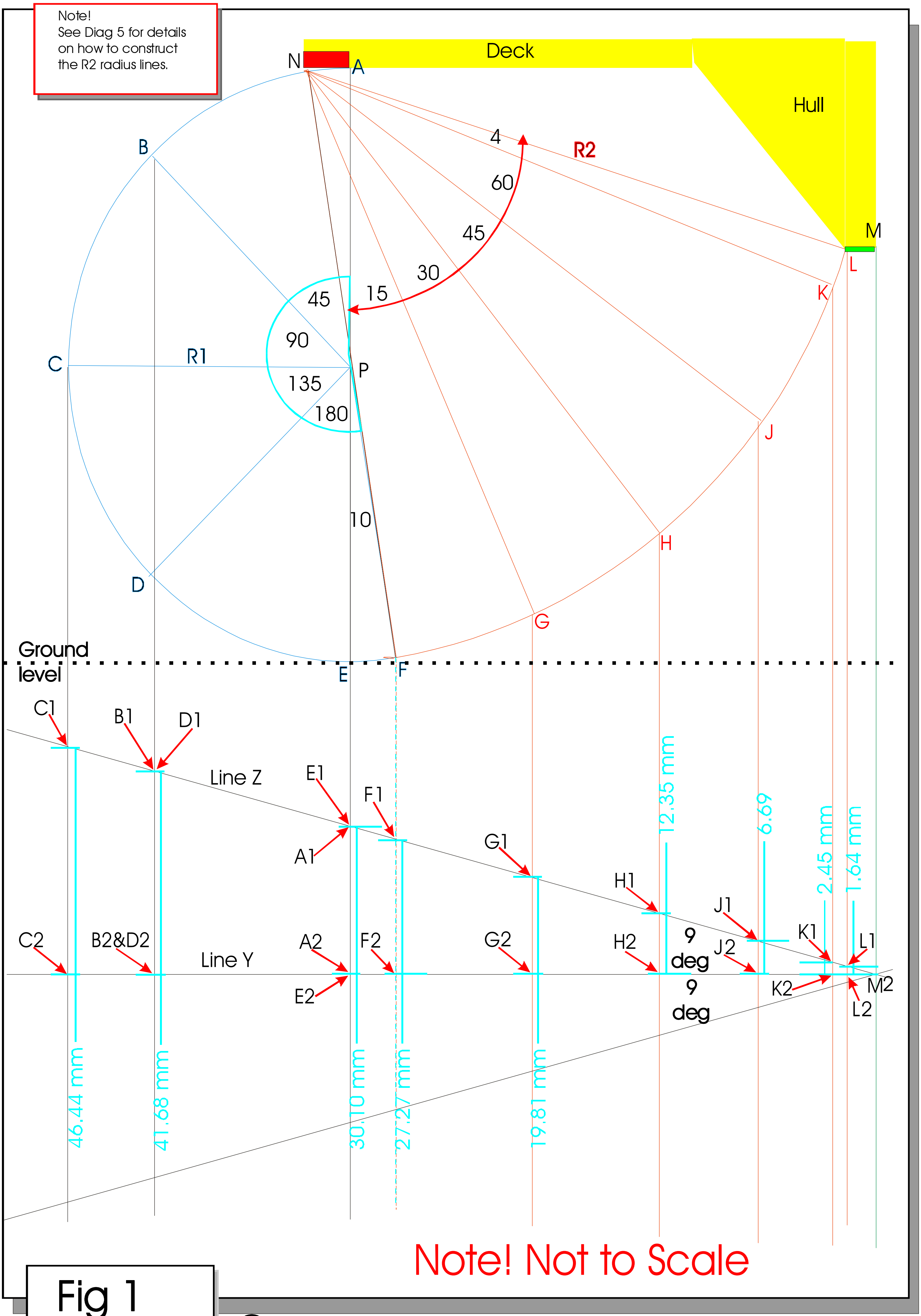

Note!
See Diag 5 for details
on how to construct
the R2 radius lines.
Deck
Hull
N
A
M
L
K
J
H
G
F
E
D
C
B
P
R1
R2
4
60
45
30
15
10
45
90
135
180
Ground
level
C1
B1
D1
E1
F1
A1
G1
H1
J1
K1
L1
Line Z
C2
B2&D2
Line Y
A2
E2
F2
G2
H2
J2
K2
L2
M2
9
deg
9
deg
46.44 mm
41.68 mm
30.10 mm
27.27 mm
19.81 mm
12.35 mm
6.69
2.45 mm
1.64 mm
Note! Not to Scale

