Knowing your way around a polar

These figures, from Paths of Soaring Flight, show how the origin of the polar can be displaced for different wind and vertical montion conditions.

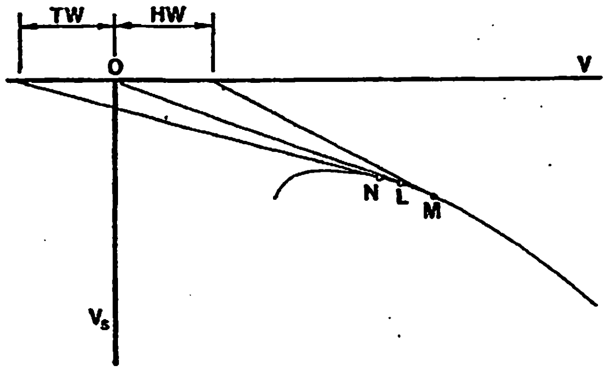


Fig. 12.7. Best speed to fly in the presence of a headwind (HW) or tailwind (TW).

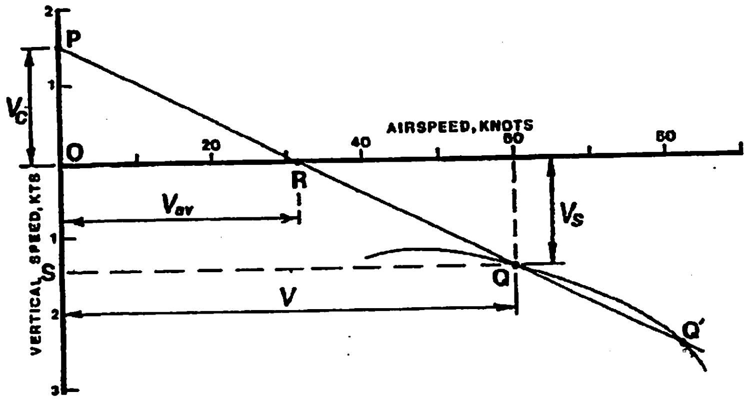


Fig. 8.3. Construction to show the average speed attained.

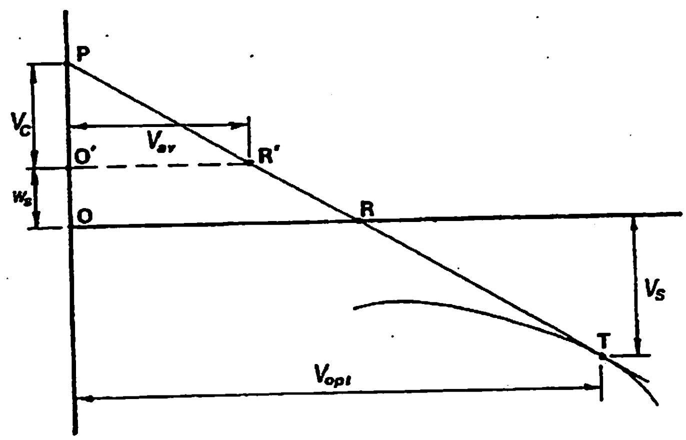


Fig. 8.5. Construction to show the maximum speed attained in the presence of a down-current.

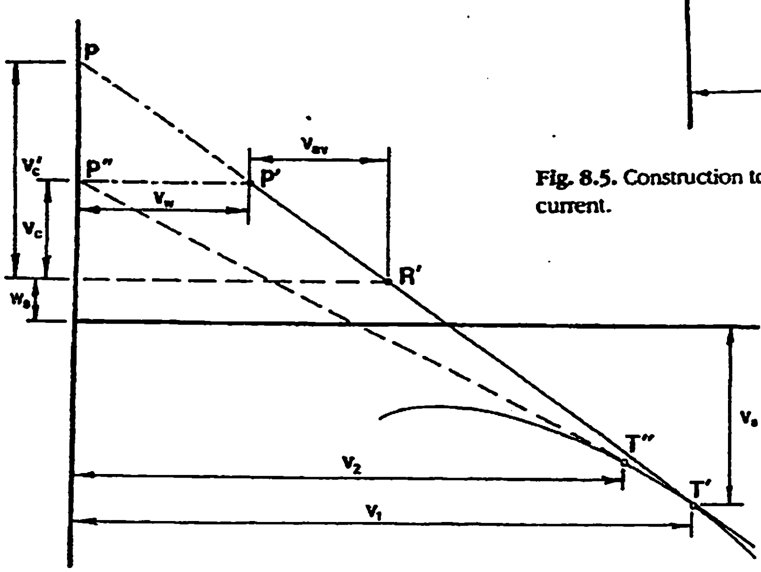
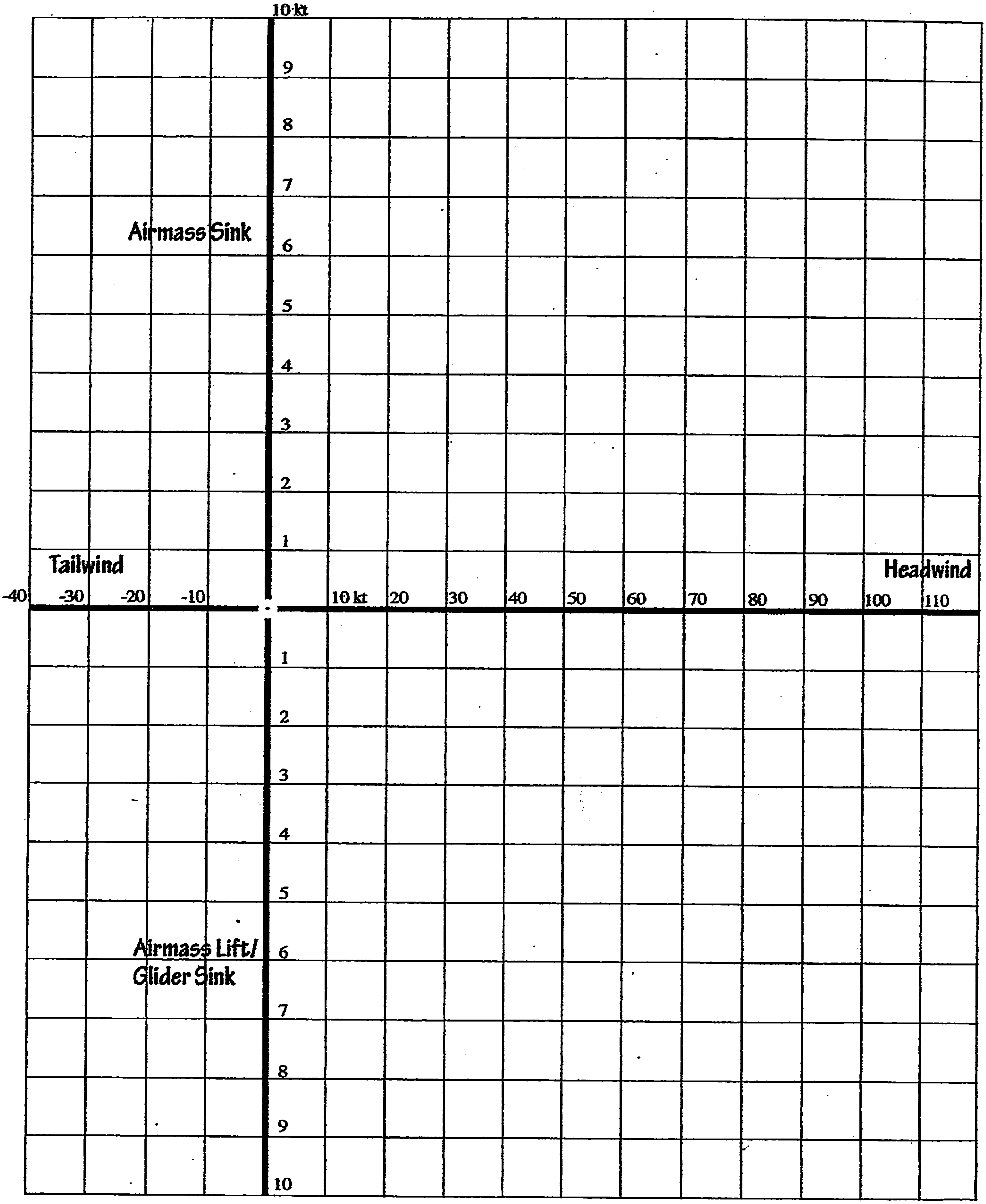


Fig. 12.9. Construction to give the best speed to fly for maximum average speed, using wave lift.

