An Airfoil for a 15 Meter Class Glider

By Udo Rumpf

In 1999 I attend the OSTIV convention in Bayreuth, where Richard Eppler talked about airfoil design and two different approaches. One, were the laminar flow is taken to a maximum extent on the bottom surface, with a relative benign top surface pressure distributions. The other approach allows for a slightly longer laminar regime on the top surface and transitioning the bottom laminar flow at or just before the hinge line of the flap and aileron, thus eliminating the blowhole turbulator on the flap and aileron.

V-FOIL, the software of Hanley Innovation, which I have used successfully on my previous project, is used for this airfoil iteration. My attempt is to match or better the performance of the typical 15 meter class airfoil with this approach as described above by R. Eppler.

I will compare my airfoil UFR 2000 to the AH93k-131-15 an airfoil which was designed with blow holes at 90% chord. This airfoil is nearly identical to an airfoil used on a current 15 meter class glider.

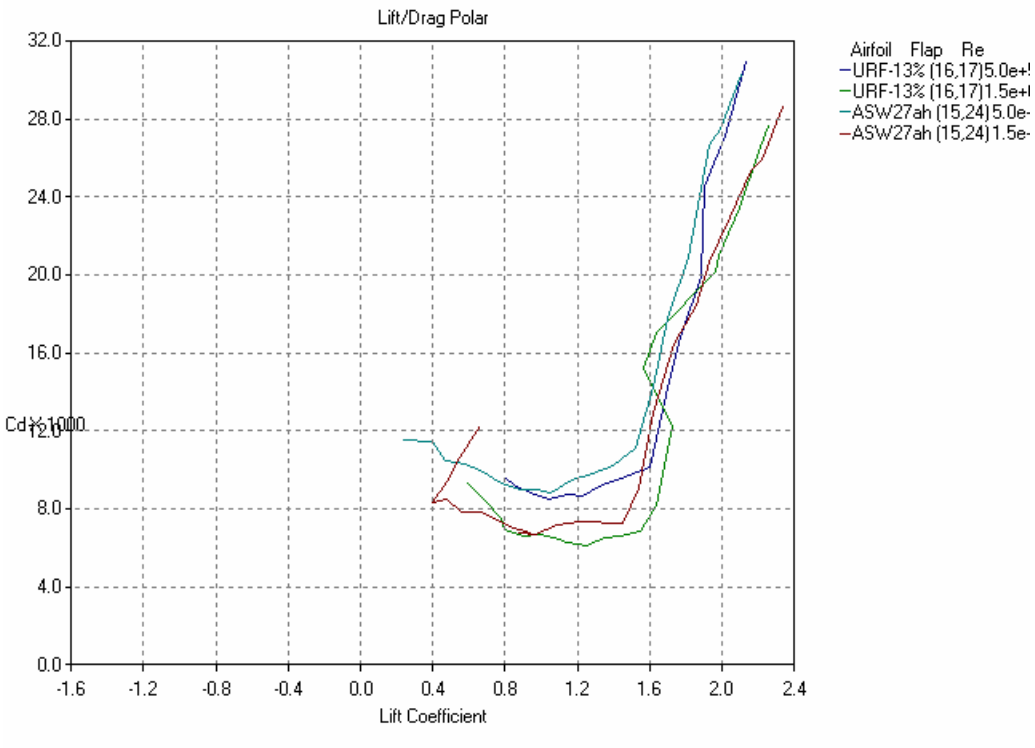
The UFR2000 is a 13% thick airfoil with a 15% flap chord.

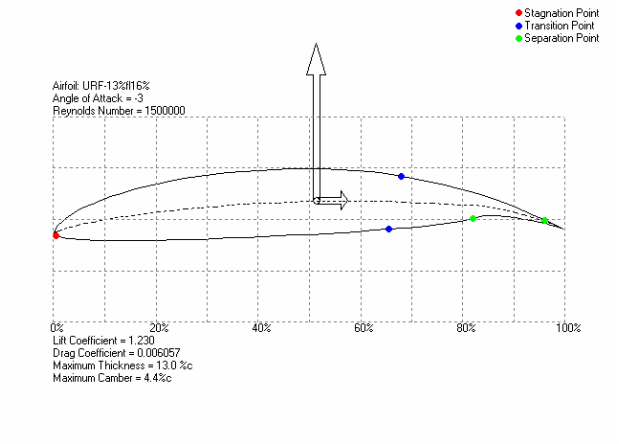
The advantage of the UFR 2000 is as follows: No blowholes have to be incorporated. The performance in climb is improved. In slow, as well as higher cruise it will have a marginal edge. Graphically, as well as numerically the evidences is that the UFR 2000 compares well. The data are presented in the typical Reynolds number range.