Fig 1

Corner Segment layout of Griffon 2000 type model

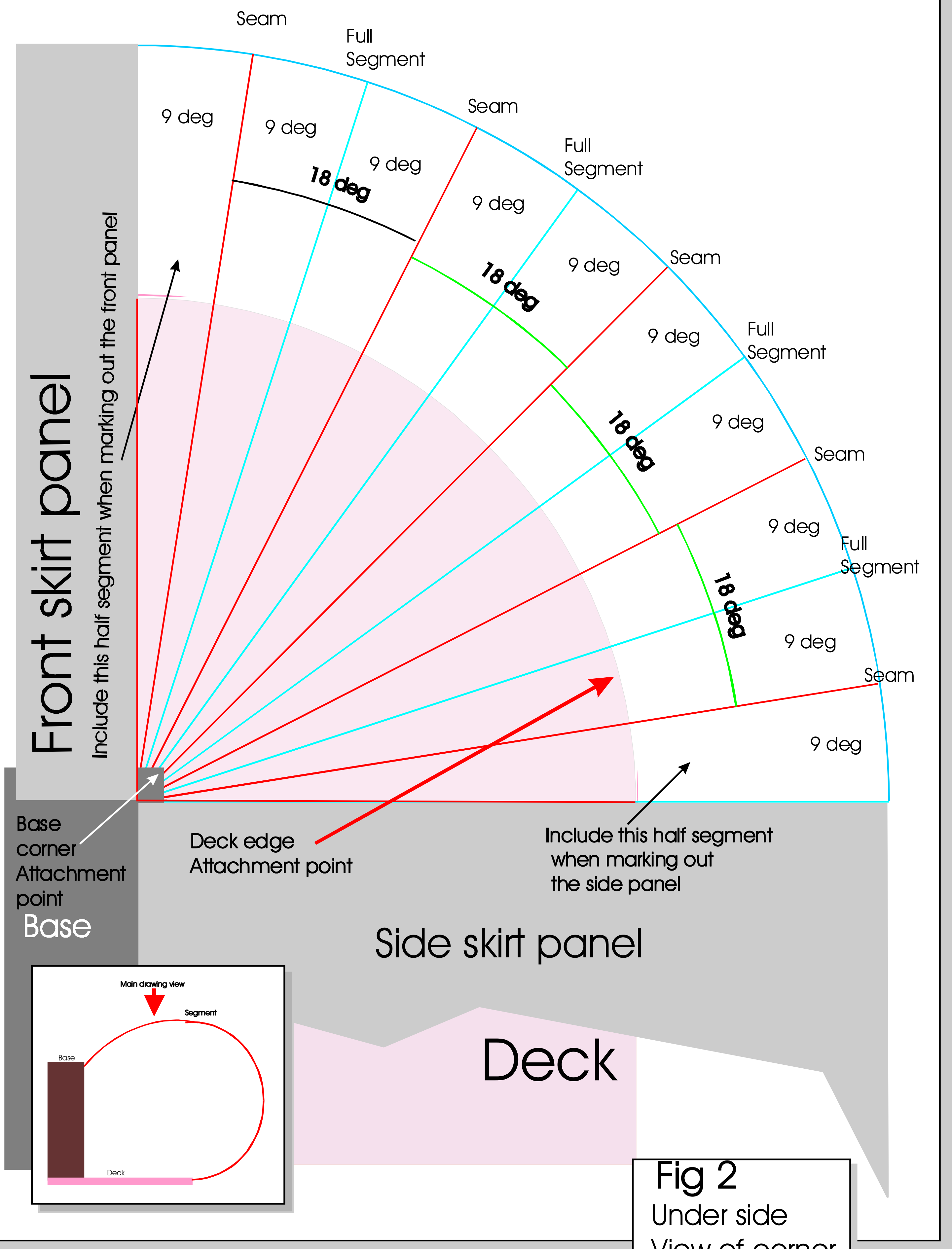


Fig 2
Under side
View of corner

Calculations

Point X to point Y = 2 x Pi x Radius x (Angle / 360) = (value)