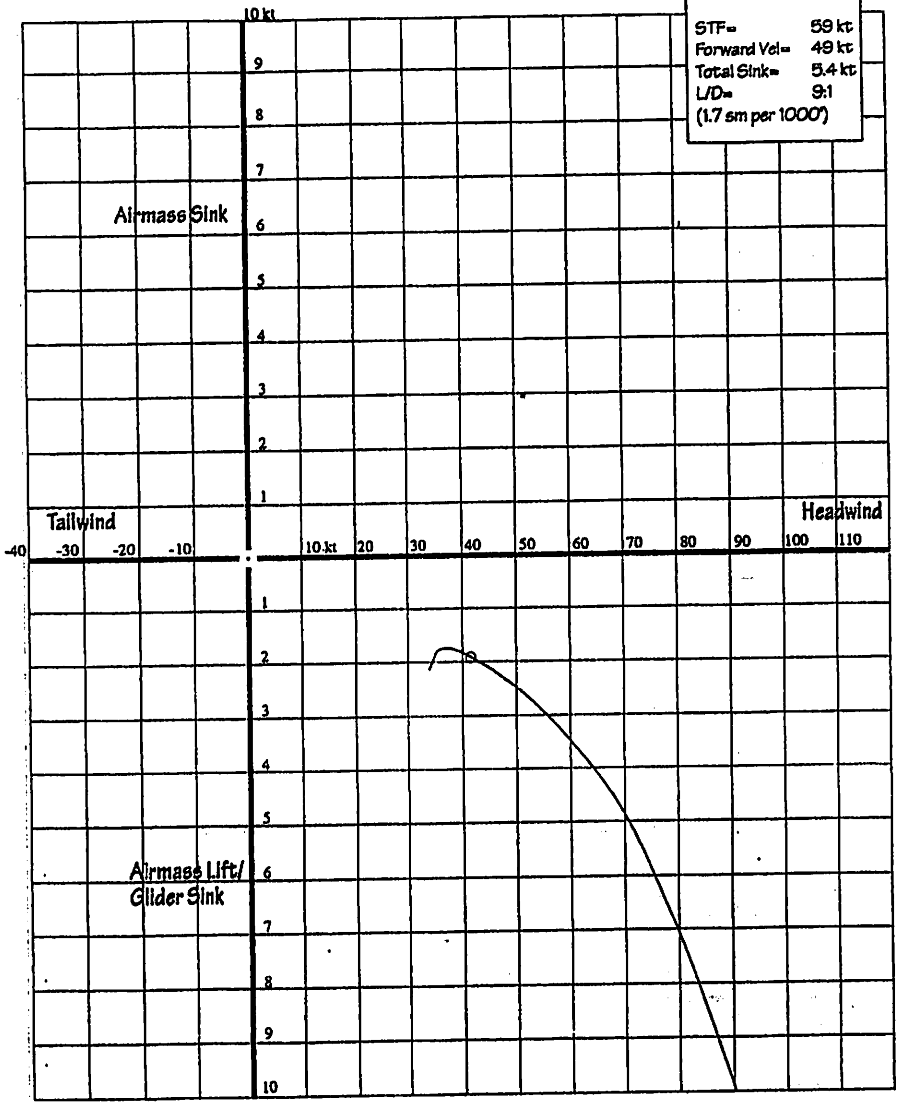


101 fpm = 1knot, 88fpm=1mph, 1.15mph= 1knot

Performance Group B— polar for 1-26e
Also suitable for Hall Cherokee and other short wing homebuilt sailplanes

STF Example
10 kt headwind
2 kt airmass sink

STF=	59 kt
Forward Vel=	49 kt
Total Sink=	5.4 kt
L/D=	9:1
(1.7 sm per 1000')	