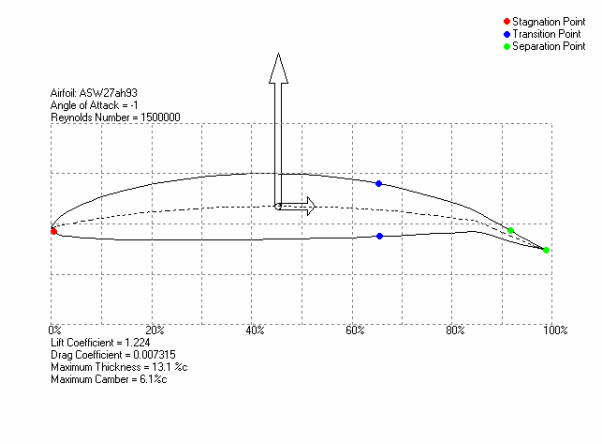
Based on my positive experience with the Super HP18 airfoil, the results of this investigation should give rise to a competitive15meter class airfoil with very good climb performance and similar cruise ability. I have started with the wing construction to incorporate this new airfoil.

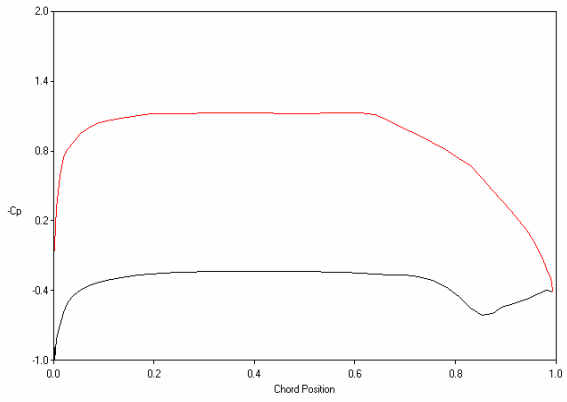
References:

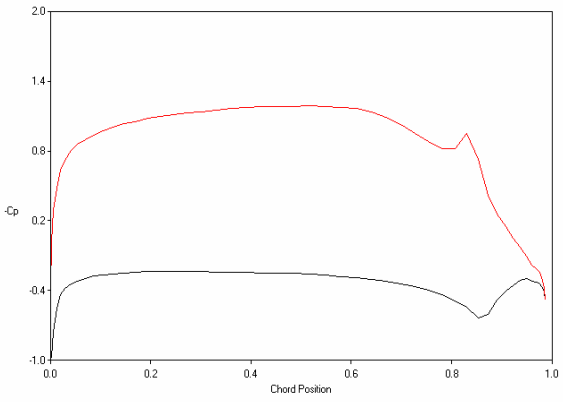
Loek Borman OSTIV 1995 Design and wind tunnel test results of a flapped laminar flow airfoil for Sailplane application.
D. Althaus Profilkatalog #2
Richard Eppler OSTIV 1999 Design Philosophies for sailplane airfoils with Flaps 1999
Richard Johnson Soaring magazine July 2003. Flight test evaluation of the HP 18.











