ACCIDENTAL SPINS OFF WINCH LAUNCHES

Two recent fatal spinning accidents, the Club Libelle at Snitterfield and the Puchacz at Shalbourne (see the last issue, p262), have concentrated minds on the various factors which may have contributed. Here Bill Scull, BGA director of operations, reviews the work that has been done and the conclusions drawn

The first and fundamental point is that gliders can and do spin while still attached to the winch cable. Although such accidents are rare, perhaps one in a million winch launches, they are of very serious concern – as is any fatal accident.

Following the second accident (the Puchacz) the BGA issued a bulletin to all instructors stating that stalling speed is increased during a winch launch. The figure quoted was 41.4%, based on assumptions of weak link strength, the weight of the glider and wing lift being twice the normal (1*g*) value. However, it's not quite as simple as that.

The Puchacz had spun from the top of the launch and the Club Libelle at the beginning. As part of the investigation into the latter accident I sought the advice of Cedric Vernon of the BGA Technical Committee and a member of OSTIV. He produced a paper on the subject which identified the increase of stalling speed over a wider range of conditions, suggesting an increase in the order of 25 – 30% above the 1*g* value for the early part of the launch, assuming a climb angle of 45°.

Cedric involved Frank Irving who had devised a computer program on this very subject. Within three days Frank had drafted a paper based on the computer data for a typical Standard Class glider which forms the basis of this article. By dint of burning some midnight oil, another three days or so saw the paper and diagrams ready for circulation. But to whom? Technical papers inevitably contain at least some mathematics which may not aid the comprehension by the average glider pilot. Worse still it may confuse them and/or fail to get the message across.

Nevertheless, a proper understanding that the stalling speed increases during a winch launch is fundamental knowledge for every pilot and instructor. So the following represents what Frank describes as a "sanitised" version. Even so there is a basic explanation of the relevant factors.

The balance of the forces acting may help your understanding. The vertical component of the lift has to balance three things, the weight of the glider, the downward component of the cable load and the vertical (downward) component of the drag. To determine the lift requires the resolution of forces, conveniently with a computer program.

The main point is that the lift is increased by a significant amount and the stalling speed by the square root of this figure, due to the speed-squared function in the equations. The extra lift required is being demanded of the glider's wing by the pilot in order to balance the cable's pull and stabilise the launch. At any given speed this places the glider closer to the stall boundary, in just the same way as if a pullout or steep turn was being made. However, unlike the pullout or turn the extra wing load, normally felt by the pilot as g, is not present as it is reacted by the cable. Thus the pilot only has the climb angle and the control feel to judge the situation.

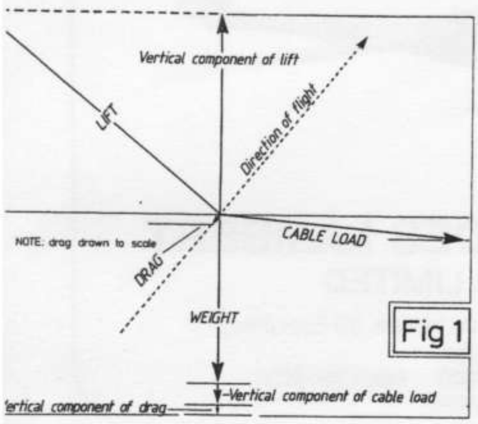

Fig 1

For example, Fig 1 shows the forces acting on a glider during the early part of the launch, with a cable angle of 5°. If the pilot demanded a flight path (climb) angle of 50° the lift would exceed that available at any speed up to 49kt. Thus 49kt is the stall speed in this condition. These figures may be typical of the Club Libelle accident.

Clearly, the speed at which the lift demanded exceeds that available is highly dependent on both the cable angle and the flight path angle. The full picture can be created from the computer program. From the information given in Fig 2 you can pick out various values. For example, the glider will come to the point of stall at 47kt and 47°, for the same cable angle of 5°. Flight path slope is the direction in which the glider is going at any instant and is not to be confused with the angle of attack or any other angles!