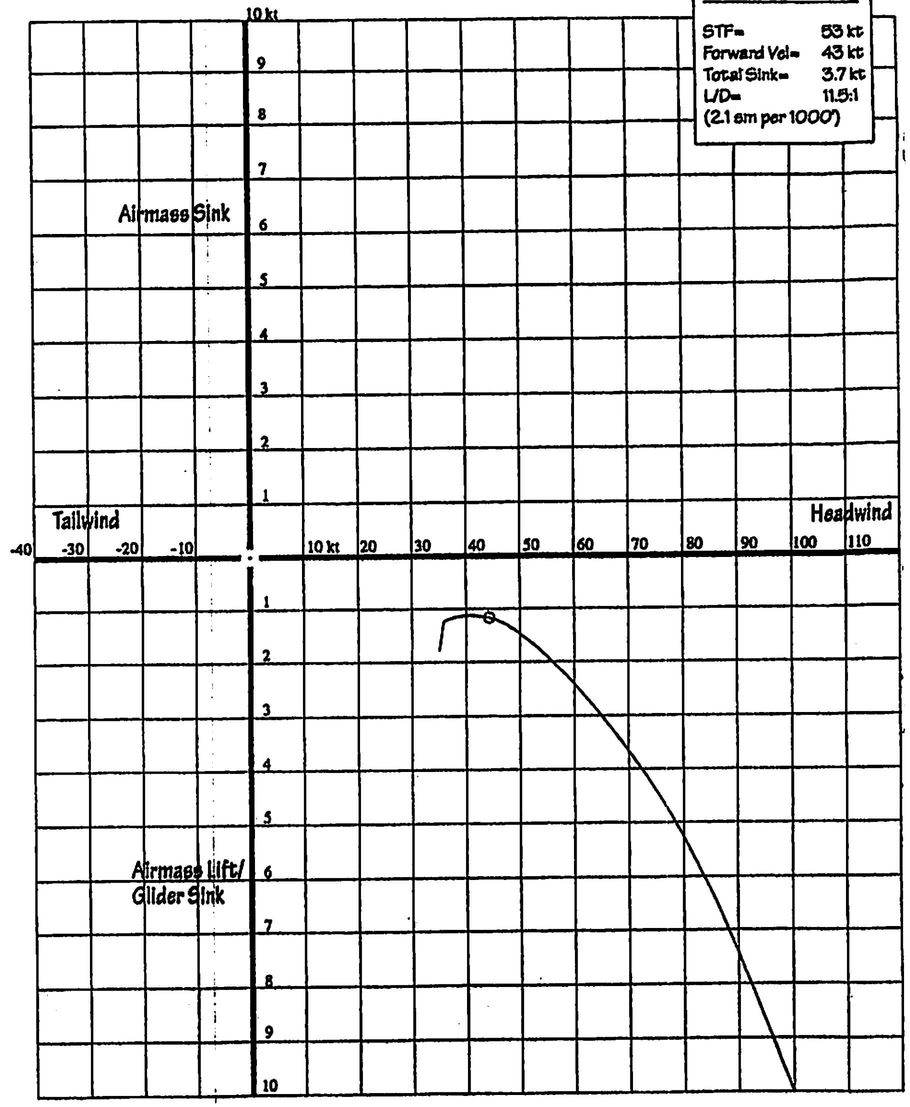


101 fpm = 1knot, 88fpm=1mph, 1.15mph= 1knot

Performance Group C— polar for K-6
Also suitable for PW-5, 1-36, L-13, SGS 1-34

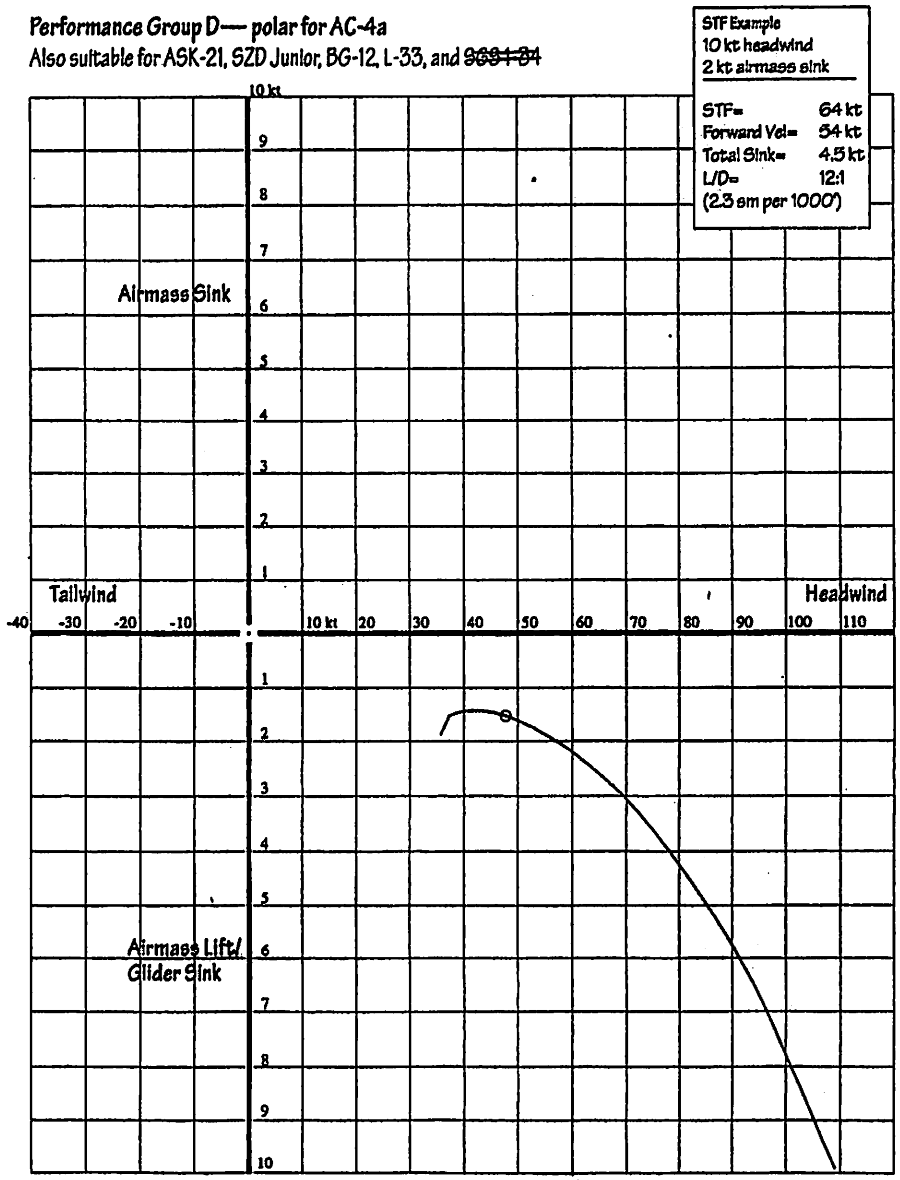
STF Example
10 kt headwind
2 kt airmass sink

STF=	53 kt
Forward Vel=	43 kt
Total Sink=	3.7 kt
L/D=	11.5:1
(2.1 sm per 1000')	



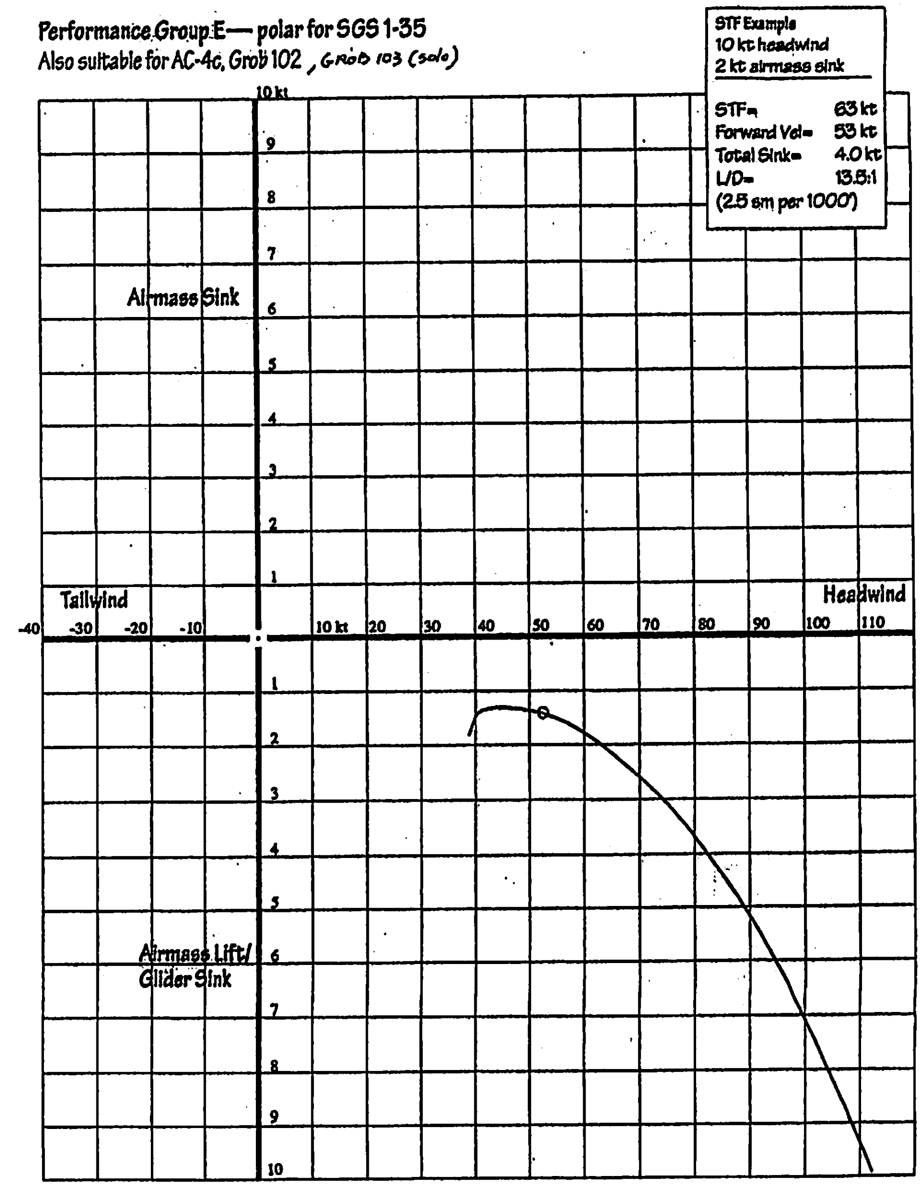
101 fpm = 1knot, 88fpm=1mph, 1.15mph= 1knot