UFR 2000 AOA -2 Flap +17

AH93k131-15 AOA -1 Flap +24

Lift-Drag Polar for URF-13mod Flap+17
Reynolds Number: 500000

Angle(Deg)	Cl	Cd	Cm	Up Tran(%c)	Lo Tran(%c)
-6.00	0.93586	0.009051	-0.182530	0.71	0.32
-5.00	1.01393	0.008772	-0.193650	0.68	0.50
-4.00	1.12166	0.008531	-0.197276	0.68	0.65
-3.00	1.22917	0.008622	-0.200842	0.68	0.71
-2.00	1.30631	0.009067	-0.211850	0.65	0.71
-1.00	1.41426	0.009382	-0.214963	0.65	0.71
0.00	1.48702	0.009692	-0.226649	0.65	0.74
1.00	1.57650	0.009909	-0.233891	0.65	0.74
2.00	1.69702	0.013244	-0.233074	0.47	0.74
3.00	1.77969	0.016630	-0.241384	0.29	0.74

Lift-Drag Polar for URF-13mod Flap +17
Reynolds Number: 1500000

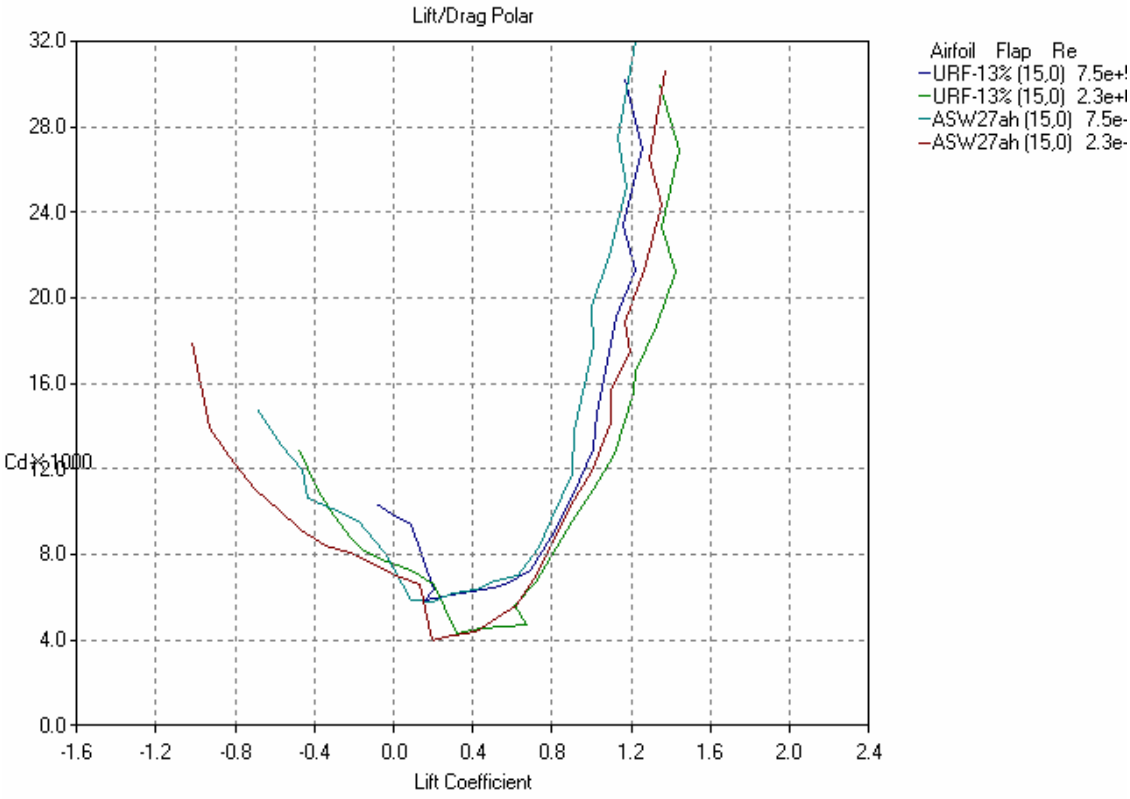
Angle(Deg)	Cl	Cd	Cm	Up Tran(%c)	Lo Tran(%c)
-6.00	0.96144	0.007043	-0.176133	0.71	0.14
-5.00	1.02524	0.006687	-0.190822	0.68	0.32
-4.00	1.13296	0.006275	-0.194451	0.68	0.53
-3.00	1.21701	0.006057	-0.203882	0.68	0.65
-2.00	1.32498	0.006418	-0.207181	0.65	0.71
-1.00	1.43268	0.006607	-0.210359	0.65	0.71
0.00	1.51525	0.006663	-0.219592	0.65	0.74
1.00	1.60342	0.007705	-0.227159	0.59	0.74
2.00	1.69452	0.011834	-0.233698	0.32	0.74
3.00	1.78011	0.014230	-0.241280	0.18	0.74