More importantly, above a speed of 49kt, if the climb is steepened beyond the critical 50° or so, the weak link will break (causing different problems). It seems evident that stalling/spinning on the winch launch is more dangerous than breaking a weak link which leads to the suggestion that there is a *minimum winch launch speed.*

It is important you understand this graphical presentation because there is more information to be gained from it. The first is the consequences of using too strong a weak link, say the next one up, 600kp rather than the correct 500kp. Although the glider would have to have a flight path slope of about 55C, which you might regard as inconceivable, the minimum safety speed would have to be increased to 53kt. Incidentally, for anyone who is interested there is a sample computer print-out at the end of this article, the figures are for a speed of 49kt (Table 1).

TABLE 1
LAUNCH

A program by Frank Irving to find the load factor, cable tension, wing root bending moment and drag for a glider during a launch. Steady-state conditions are assumed.

In the tables below, the load factor is the ratio of the lift to the weight. The cable tension is expressed in multiples of the glider weight, and the wing root bending moment is expressed in multiples of its value in 1*g* flight. The dimensionless speed is the ratio of the actual speed to the speed for max L/D in 1*g* flight.

Max Lift/Drag ratio = 39
Ratio of wing weight to total weight = 0.4
Spanwise location of wing C of G/semispan = 0.35
Dimensionless speed = 0.961
Slope of the cable to the horizontal = 5°

Flight path Slope (deg)	*Load Factor*	*Cable Tension*	*Wing Root BM*	*Lift/Drag Ratio*
10.000	1.039	0.208	1.065	38.733
15.000	1.070	0.305	1.122	38.580
20.000	1.113	0.409	1.198	38.332
25.000	1.168	0.524	1.297	37.948
30.000	1.239	0.651	1.423	37.372
35.000	1.331	0.796	1.583	36.533
40.000	1.450	0.967	1.787	35.344
45.000	1.607	1.174	2.050	33.701
50.000	1.819	1.436	2.399	31.482
50.200	1.829	1.448	2.416	31.379
50.300	1.834	1.454	2.424	31.327

Max Lift/Drag ratio = 39
Ratio of wing weight to total weight = 0.4
Spanwise location of wing C of G/semispan = 0.35
Dimensionless speed = 1.275
Slope of the cable to the horizontal = 5°

Flight path Slope (deg)	*Load Factor*	*Cable Tension*	*Wing Root BM*	*Lift/Drag Ratio*
10.000	1.039	0.210	1.066	35.397
15.000	1.071	0.307	1.123	35.834
20.000	1.113	0.411	1.199	36.365
25.000	1.169	0.524	1.298	36.967
30.000	1.239	0.651	1.423	37.606
35.000	1.330	0.794	1.581	38.225
40.000	1.446	0.962	1.781	38.735
45.000	1.599	1.164	2.038	38.995
50.000	1.803	1.417	2.375	38.791
50.800	1.842	1.463	2.439	38.696
50.900	1.847	1.469	2.447	38.683
51.000	1.853	1.475	2.455	38.670
55.000	2.088	1.749	2.835	37.809
55.100	2.095	1.757	2.846	37.779
55.200	2.102	1.764	2.856	37.748

Here I must digress to a practical point. During the initial acceleration phase of the launch (from