Performance Group D— polar for AC-4a
Also suitable for ASK-21, SZD Junior, BG-12, L-33, and ~~SGS 1-34~~



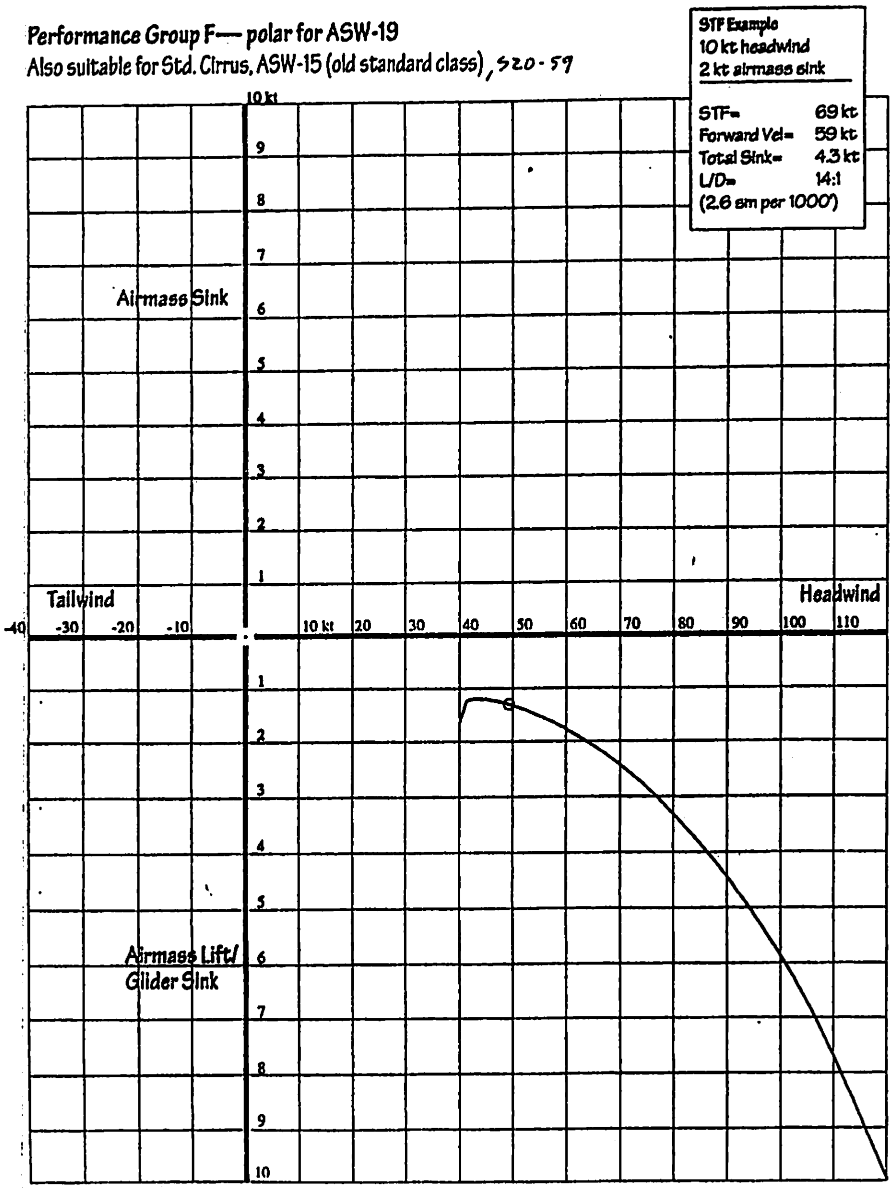
Turbulators and gap seals installed. Fairings not installed. No bugs. C.D. Herold and D. Johnson Data
101 fpm = 1knot, 88fpm=1mph, 1.15mph= 1knot

Performance Group E— polar for SGS 1-35
Also suitable for AC-4c, Grob 102 , Grob 103 (solo)



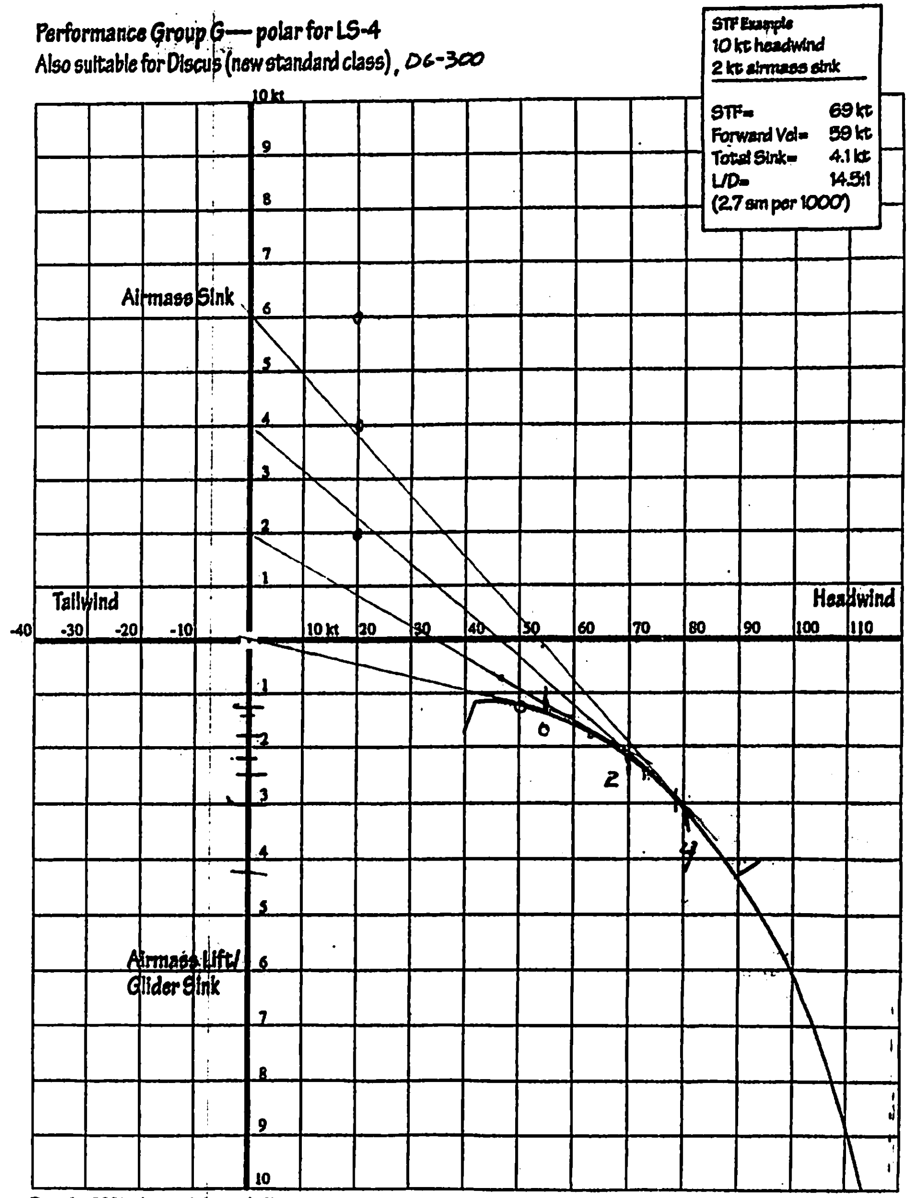
101 fpm = 1knot, 88fpm=1mph, 1.15mph= 1knot