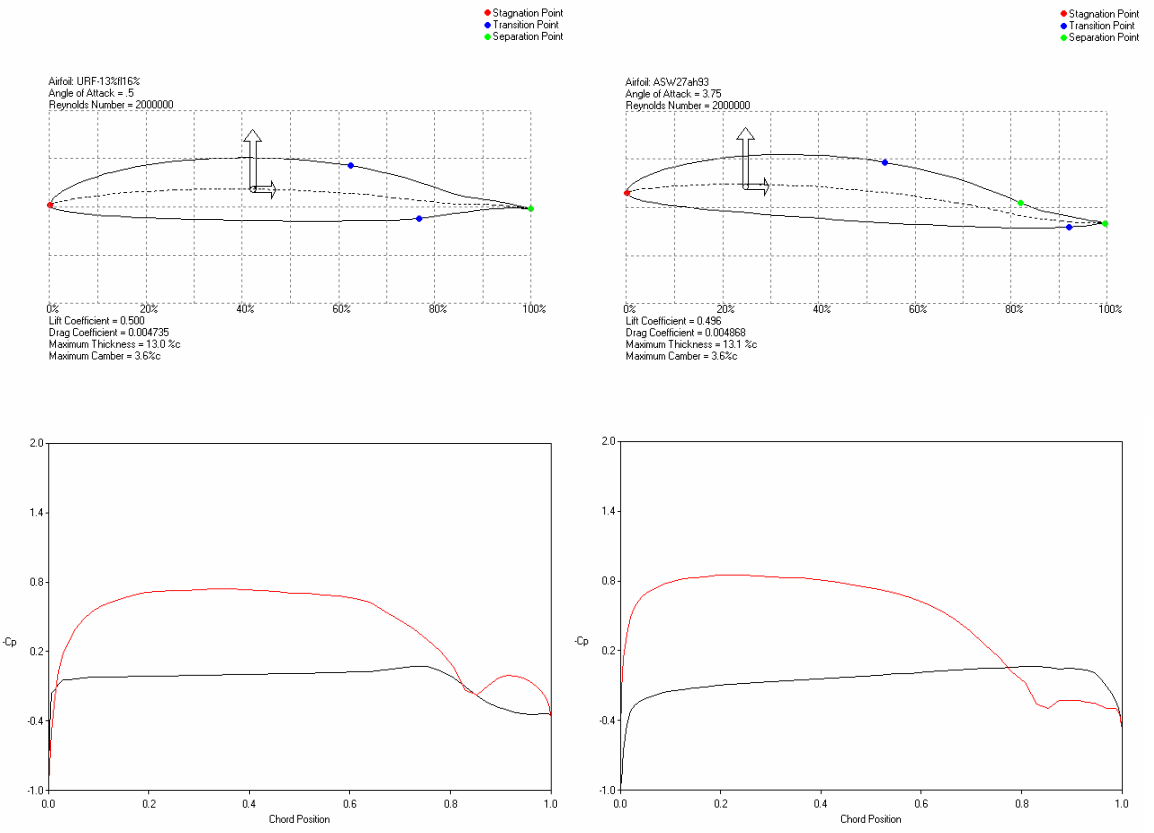
Lift-Drag Polar for ah93 13% Flap+24
Reynolds Number: 500000

Angle(Deg)	Cl	Cd	Cm	Up Tran(%c)	Lo Tran(%c)
-4.00	0.97720	0.009008	-0.265101	0.68	0.56
-3.00	1.05106	0.008843	-0.278680	0.68	0.62
-2.00	1.16700	0.009500	-0.281553	0.65	0.62
-1.00	1.28268	0.009795	-0.284271	0.65	0.65
0.00	1.39804	0.010204	-0.286804	0.65	0.65
1.00	1.51932	0.011071	-0.287559	0.62	0.68
2.00	1.61970	0.014212	-0.293200	0.47	0.68
3.00	1.69529	0.017783	-0.304665	0.26	0.71