Example

(Use R1 radius for A to F plots)

A to B = 2 x Pi x 62.5 x (45/360) = 49.09
A to C = 2 x Pi x 62.5 x (90/360) = 98.18
A to D = 2 x Pi x 62.5 x (135/360) = 147.26
A to E = 2 x Pi x 62.5 x (180/360) = 196.35
A to F = 2 x Pi x 62.5 x (189/360) = 206.17

(Use R2 radius for plots F to L)

F to G = 2 x Pi x 125 x (15/360) = 32.7
F to H = 2 x Pi x 125 x (30/360) = 65.5
F to J = 2 x Pi x 125 x (45/360) = 98.2
F to K = 2 x Pi x 125 x (60/360) = 131
F to L = 2 x Pi x 125 x (64/360) = 139.62

Fig 3a

Note
Line A to L is constructed using the calculation shown in the example Fig 3a.

The lines A to A1........L to L1 are constructed using the dimensions measured from the same lines in Fig 1.

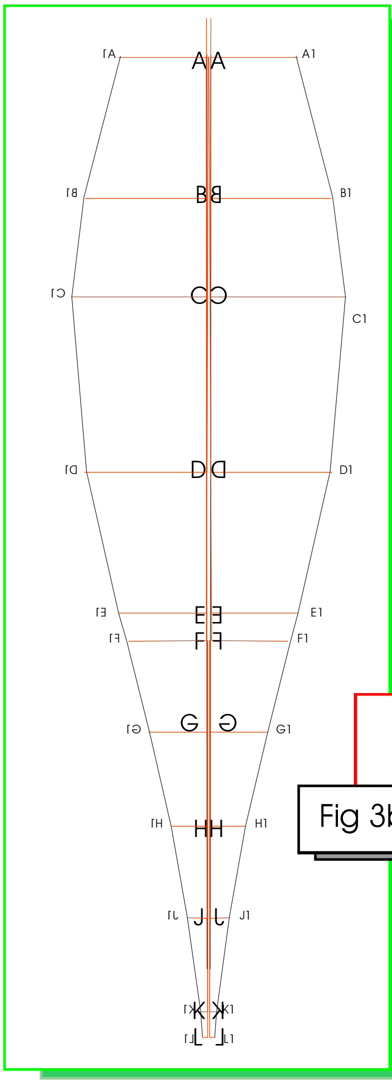
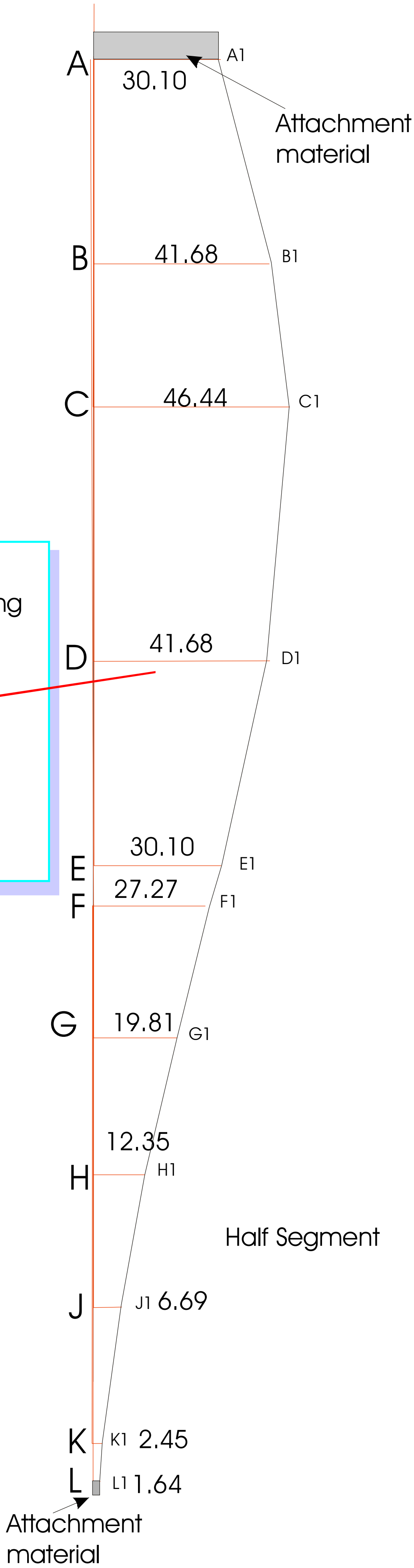