Performance Group F— polar for ASW-19
Also suitable for Std. Cirrus, ASW-15 (old standard class), S20-59



Data for 200# pilot weight, no ballast
101 fpm = ... fpm=1mph, 1.15mph= 1knot

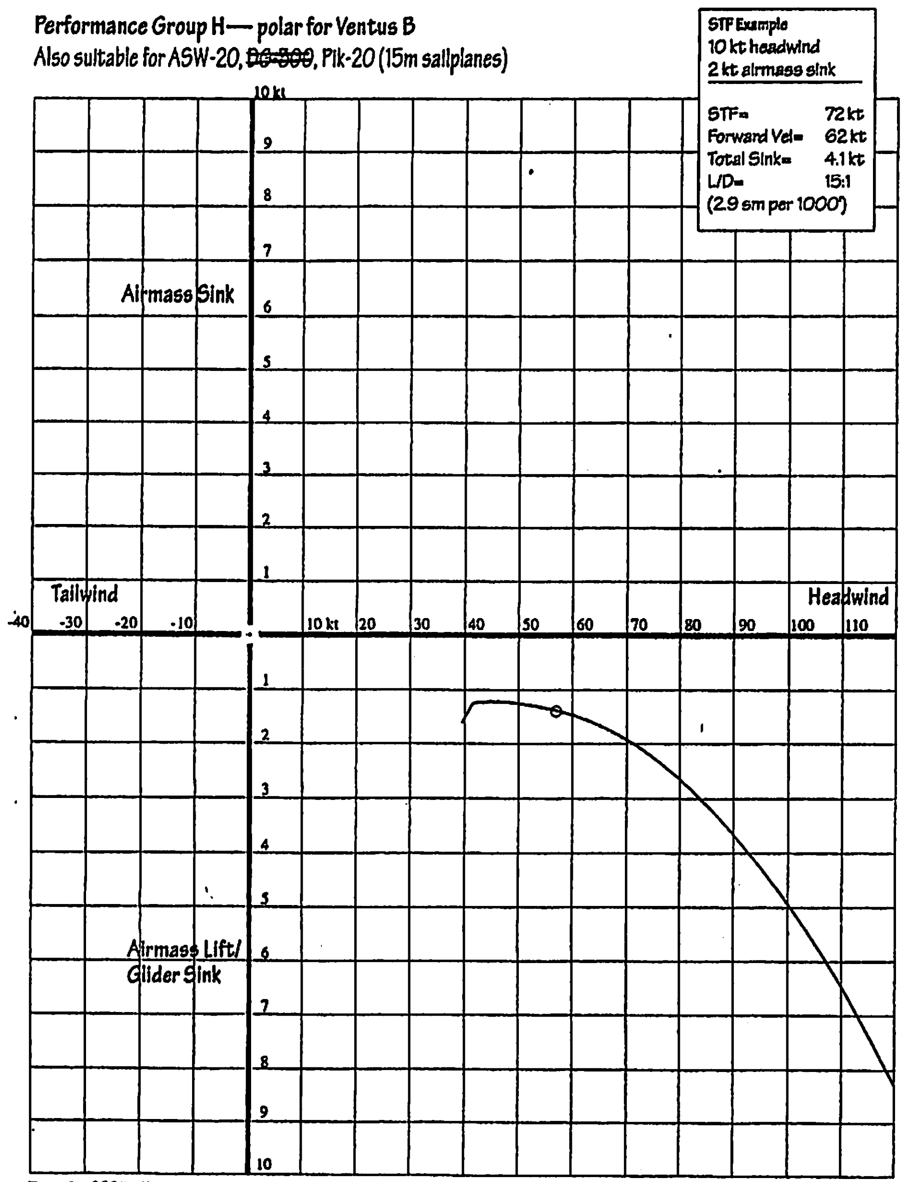
Performance Group G— polar for LS-4
Also suitable for Discus (new standard class), D6-300



Data for 200# pilot weight, no ballast
101 fpm = 1knot, 88fpm=1mph, 1.15mph= 1knot

Performance Group H— polar for Ventus B

Also suitable for ASW-20, ~~DG-300~~, Pik-20 (15m sailplanes)