Lift-Drag Polar for ah93 13% Flap +24
Reynolds Number: 1500000

Angle(Deg)	Cl	Cd	Cm	Up Tran(%c)	Lo Tran(%c)
-3.00	0.96598	0.006636	-0.299949	0.68	0.62
-2.00	1.09013	0.007162	-0.300771	0.65	0.62
-1.00	1.21399	0.007315	-0.301442	0.65	0.65
0.00	1.45114	0.007251	-0.273530	0.65	0.65
1.00	1.53832	0.009081	-0.282808	0.53	0.68
2.00	1.61970	0.012891	-0.293200	0.29	0.68
3.00	1.73879	0.016470	-0.293789	0.11	0.71





UFR Flap 0 deg

AH93 Flap +3.7

Lift-Drag Polar for URF-13%fl16%
Reynolds Number: 750000

Angle(Deg)	Cl	Cd	Cm	Up Tran(%c)	Lo Tran(%c)
0.00	0.28805	0.006121	-0.125130	0.62	0.77
1.00	0.39560	0.006243	-0.129015	0.62	0.77
2.00	0.50309	0.006404	-0.132854	0.62	0.77
3.00	0.58429	0.006704	-0.143170	0.59	0.77
4.00	0.69008	0.007236	-0.147205	0.56	0.77
5.00	0.79574	0.008803	-0.151099	0.44	0.79

Lift-Drag Polar for ASW27ah93
Reynolds Number: 750000

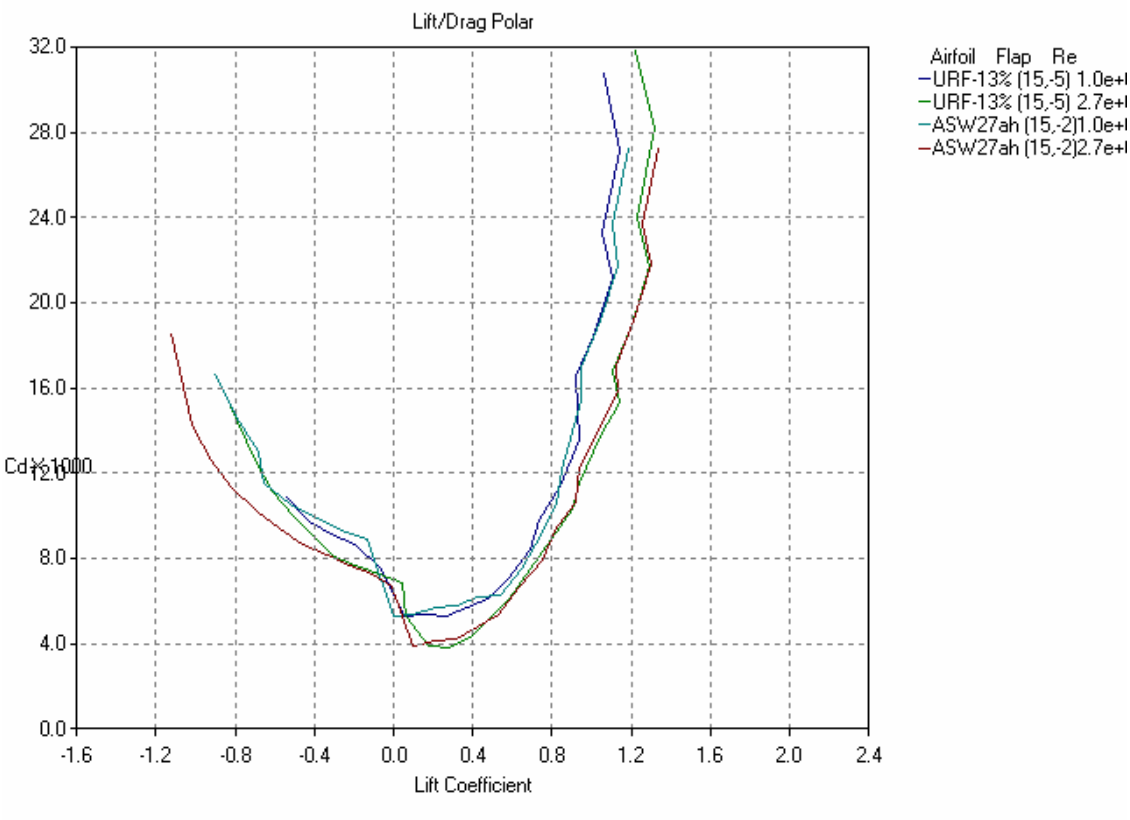
Angle(Deg)	Cl	Cd	Cm	Up Tran(%c)	Lo Tran(%c)
2.00	0.30280	0.006145	-0.027817	0.56	0.92
3.00	0.41224	0.006306	-0.032913	0.56	0.92
4.00	0.51498	0.006788	-0.039629	0.53	0.92
5.00	0.63089	0.006989	-0.042957	0.53	0.94
6.00	0.73257	0.008308	-0.049709	0.44	0.94
7.00	0.79531	0.009640	-0.066022	0.35	0.94
8.00	0.89982	0.011790	-0.071681	0.23	0.94
9.00	0.91222	0.013748	-0.100117	0.14	0.95