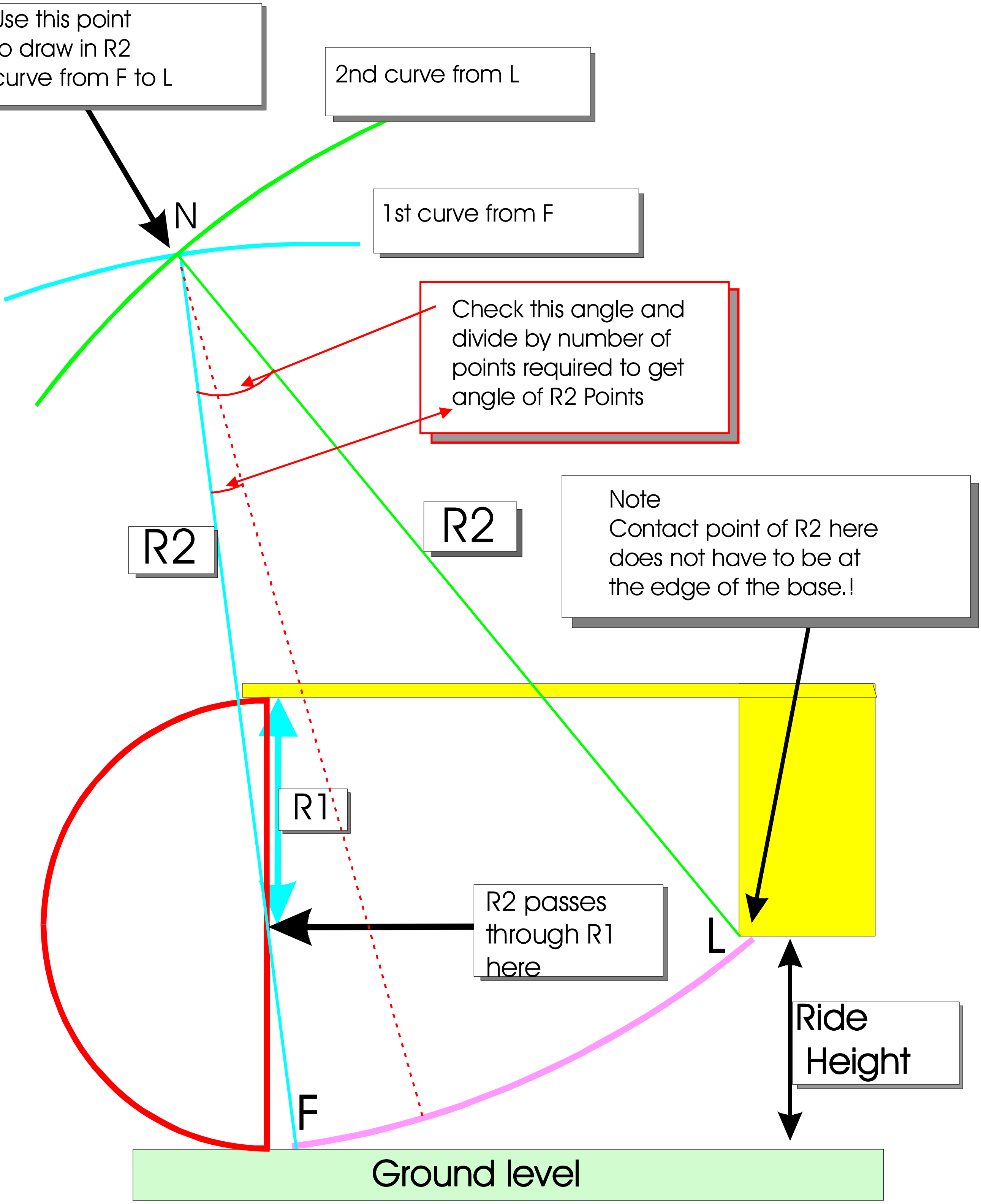
Fig 3b

Mirror half segment to give full segment



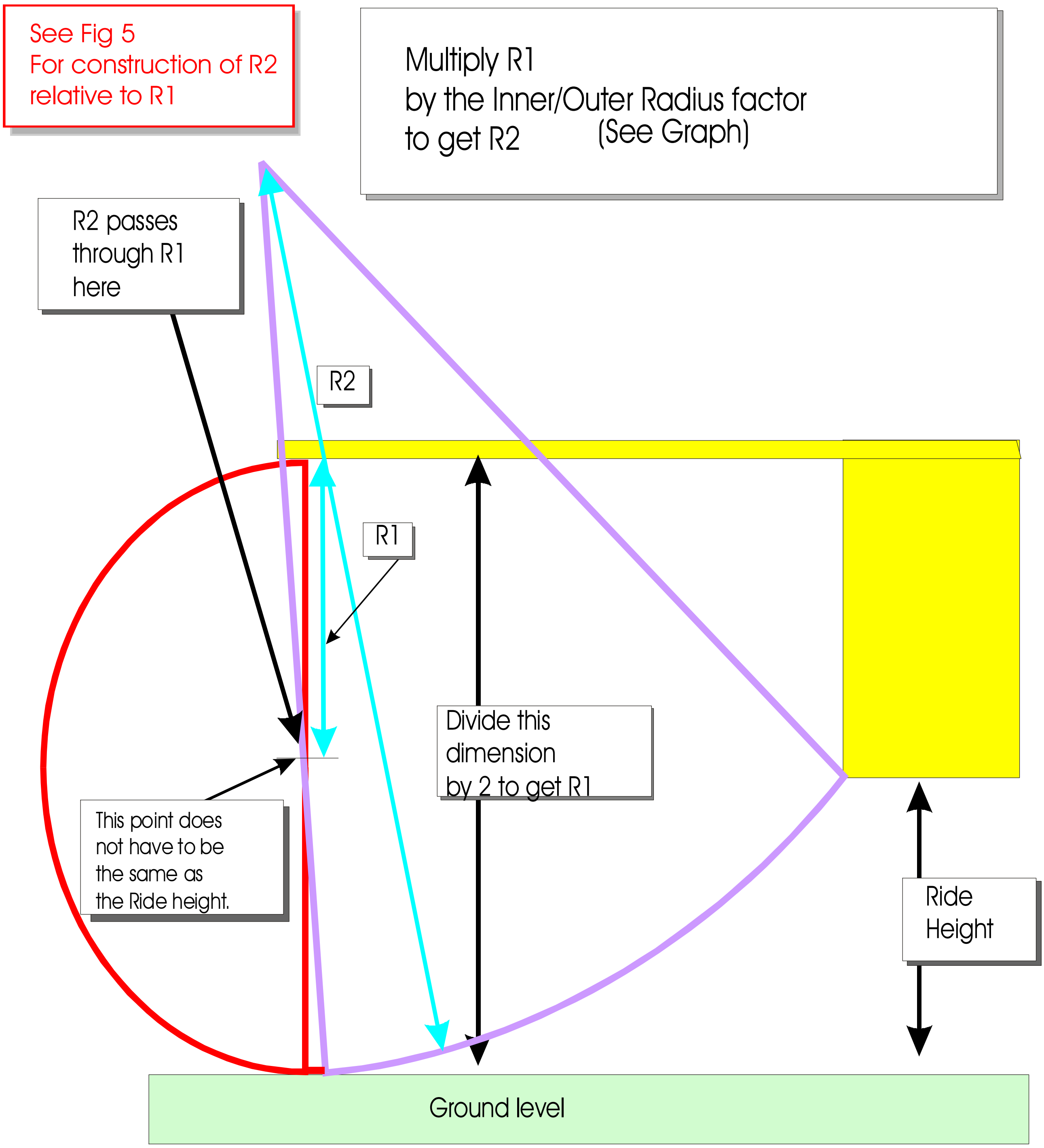
Note! Not to Scale

Fig 3



Construction of R2 relative to R1