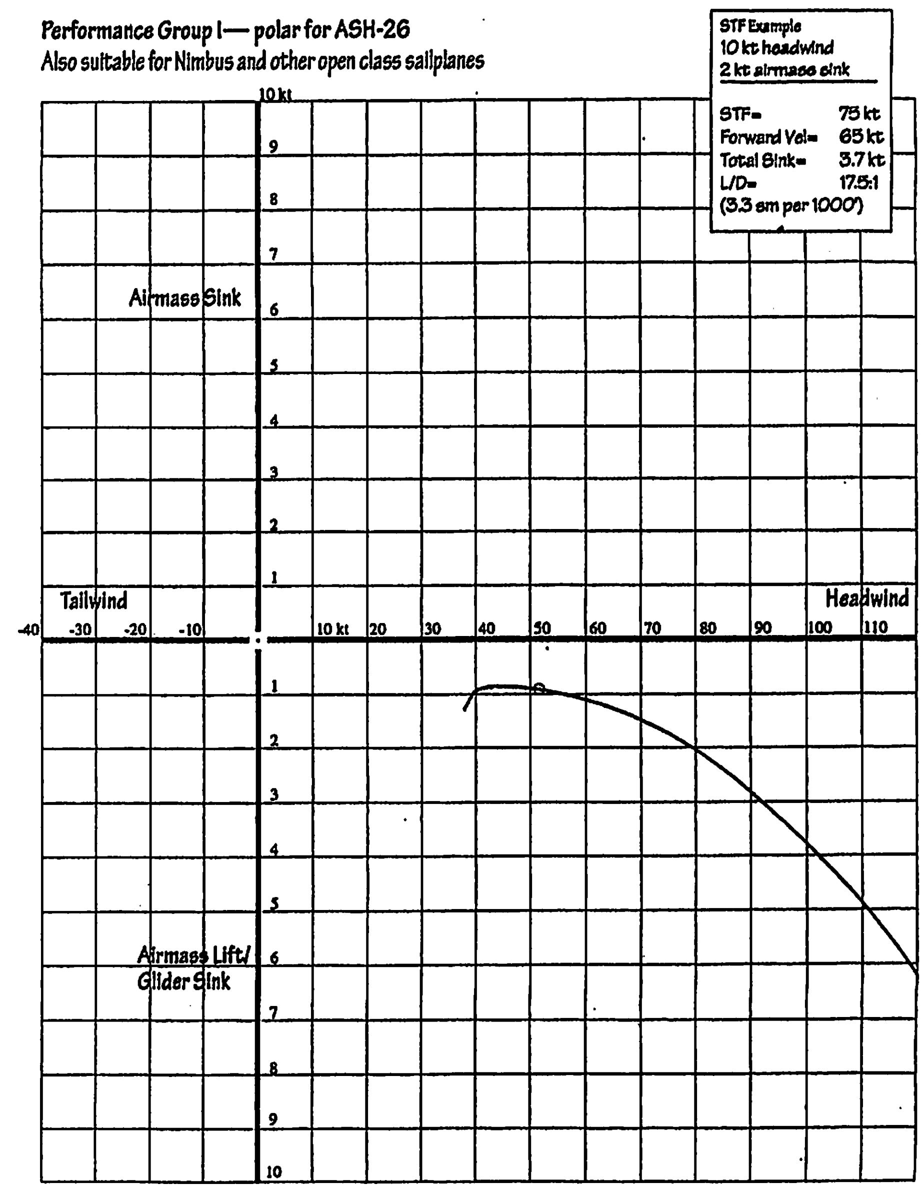


Data for 200# pilot weight, no ballast

101 fpm = 1knot, 88fpm=1mph, 1.15mph= 1knot

Performance Group I— polar for ASH-26

Also suitable for Nimbus and other open class sailplanes



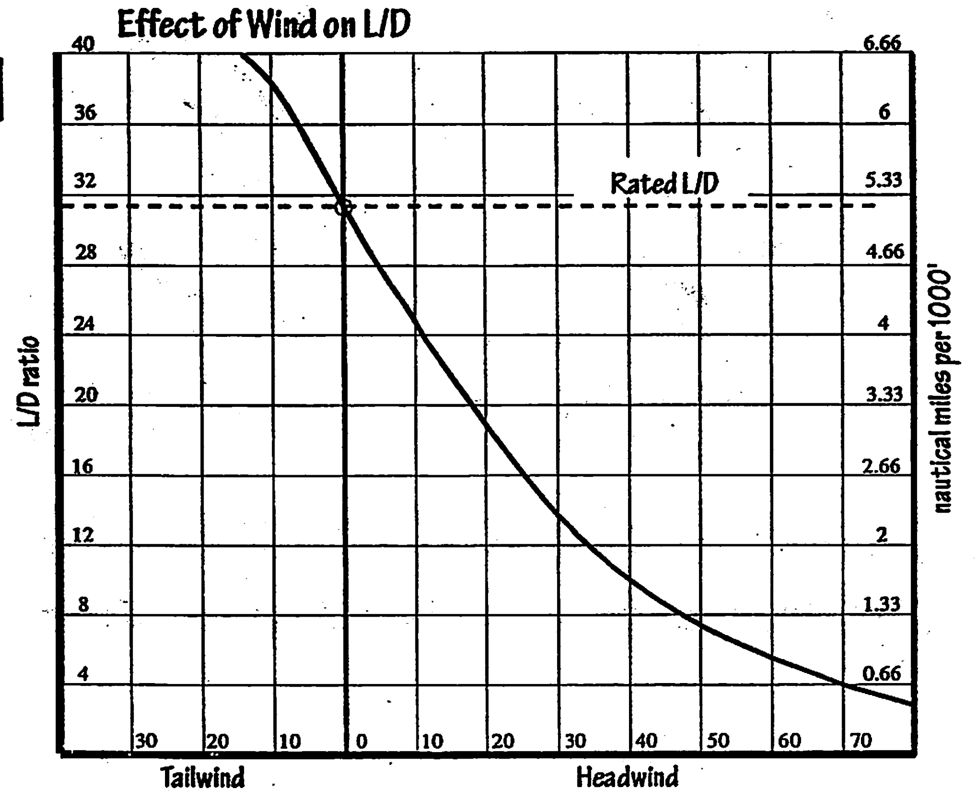
Data for 200# pilot weight, no ballast

101 fpm = 1knot, 88fpm=1mph, 1.15mph= 1knot

Effect of Wind

1. Again using the AC-4 as an example. Wind has a large effect on glide ratio, particularly on sailplanes with light wing loading. 20 knot headwinds are common, and substantially cut a glider's L/D ratio. For gliders with performance similar to the AC-4a, 18:1 or 3 nm per 1000 feet is a suitable conservative estimate of performance in real world conditions.
2. A common rule of thumb for headwinds is to add 1/2 the wind speed to the best L/D speed. This method is crude and will cost you performance. The best speed to fly for winds is shown with the solid line.
3. It is best to know a few MacCready speeds for common headwinds. Type them out and tape it to your panel or add to checklist. Every glider is different, but most performance curves will behave similarly.

1

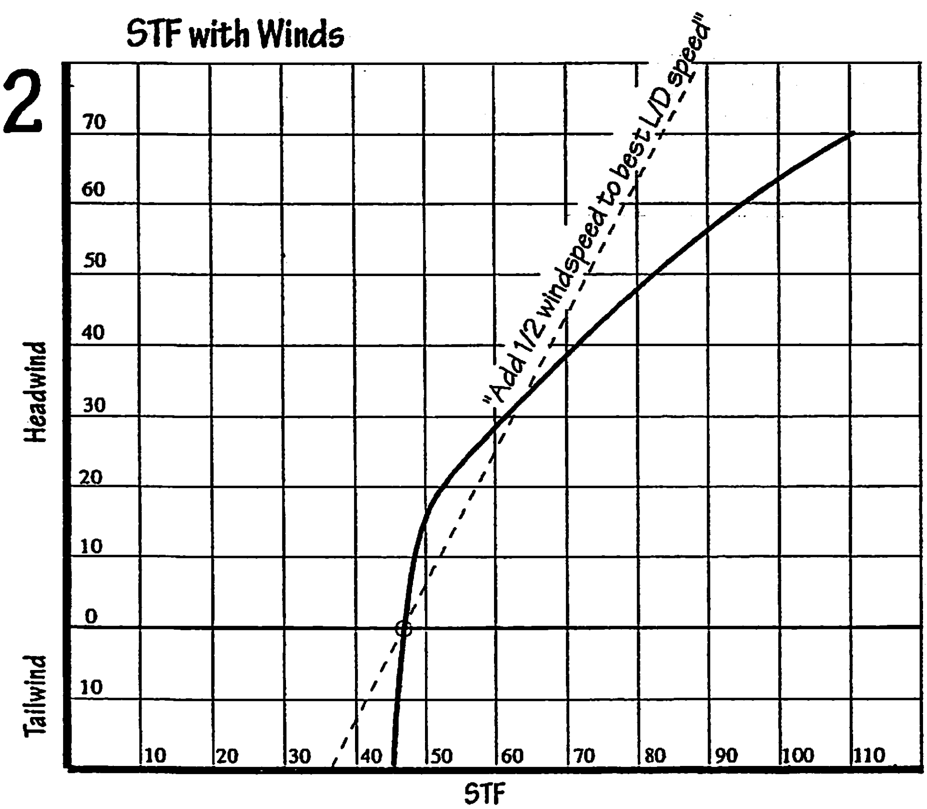


3

STF for headwinds	
10 kts	48 kt
20 kts	52 kt
30 kts	62 kt
40 kts	72 kt
50 kts	83 kt

Note:
STF for headwind is different than rules for approaches. It is commonly taught to add 1/2 the wind speed on landings to avoid stalls associated with gusts and shear.