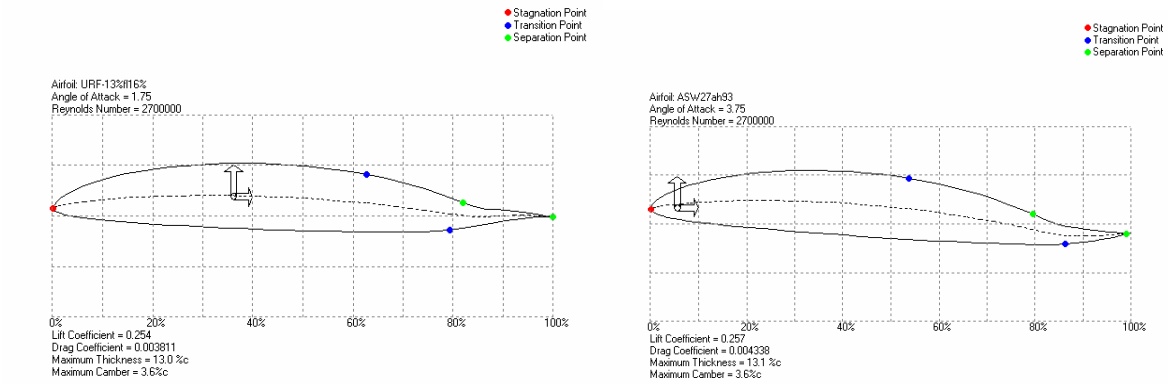
Lift-Drag Polar for URF-13%fl16%
Reynolds Number: 2250000

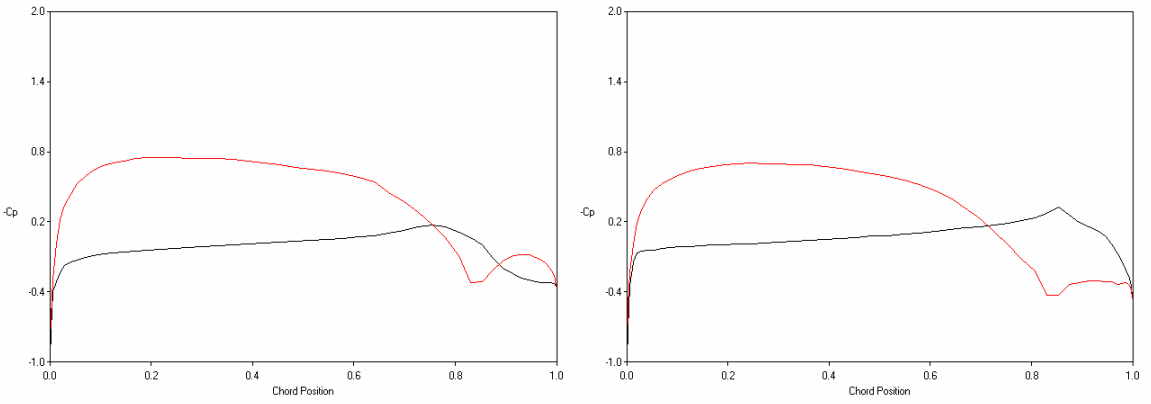
Angle(Deg)	Cl	Cd	Cm	Up Tran(%c)	Lo Tran(%c)
-2.00	0.20363	0.006609	-0.084658	0.65	0.11
-1.00	0.32219	0.004317	-0.085798	0.65	0.77
0.00	0.44071	0.004548	-0.086964	0.62	0.77
1.00	0.55915	0.004607	-0.088128	0.62	0.77
2.00	0.67365	0.004731	-0.090215	0.62	0.77
3.00	0.61051	0.005573	-0.136617	0.50	0.77
4.00	0.71781	0.006656	-0.140271	0.41	0.77
5.00	0.79574	0.007907	-0.151099	0.29	0.79