Fig 5



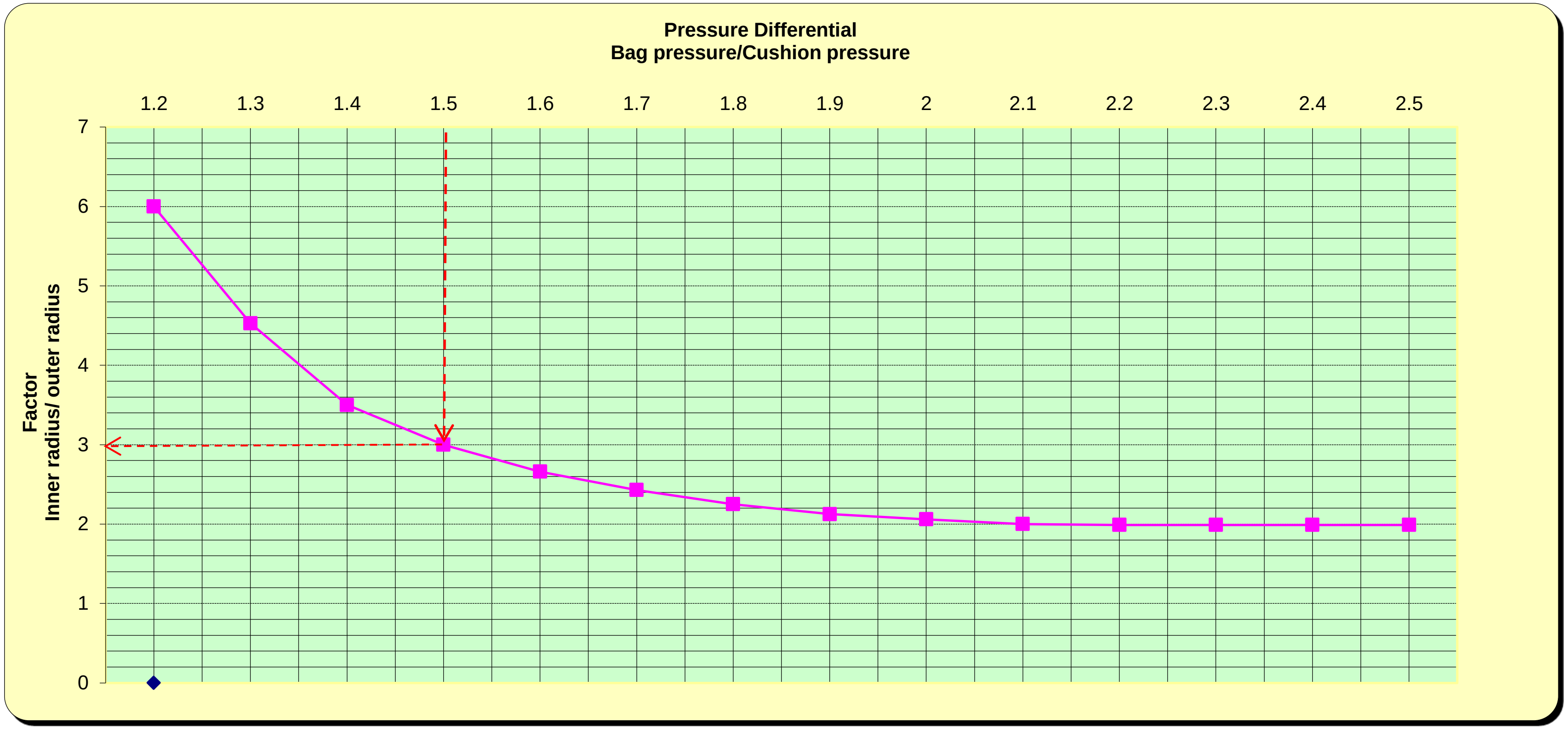
R1 and R2 Relationship with ride height and hover

V2

Fig 4

Pressure Differential to Inner/outer Radius Factor

Pressure Differential - Bag Pressure/Cushion Pressure	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2	2.1	2.2	2.3	2.4	2.5
factor - Inner radius/Outer radius	6	4.53	3.5	3	2.66	2.43	2.25	2.125	2.06	2	1.99	1.99	1.99	1.99