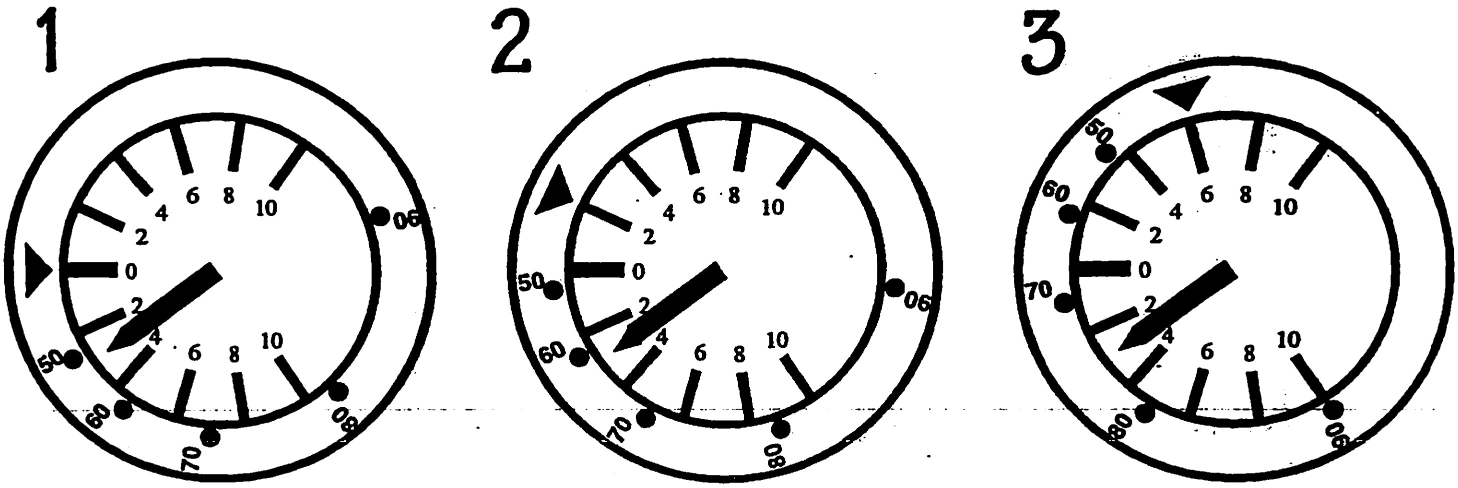
2



Note:
The polars and MacCready speeds here are for sea level temperature and pressure. At high altitudes, the effect of wind on sailplane performance is reduced. Use an E6b to convert true airspeeds to indicated airspeeds for higher density altitudes. For example, a 25 knot wind at 15,000' feels like a 20 knot wind.

Using the Speed Ring

1. Set the Speed Ring to 0. The 0 setting is the most conservative. Speeds flown with the zero setting are maximized for **distance efficiency**. In this example, 3 knot indicated sink (glider plus airmass) will direct the pilot to fly 52 knots. If increased sink is encountered, say 7 knot sink, the pilot is directed to fly 70 knots. Remember to ease up to the STF, don't chase the needle.
2. Here the pilot is anticipating 2 knot lift. 3 knot indicated sink will direct the pilot to fly 62 knots (10 knots faster than a 0 setting).
3. This brave pilot is expect ing 6 knot lift. 3 knot indicated sink will direct the pilot to fly 76 knots (14 knots faster than a 0 setting).



Remember the expected climb setting is the average achieved climb in the next thermal. Most pilots set the speed ring to a value lower than what they expect, thereby giving the pilot more time to look for lift, make decisions, and the corresponding lower speed allows a better glide path and lift sensitivity.

Speed Ring Settings of 0 are optimized for distance. Speed Ring Settings greater than 0 are optimized for speed and time. There is no advantage to setting the speed ring below 0.

Some Speed Ring Strategies

New XC pilots may want to start out with the speed ring set to 0. More accomplished pilots may want to set the speed ring at 1/3 to 1/2 the expected climb. For example, if the day is consistently producing 6 knot thermals, set the speed ring at 2 or 3 knots. Competition pilots set the speed ring at 1/2 to all of the expected climb.

Catagorize your speed ring setting by altitude. When close to cloudbase, set the speed ring at its full value. As you decend, set it to 1/2 the expected climb rate. And if you feel low, rotate the ring back to 0 to maximize gliding distance.

When under a cloud street, set the speed ring to the setting that gives you a constant altitude over the long run.

Set the speed ring to 0 whenever terrain clearance is a problem or you feel uncomfortably low.

Set the speed ring slightly higher with headwinds and slightly lower with tailwinds.

Set your speed ring slightly lower if you have numerous bugs on your leading edge or rain.

Back off on the recommended speed if you think you are approaching lift. This allows you to better feel the location of the next thermal.

If you are bumping into the base of clouds, set the speed ring higher. If you are arriving at thermals too low, set the speed ring lower.

Mix and match strategies to make MacCready theory work for you!

Speed to Fly Worksheet

Headwind= 0

airmass	STF		forward velocity	sailplane sink		total sink	L/D (forward vel. / sinkrate)
0 kt sink	______	-0 =	______	______	+0=	______	______
2 kt sink	______	-0 =	______	______	+2 =	______	______
4 kt sink	______	-0 =	______	______	+4 =	______	______
6 kt sink	______	-0 =	______	______	+6 =	______	______
8 kt sink	______	-0 =	______	______	+8 =	______	______
10 kt sink	______	-0 =	______	______	+10 =	______	______

Headwind= 20

airmass	STF		forward velocity	sailplane sink		total sink	L/D (forward vel. / sinkrate)
0 kt sink	______	-20 =	______	______	+0=	______	______
2 kt sink	______	-20 =	______	______	+2 =	______	______
4 kt sink	______	-20 =	______	______	+4 =	______	______
6 kt sink	______	-20 =	______	______	+6 =	______	______
8 kt sink	______	-20 =	______	______	+8 =	______	______

Headwind= 40

airmass	STF		forward velocity	sailplane sink		total sink	L/D (forward vel. / sinkrate)
0 kt sink	______	-40 =	______	______	+0=	______	______
2 kt sink	______	-40 =	______	______	+2 =	______	______
4 kt sink	______	-40 =	______	______	+4 =	______	______

Tailwind= 20

airmass	STF		forward velocity	sailplane sink		total sink	L/D (forward vel. / sinkrate)
0 kt sink	______	+20 =	______	______	+0=	______	______
2 kt sink	______	+20 =	______	______	+2 =	______	______
4 kt sink	______	+20 =	______	______	+4 =	______	______
6 kt sink	______	+20 =	______	______	+6 =	______	______

The penelty for flying too slow in sink or headwind conditions can be severe. For example, look at the L/D for a 6 knot sink condition and a 20 knot headwind. Now recompute the value, but instead of flying the MacCready recommended speed, fly 60 knots. What is the L/D ratio then?

6kt sink, 20 kt headwind: Using MacCready STF, L/D= ______ (from above) 60 knots, L/D= ______

Flying the recommended MacCready speed maximizes gliding distance. Flying a few knots slower than recommended STF imparts little penalty, but errors of ten knots or more will rob you of valuable L/D points.

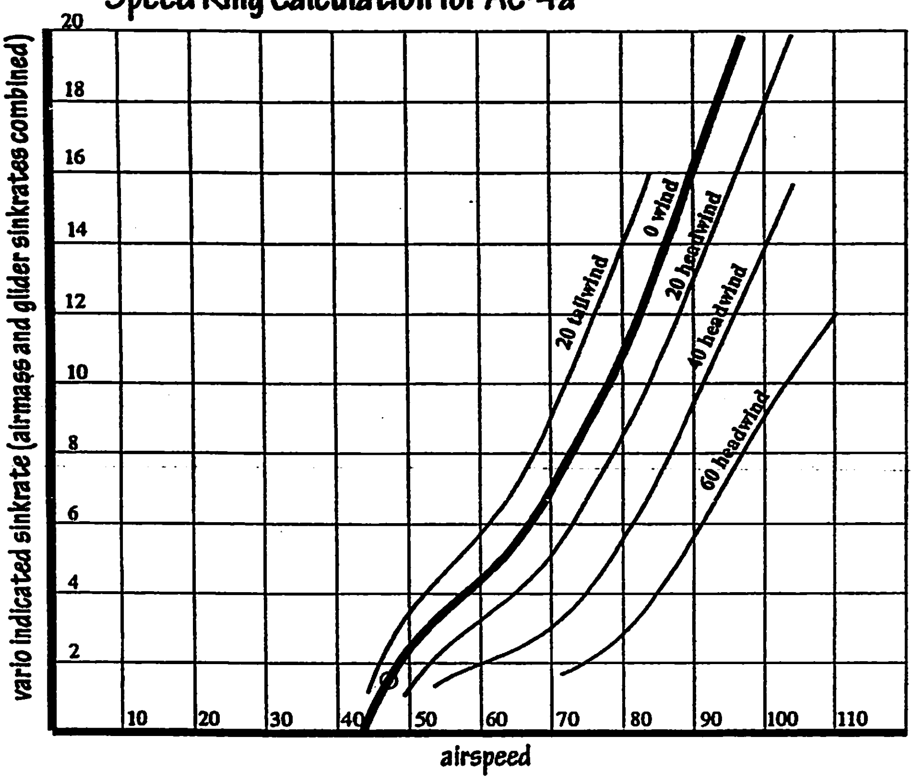
Making a Speed Ring

1. Let's use the AC-4 as an example. From the first table on the worksheet (for 0 knot headwind), we plot the STF against the **total sinkrate**, connecting the dots with a curve. We combine both the airmass sinkrate and glider sinkrate because this is what the variometer is sensing, unless you have a netto variometer. Curves for various headwinds and tailwinds are also shown for interest.