Lift-Drag Polar for ASW27ah93
Reynolds Number: 2250000

Angle(Deg)	Cl	Cd	Cm	Up Tran(%c)	Lo Tran(%c)
2.00	0.30314	0.004237	-0.027732	0.56	0.92
3.00	0.41343	0.004346	-0.032615	0.56	0.92
4.00	0.52365	0.004995	-0.037460	0.50	0.92
5.00	0.61878	0.005628	-0.045984	0.44	0.94
6.00	0.72722	0.007097	-0.051046	0.32	0.94
7.00	0.83551	0.009028	-0.055971	0.18	0.94







UFR Flap -5

AH93 Flap -2

Lift-Drag Polar for URF-13%fl16%
Reynolds Number: 1000000

Angle(Deg)	Cl	Cd	Cm	Up Tran(%c)	Lo Tran(%c)
0.00	0.05158	0.005298	-0.062394	0.62	0.77
1.00	0.15783	0.005343	-0.066659	0.62	0.77
2.00	0.26408	0.005316	-0.070937	0.62	0.79
3.00	0.37030	0.005654	-0.075198	0.59	0.79
4.00	0.47646	0.006060	-0.079410	0.56	0.79
5.00	0.58254	0.007122	-0.083541	0.47	0.79

Lift-Drag Polar for ASW27ah93
Reynolds Number: 1000000

Angle(Deg)	Cl	Cd	Cm	Up Tran(%c)	Lo Tran(%c)
0.00	-0.00270	0.005313	0.011192	0.59	0.86
1.00	0.10056	0.005353	0.004591	0.59	0.86
2.00	0.20967	0.005658	-0.000601	0.56	0.86
3.00	0.31877	0.005777	-0.005813	0.56	0.86
4.00	0.42782	0.006186	-0.011011	0.53	0.86
5.00	0.53679	0.006295	-0.016164	0.53	0.89

Lift-Drag Polar for URF-13%fl16%
Reynolds Number: 2700000

Angle(Deg)	Cl	Cd	Cm	Up Tran(%c)	Lo Tran(%c)
0.00	0.06548	0.005249	-0.058918	0.62	0.41
1.00	0.17329	0.003876	-0.062794	0.62	0.77
2.00	0.28109	0.003825	-0.066685	0.62	0.79
3.00	0.38886	0.004326	-0.070558	0.56	0.79
4.00	0.47646	0.005151	-0.079410	0.47	0.79
5.00	0.58254	0.006118	-0.083541	0.38	0.79
6.00	0.68852	0.007482	-0.087563	0.26	0.79

Lift-Drag Polar for ASW27ah93
Reynolds Number: 2700000

Angle(Deg)	Cl	Cd	Cm	Up Tran(%c)	Lo Tran(%c)
0.00	-0.00876	0.006655	0.009676	0.59	0.11
1.00	0.10161	0.003852	0.004855	0.59	0.86
2.00	0.21200	0.004116	-0.000019	0.56	0.86
3.00	0.32237	0.004199	-0.004912	0.56	0.86
4.00	0.42241	0.004753	-0.012362	0.50	0.86
5.00	0.53109	0.005348	-0.017590	0.44	0.89