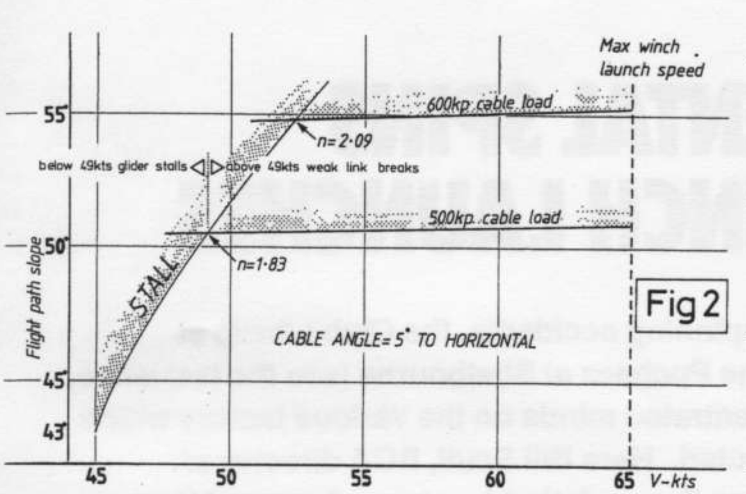

Fig 2

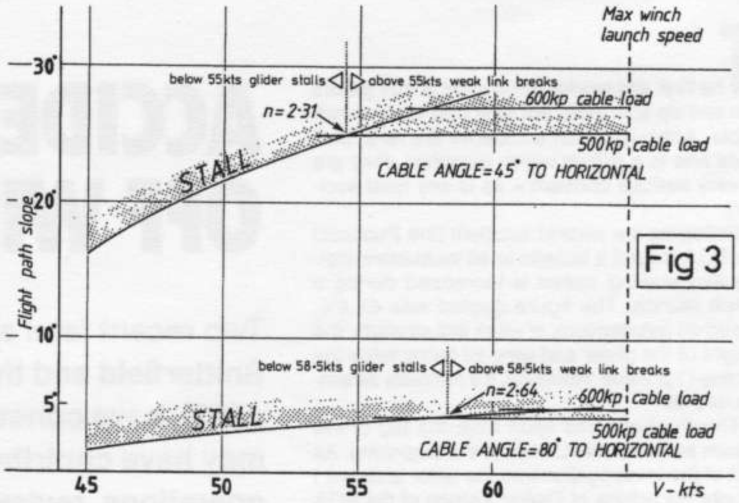

Fig 3

take-off until a steady speed is achieved) there is a marked nose-up pitching tendency from the pull of the cable. This is evident from the forward stick movement needed to counteract it. In some gliders the stick may be on the front stop and the nose is still rising! Even though the situation stabilises quite quickly accidents seem to confirm the critical figures.

It is equally interesting to note that a letter from Glasflugel, in 1975, recommended winch launch speeds for the Club Libelle of 54 to the maximum 65kt and abandoning the launch if the speed fell below 46kt. It is probable that these figures apply to many of the modern GRP gliders.

Returning to the theory it will be evident that there are other cases to examine, notably for different angles of the cable to the horizontal. Fig 3 gives two cases, 45 and 80°; it should be noted that the latter figures is 5° more than the value in the design requirements, JAR 22. Again a minimum safety speed can be established:

- For a cable angle of 45° to the horizontal the glider could be stalled at 50kt and a flight path slope of a little over 20°. The minimum safety speed is 55kt.
- Even at a cable angle of 80° to the horizontal, the very top of the launch, the glider could stall at a flight path slope of less than 5°.

The second of these cases seems to fit the circumstances of the Puchacz double fatality. Both the gliders involved have interesting spinning characteristics and so it is worth returning to the practical aspects again. This time the entry into the spin.

Most pilots will be used to entries from an under-banked, over-ruddered turn, with a near-normal nose attitude. You may have entered a spin from a well-banked turn, 45° or so; this is a standard training demonstration. But have you ever entered a spin from a near-vertical dive? Probably not. But this circumstance arises after a spin when pulling out of the subsequent dive too abruptly. The result? A spin in the opposite direction! This too happened to the Puchacz.

Now, let's stretch you imagination a bit further. Have you ever entered a spin from a steep nose-up attitude? No, of course not because you're reading this article.

The thing to appreciate is that the entry and the spin are potentially disorientating, and particularly so from an unusual attitude, say steeply nose down or nose up; either represents a 'flick' manoeuvre of the sort you see in aerobatic displays. In the glider winch launch case the stall is 'accelerated' due to the pull of the cable. Of course, equally fundamental is the height needed for recovery; on a winch launch there may not be enough.

In Summary

For the many pilots this detailed information is probably new and the implications are obvious.

1. Climbing too steeply at the start of launch incurs the risk of stalling then spinning, a flick manoeuvre from which recovery is impossible.
2. The stalling speed increases during the winch launch by as much as 25 – 30% above the normal (1*g*) value. At low level the best protection is a minimum safety speed, 50kt for a typical Standard Class glider and more for gliders with higher wing loadings..
3. The use of a stronger-than-specified weak link means the glider can stall at even higher speeds. The wing bending loads are also increased substantially, near to critical values in the worst case.

References:
1. "Stalling speed during a winch launch" By C.O.Vernon (unpublished); 2. "Variation of stalling speed on the winch launch" by F.G. Irving (to be published as an OSTIV paper) and 3. Letter from Glasflugel dated June 3 1975.