2. Then we pick off values for nice, even speeds of 50, 60, 70, 80, 90, and 100 knots. The corresponding vario indications are tabulated below.

1

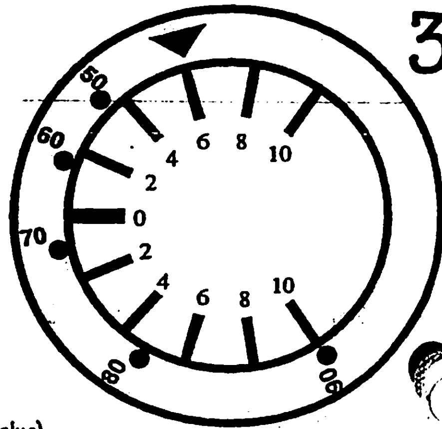
Speed Ring Calculation for AC-4a



2

Speed Ring Table no wind	
50 kts	2.5 kt
60 kts	4.4 kt
70 kts	7.0 kt
80 kts	10.8 kt
90 kts	16.0 kt

3



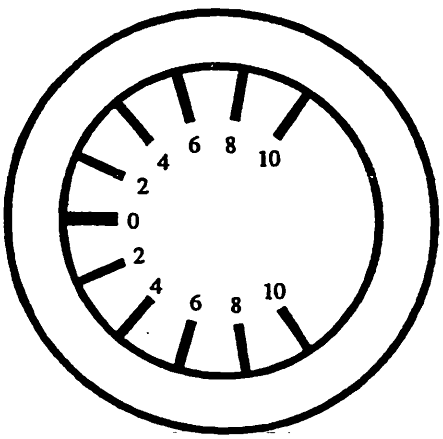
3. Put a triangle or some other symbol anywhere on your variometer's speed ring (this will be the expected lift value). Turn the ring to some high value that enables you to plot all of your speeds.

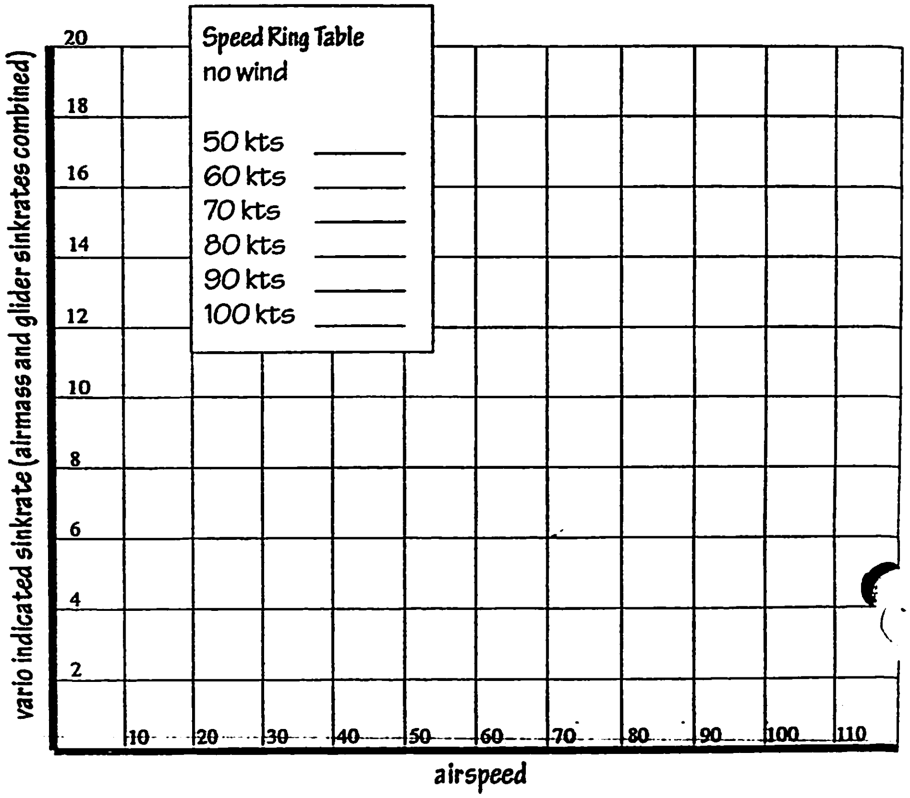
Count down from the triangle symbol 2.5 knots, and mark your 50 kt STF there.

Count down from the triangle symbol 4.4 knots, and mark your 60 kt STF there.

And so on.

Now try it for your sailplane type below.





Speed Ring Table no wind	
50 kts	______
60 kts	______
70 kts	______
80 kts	______
90 kts	______
100 kts	______

Speed to Fly Worksheet

Headwind= 0

airmass	STF		forward velocity	sailplane sink		total sink	L/D (forward vel. / sinkrate)
0 kt sink	______	-0 =	______	______	+0=	______	______
2 kt sink	______	-0 =	______	______	+2 =	______	______
4 kt sink	______	-0 =	______	______	+4 =	______	______
6 kt sink	______	-0 =	______	______	+6 =	______	______
8 kt sink	______	-0 =	______	______	+8 =	______	______
10 kt sink	______	-0 =	______	______	+10 =	______	______

Headwind= 20

airmass	STF		forward velocity	sailplane sink		total sink	L/D (forward vel. / sinkrate)
0 kt sink	______	-20 =	______	______	+0=	______	______
2 kt sink	______	-20 =	______	______	+2 =	______	______
4 kt sink	______	-20 =	______	______	+4 =	______	______
6 kt sink	______	-20 =	______	______	+6 =	______	______
8 kt sink	______	-20 =	______	______	+8 =	______	______

Headwind= 40

airmass	STF		forward velocity	sailplane sink		total sink	L/D (forward vel. / sinkrate)
0 kt sink	______	-40 =	______	______	+0=	______	______
2 kt sink	______	-40 =	______	______	+2 =	______	______
4 kt sink	______	-40 =	______	______	+4 =	______	______

Tailwind= 20

airmass	STF		forward velocity	sailplane sink		total sink	L/D (forward vel. / sinkrate)
0 kt sink	______	+20 =	______	______	+0=	______	______
2 kt sink	______	+20 =	______	______	+2 =	______	______
4 kt sink	______	+20 =	______	______	+4 =	______	______
6 kt sink	______	+20 =	______	______	+6 =	______	______

The penelty for flying too slow in sink or headwind conditions can be severe. For example, look at the L/D for a 6 knot sink condition and a 20 knot headwind. Now recompute the value, but instead of flying the MacCready recommended speed, fly 60 knots. What is the L/D ratio then?

6kt sink, 20 kt headwind: Using MacCready STF, L/D= ______ (from above) 60 knots, L/D= ______

Flying the recommended MacCready speed maximizes gliding distance. Flying a few knots slower than recommended STF imparts little penalty, but errors of ten knots or more will rob you of valuable L/D points.