SAFE ROTATION

The BGA safety team reminds us of the vital importance of understanding the detail of a winch launch

AEROBATIC display pilots are given individual display authorisations that specify the minimum height at which they may perform aerobatic manoeuvres. The lower this level, the more demanding the authorisation requirement, because there's a narrower margin in which to recover from any power failures or errors. The lowest limit is generally 200ft above the airfield.

Yet glider pilots perform what's akin to an aerobatic manoeuvre* every time they rotate into a winch launch. It's vital to understand the detail.

Winch launch rotation

Rotation from the level attitude in which we leave the ground to the steep nose-high attitude of the full winch climb resembles the beginning of a loop. In both the aerobatic loop and the winch launch, the curved flight path accelerates the glider upwards, pressing the pilot into the seat.

The loop begins at an elevated airspeed to ensure that the glider has enough energy to keep flying at the top. It is tight enough for the accelerometer to read 3g, meaning that the lift generated by the wings not only overcomes 1g gravity, but also provides 2g of centripetal acceleration towards the loop's centre. The stall speed in this state will be 70 per cent above that in level flight (Vs), but well below the typical loop entry speed of 2.5 Vs [2]. Pilots nonetheless take care to avoid stalling as the airspeed falls.

In contrast, rotation into the full winch climb begins at a much lower airspeed – typically 1.5 Vs [3]. As well as generating enough lift to overcome gravity, the wings must balance a component of the cable tension and, as in the loop, they must also provide centripetal acceleration to steepen the climb angle. This acceleration, though much lower than in a loop, is important.

While the steady forces during winch launches have long been understood [4], the significance of centripetal acceleration has been appreciated only more recently [5,6]. In the decades before the BGA Safe Winch Launch initiative in 2005, winch launches were the largest source of serious gliding accidents in the UK, averaging around one fatality and two serious injuries a year. Analysis of accident records identified flick rolls during rotation as an important cause. Although relatively rare, such accidents were nearly always serious and, between 1987 and 2004, seven pilots were killed and nine badly injured. Pilots were rotating into the full climb too quickly.

Raising the glider's nose by 40° in two seconds at 55kts requires a 1g centripetal acceleration [7] – equivalent to doubling the glider's weight. A cable tension component readily takes the overall load factor to 2.25g and the stall speed to 1.5 Vs. With its nose high in the air, the glider will undergo an accelerated stall that could develop into a flick roll. No aerobatic pilot would attempt this so close to the ground.

The BGA Safe Winch Launch guidance, to take at least five seconds to rotate to the full

*** CAP1724 [1] identifies any flight at a pitch angle above 30° as aerobatic**

■ Clubs can obtain printed copies of Safety Briefings from the BGA Office.

Below: K-21 launching (Mark Layton)

climb with a typical pitch angle of 35°, limits the centripetal loading to around 0.3 g and keeps the airspeed well above the stall. Since this revision to our training in 2005 [8], there has been only one serious UK accident in the rotation stage of the winch launch.

Launch failure recovery

Recovery from a launch failure after the glider has rotated into the climb requires the nose to be lowered promptly. This causes the glider to perform a bunt that trades some of its airspeed for height before accelerating downwards. The pilot experiences reduced or negative g, which can be disconcerting but reduces the risk of a stall, though it is important to retain enough airspeed for control authority.

From a 35° full climb at 55kts, a prompt 0g 'weightless' push-over would take just 1.6 seconds to reach a zenith 40ft higher, with a 10kt drop in the airspeed. Pilots' reactions, however, are not immediate. If the climb attitude is maintained for just 1 second, the minimum airspeed will be only 36kts and, although the attitude will look normal, the glider could stall in level flight. The push-over must therefore be continued to an appropriate recovery attitude and this then maintained until manoeuvring speed has been regained.

To recover from the nose-down attitude, the glider must then perform another positive g manoeuvre. Attempting this, or a steep turn, with insufficient airspeed will again result in a low accelerated stall.

Accidents from low launch failures between 1987 and 2004 seriously injured nearly one pilot a year.