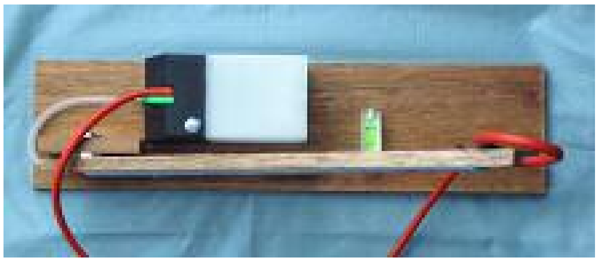
Notes
Ground contact point is normally 15 deg in from edge of craft and should never be outside the edge of the craft.
Ride height is normally 1/8 the width of the craft
Outer radius is normally half the ride height
Divide the Bag pressure by the Cushion pressure then use chart to find the factor required for the inner/outer radius.
Inner radius is equal to the outer radius multiplied by the factor value taken from the chart above

To use -
1) Measure the bag pressure when hoviring at full lift
2) Measure the cushion pressure under the model at full lift
3) Divide the bad pressure by the cushion pressure
4) Find the result of 3) above on the top line of the graph
5) Where the vertical in 4) above crosses the curve gives the ratio of the inner radius to the outer radius in the skirt design

Example - see dotted red lines on chart
bag pressure = 0.75
Cussion pressure= 0.5
therefore ratio = 0.75/0.5 which equals 1.5

Find 1.5 on top line of chart
Follow the vertical down until the curve is reached.
Take a horizontal line out to the left edge of the chart.
The figure reached to the left is the ratio required
Use 3 to 1 for the inner to oter radius sizes i.e the inner radius will be 3 times that chosen for the outer radius.

Inclined Manometer

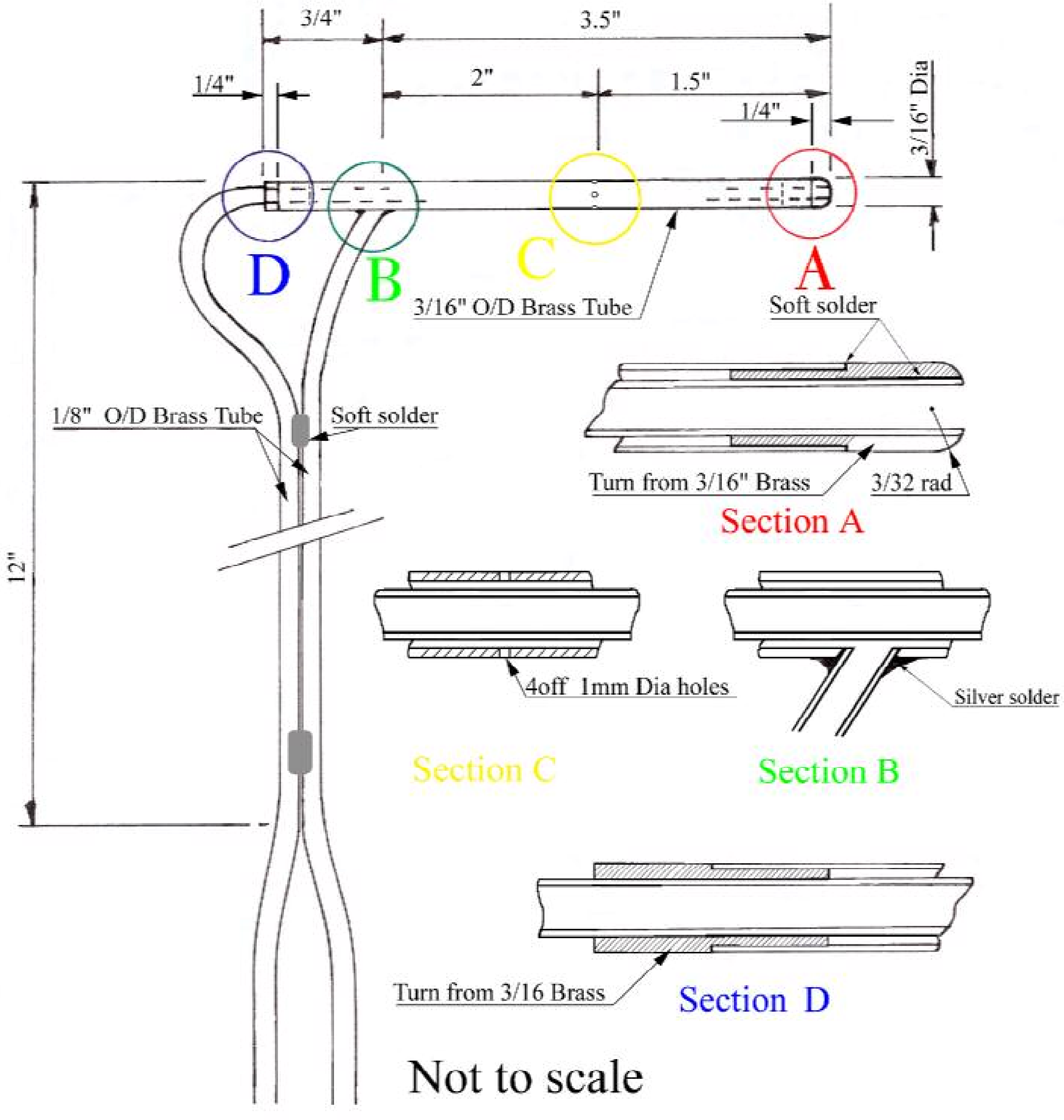
Firstly, “what is a manometer?” It is a device for measuring the pressure of gasses and vapours, and in its simplest form is a vertical glass “U” tube half filled with water. A positive pressure applied to one arm of the tube causes the water to move down in that arm and up the other arm, the pressure is the distance between the lower meniscus and the upper meniscus, and is usually measured in inches. The unit of this pressure is then “inches of water”. When using a simple “U” tube type manometer it is necessary to reset the scale zero to the lower meniscus, before taking the reading at the upper meniscus.

