



**NOTE:**  
Rudder is inclined 4.3° in hull.  
Rudder is shown with a vertical post for clarity.  
The intersection of rudder CL and baseline corresponds with the installed intersection of rudder CL and hull DWL.

**NOTE:**  
See Rhino file for actual 3D rudder blade and post geometry.  
Dimensions of blade are shown for reference only.

**Rudder Post TP Reinforcing Pile**  
(1) Pile of 200 gram Carbon fiber, 3mm wide x 350mm long.  
Apply each side of post between post and inner blade skin.  
Locate as shown.

**RUDDER STOCK LAMINATE DETAILS**  
Post Material = T300, 300 gram, Carbon Epoxy Pre Preg  
Curing = Autoclaved at 80 psi (5.4 Atm) at 270° F (132° C) for 4 hours  
Skin by Weight Ratio = 37% to 39%  
The rudder stock laminate consists of repeating stacks of 4 plies @ 1 ply @ 45°, 1 ply @ 90°, and 0°. A single 90° ply is added after every 3 stacks (2 plies total).

**RUDDER LAMINATE TABLE**

Stack	Notes	Distance from		Overall Length	Thickness (mm)	
		Bottom	Top		Skins	Core/AB
1		0	0	3000	1.2	1.2
2		0	0	3000	2.4	2.4
3		0	0	3000	3.6	3.6
90° @ 90°		0	0	3000	1.0	1.0
0° @ 0°		0	0	3000	4.2	4.2
4		350	200	2510	5.4	
0° @ 0°		350	200	2510	5.7	
5		700	400	1900	6.0	
0° @ 0°		700	400	1900	7.2	
6		1050	600	1410	8.4	
0° @ 0°		1050	600	1410	8.7	
90° @ 90°		1050	600	1410	9.0	
7		1400	800	800	10.2	
0° @ 0°		1400	800	800	10.5	
8		1750	1000	285	11.7	
0° @ 0°		1750	1000	285	12.0	
0° @ 0°		1750	1000	285	12.3	4.2
9		600	0	2400	13.5	5.4
10		1200	0	1800	14.7	6.6
0° @ 0°		1350	0	1710	15.0	6.9
0° @ 0°		1500	0	1590	15.3	7.2
0° @ 0°		1620	0	1455	15.6	7.5
0° @ 0°		1770	0	1285	15.9	7.8

Note:  
Final side laminate thickness is shown as 16mm.  
Final fore and aft wall thickness is shown as 4mm from top edge down to 4mm at bottom of post.

**BEARING BUILDUP**  
• The bearing and tiller arm build-ups are to be laminated with multiple layers of 400 gram woven E-glass. The number of layers will be dictated by the required build up thickness.  
• The buildup is to be bonded to the inside diameter of the lower bearing sleeve less 1mm, concentric to the stack axis.  
• Bond stainless steel sleeves to bearing build up with epoxy.

**BLADE LAMINATE**  
The blade is to be coated with 100 Corcoat machined to shape forward and aft of the stock as shown. Laminate material is by T300, 300 gram, Carbon Epoxy Pre Preg  
Blade skin from inside-out is to be as follows:  
Core:  
200 gram fiber adhesive  
1 ply 120 gram flat woven woven carbon  
1 ply 300 gram carbon veil @ 90° (across blade)  
1 ply 300 gram carbon veil @ 45°  
1 ply 300 gram carbon veil @ 0° (along axis)  
1 ply 300 gram carbon veil @ 45°  
1 ply 300 gram carbon veil @ 90° (across blade)  
1 ply 300 gram carbon veil @ 45°  
1 ply 300 gram carbon veil @ 0° (along axis)  
1 ply 300 gram carbon veil @ 45°  
1 ply 120 gram flat woven woven carbon  
Total blade laminate thickness = 2.6mm  
Blade fairing and primer thickness = approximately 0.3mm

**ABS RUDDER STOCK CALCULATIONS**

Length Over All = 9' - 0"  
Max. Displacement = 13,000 lbs  
Depth of Blade = 6' - 3"  
Distance Between Bearings = 41.38"  
Rudder Area = 31.20 sq ft  
Rudder L/B = 18,463 lbs  
Rudder T/C = 23,177 in lbs  
Bending Moment = 893,145 in lbs  
Side Force at Upper Bearing = 21,647 lbs (9,790 kg)  
Side Force at Lower Bearing = 40,050 lbs (18,163 kg)  
ABS required minimum inertia at Lower Bearing = 35.6 in<sup>4</sup>  
Actual inertia at Lower Bearing = 44.6 in<sup>4</sup>  
Post Material = T300 Carbon Pre Preg  
Ultimate Tensile Strength = 160,000 psi (1,167 MPa)  
ABS required fiber safety factor = 2.33

Rev 0 Date 2/14/07 First Issue By MS  
Part Rudder Construction  
Project Director Shipyard 46m GEMINI Cat  
Drawn by M Smith Scale 1 : 5 Drawn by Gemini-Rudder-Construction