Technical analysis of low-level launch failures reveals a further reason why a prompt and positive reaction is crucial. Maintaining the climb attitude or pushing over less vigorously slows the glider's horizontal motion, making the downward pitch angle steeper for a given airspeed and requiring a tighter pull-out to recover.

The BGA Safe Winch Launch guidance ensures that the glider always has enough height and airspeed for a safe recovery, provided this is started promptly and conducted correctly. Since its introduction, there has been only one serious injury from a low launch failure.

Safe winch launch rotation

Our current generation of glider pilots may be unaware of the accidents we had until 15 years ago, and others may have forgotten or not fully understood the reasons for them. If we're to maintain our recent safety record, it's crucial that we continue to follow the Safe Winch Launch guidance [9,10].

The recipe for a safe rotation into the full winch climb is:

- Leave the ground in a level attitude.
- Maintain a shallow climb (10-15°) until you have attained adequate airspeed (at least 1.5 Vs) with continuing acceleration.
- Rotate the glider smoothly ensuring that the transition from level flight to the full climb is controlled, progressive and takes at least five seconds.
- If the launch fails, immediately lower the nose to an appropriate recovery attitude and don't manoeuvre or use the airbrakes unless a safe speed has been attained.

These succinct guidelines merit a little amplification:

- Just as for an aerotow, the level starting attitude is with the glider balanced on the mainwheel during the ground run.
- Don't hold the glider down: a shallow but positive initial climb allows height to be gained without rotation or significant pitch, and provides a cable load that keeps the parachute from inflating.
- A higher airspeed may be appropriate before starting rotation when it's windy to ensure that you can penetrate the wind gradient in a launch failure recovery [11].
- The recovery attitude will vary with the conditions: steeper in a wind gradient if there's enough height, and shallower if the glider is close to the ground.

The winch launch is not, however, a manoeuvre that can be flown 'by numbers': it requires knack and feel, as well as prompt and accurate responses if something goes wrong. For this reason it's not taught until pilots have mastered fundamental flying skills, and the early part of the launch is not attempted until pilots have gained some feel from flying the later stages.

It's not really an aerobatic manoeuvre either, so please don't try to make it into one.

Tim Freegarde and the BGA safety team

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Why It Is Good to Think Ahead (Aug/Sep 19)
The Effects of Wind Gradient (Oct/Nov 19)
A Fun but Safe Introduction (Dec 19/Jan 20)
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Avoiding Upset (Apr/May 20)
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Cockpit muddle (Aug/Sep 20)

GLIDER PILOTS PERFORM WHAT'S AKIN TO AN AEROBATIC MANOEUVRE EVERY TIME THEY ROTATE INTO A WINCH LAUNCH

■ For more information, see booklets and videos on the BGA Safe Winch Launch webpages [10] and Instructor Manual [3].

[1] CAA, Flying Display Standards, CAP1724 (2020) *https://tinyurl.com/flyright2028*
[2] P Mallinson & M Woollard, *The Handbook of Glider Aerobatics*, Airlife (1999)
[3] BGA Instructor Manual section 16 *https://tinyurl.com/flyright2029*
[4] J Gibson, *The Mechanics of the Winch Launch (2002) https://tinyurl.com/flyright2030*
[5] H Browning, *Boundaries of Safe Winch Launching*, Technical Soaring **31** (4), 95 (2007) *https://tinyurl.com/flyright2031*
[6] T Hills, *Safety Analysis of the Winch Launch*, Technical Soaring **31** (4), 101 (2007) *https://tinyurl.com/flyright2032*
[7] The centripetal acceleration is calculated by multiplying the airspeed by the rate of change of pitch angle. In aviation units: the additional g loading is (0.0009 *v r*), where *v* is the airspeed in knots and *r* the rotation rate in degrees per second.
[8] H Browning, Safe Winch Launches, Technical Soaring **37** (1), 3 (2013) *https://tinyurl.com/flyright2033*
[9] H Browning, *S&G* June/July 2009, p26; June/July 2011, p28; April/May 2012, p48
[10] *BGA Safe Winch Launching https://tinyurl.com/flyright2034*
[11] *The Effects of Wind Gradient, S&G* Oct/Nov 2019