Now to the inclined manometer, shown above, this is just a more complex “U” tube. One arm of the instrument is a glass tube in a mount to which is attached a scale, in this case a 12 inch ruler, the other arm is a plastic container, a model aircraft fuel tank. The tank has two connections, one at the bottom, which connects to the lower end of the glass tube, and the other is the pressure connection at the top of the tank. A pressure applied to the tank causes the water in the tank to be forced up the glass tube and read on the scale. The glass tube/scale assembly can be either vertical, giving a direct reading, or set at an angle to give a scale factor, e.g. set to 30 degrees, the pressure will be the scale reading multiplied by 0.5 (sine 30 degs), thus allowing low pressures to be read more accurately.

The main considerations when designing this instrument were, accuracy, and zero stability, these two parameters are interrelated. When pressure is applied and water rises in the tube, the water in the tank lowers. This means that the zero lowers and the pressure read on the scale is therefore lower than the actual pressure, (by about 0.3% on this instrument, see later). To minimise this error, the surface area of the water in the tank must be large compared, with the cross sectional area of the tube. The tube inside diameter is 0.187 inches, area 0.02746 sq. in, area of the tank, 4 inches x 2.3 inches, is 9.2 sq. in, this gives an error of 0.298%. This error can be reduced by carefully adjustment to the angle of inclination of the measuring tube/arm. The pivot point of the arm is at the zero point, so that the zero does not change significantly when the angle of inclination is changed. The scale can be moved up to + or – 3/8 of an inch, to allow some adjustment, to zero the instrument. Spirit levels are added to check that the instrument is horizontal in both planes before zeroing the instrument and taking readings. Commercial instruments use a blend of paraffin instead of water and are scaled to allow for the density of paraffin, which is about 0.8. It would be necessary to measure the density accurately if one does use such a liquid, so that the accuracy of the instrument can be maintained. Algae will grow in water left in the instrument for a long time, to prevent this, the manometer should be drained when not in use.

Uses for this instrument in model Hovercraft are, the measurement of the plenum and bag skirt pressures and air velocity when coupled to a Pitot tube.

PITOT TUBE



Velocity = $18.29\sqrt{\frac{h}{\rho}}$ ft/sec. Where h is pressure in inches of water
ρ is air density in lb/cu. ft

The dimensions for this Pitot tube are based on the Britsh Standard B.S 1042 section 2.1 : 1983 and the construction modified for ease of manufacture.