SUPPLEMENT TO BGA 'SAFE WINCH LAUNCHING' LEAFLET

INTRODUCTION

This document summarises the main hazards associated with the wire launching of gliders and how these hazards may be anticipated and avoided. It attempts to explain the reasons for some of the advice in the safe winch launch leaflet which was published by the BGA in October 2005 and updated in January 2007. It does not pretend to provide a comprehensive briefing on all aspects of safe winch launching.

Instructors are advised to read the present document in conjunction with Chapter 16 of the BGA instructor's manual.

DEFINITIONS

A 'winch accident' is one that occurs during a winch launch or in the immediate aftermath of an incomplete winch launch. 'Incomplete' means that the launch did not continue to the normal launch height. This can be because the wing dropped, the glider stalled, power failed at the winch, the weak link broke, the pilot released, the instructor released, or for any other reason.

Remarks made in respect of winch launches apply equally to autotow and reverse pulley launches.

WINCH ACCIDENTS

All UK winch accidents since 1974 have been surveyed.

The average frequency of winch accidents is 1 in every 13000 launches. The volume of winch launching is such, however, that there were 731 winch accidents from 1974 to 2006. These accidents included 35 deaths and 72 serious injuries for an average of one death and two serious injuries per year. In that period winch accidents accounted for 273 written off or substantially damaged gliders.

A civilian club that conducts 4000 winch launches per year would expect a fatal or serious injury every 21 years, a severely damaged glider every 7 years, and a winch accident of any kind every 3 years. These apparently rare accidents aggregated for the UK result in an unacceptable number of fatal and serious injuries and crashes. Clubs need to reduce winch accident rates that may already *appear* to be low.

Although the glider fleet has changed materially and powerful winches have become commonplace the rates and the severity of wire launch accidents have stayed the same throughout the period 1974-2005.

The glider crash rate on winch launches is 50% higher than on aerotow launches but the fatal and serious injury rate on winch launches is eight times that on aerotow launches.

Inadvertent stalling and spinning, winch launches, and collisions are the three main contributors to fatal and serious injury gliding accidents.

WINCH LAUNCH HAZARDS

Winch accidents at each stage of the launch are associated with particular hazards:

1987-2006

	fatal injury	serious injury	severe damage	total accidents	main hazard
ground	1	2	36	75	cartwheel
rotation	7	8	18	20	stall, flick roll
power loss <100ft	1	17	55	132	stall
power loss >100ft	9	9	47	86	spin
other	2	2	11	112	cable
total	20	38	167	425	

Ground
If the wing drops on the ground the glider may rotate about the wing tip and cartwheel. If the wing drops in every hundredth launch, there will be one wing drop accident in 800 wing drop incidents. This is a recipe for complacency and indeed it is experienced pilots who have the majority of wing drop accidents. After the wing has dropped the cartwheel can be so rapid that no recovery by releasing or other means is possible. This hazard must be anticipated and pre-empted by conducting the launch with the left hand *on* the release, and releasing *immediately* if it is not possible to keep the wings level.

Leaflet advice:

- Start the launch with your hand on the release.
- If you cannot keep the wings level, release immediately.

Rotation
These accidents are very rare but often fatal.

During any part of the winch launch the lift required from the wing is greater than in cruising flight because the lift force is tilted away from the vertical and extra lift is needed to oppose the pull in the cable.

During the transition from level flight at take off to the full climb the wing must generate a force sufficient to accelerate the vertical speed of the glider from zero to about 40 knots.

The lift demanded from the wing during rotation to support the weight of the glider, to oppose the pull in the cable, and to provide vertical acceleration means that during rotation the lift factor can be very high. The stalling speed is proportional to the square root of the lift factor. If a stall occurs during rotation it is a dynamic or high speed stall after which the glider may flick roll. The glider is spinning while attached to the cable. The rolling of the flick roll is the autorotation of a spin. In some cases the glider hits the ground inverted with the cable still attached. Once the glider has stalled, recovery is probably impossible. This hazard must also be anticipated and pre-empted.

It will be appreciated that the shorter the time taken for rotation, the greater the vertical acceleration, and hence the greater the increase in stalling speed. Computer simulation has shown that a stall during rotation indeed results from a low airspeed combined with a rapid rotation rate. A glider with a 1g stalling speed of 34 knots will stall at about 50 knots during rotation on a winch launch if the rotation rate is 20º per second. It will stall at about 45 knots if the rotation rate is 15º per second.

Rates of rotation in degrees per second can easily be expressed and communicated as the time taken for the transition from take off to the full climb. This concept is incorporated in the advice in the BGA safe winch launch leaflet.

A low airspeed and a high rotation rate can arise from a too rapid rotation at low airspeed, or from a rotation with an airspeed that was initially adequate but which reduces during the latter part of the rotation.

Simulation of the recommended technique indicates it should provide a margin of at least 10 knots above the stalling speed at all stages from take off to becoming established in the full climb.

Leaflet advice:

- Avoid taking-off with a significant amount of yaw present.
- Maintain a shallow climb until adequate speed is seen, with continuing acceleration
- Ensure the transition from level flight at take off to the full climb (typically 35º) is controlled, progressive, and lasts at least 5 seconds

Power loss <100ft

This is the most common winch accident with an average of one serious injury, 1.5 minor injuries, and three crashes per year. Compressed vertebrae are common.

Usually the glider lands in a stalled state but in 20% of the accidents the glider hits the ground nose first, unstalled.

40% of these accidents are instructors instructing, usually simulating a cable break.

Although the category is defined as power loss below 100ft, 80% of the accidents are after power loss below 50ft. Accidents from landing ahead after power loss above 100ft are rare.

These observations strongly suggest that after power loss below 100ft prompt and accurate handling is essential to avoid unrecoverable combinations of airspeed and climb angle.

This was confirmed by computer simulation which entailed breaking the flight into four segments. Firstly a climb without power, representing a reaction time, then a push over to a recovery dive, maintained to achieve a particular speed, and finally a pull out to level flight for landing. The variables that were examined were the airspeed and climb angle at the moment of power loss, the reaction time, the push over g, the steepness of the recovery dive, the target airspeed in the recovery dive, the pull put g, and the stalling speed and L/D of the glider. Recoverability was defined as the capacity to achieve level flight at ground level at 45 knots without use of airbrake.

The hazard of power loss below 100ft can be reduced by adopting a launch technique that avoids being low, slow, and steep. A suitable technique is that in the BGA leaflet, quoted above.

If power is lost, regardless of the technique which has been employed, the imperative is to follow the advice in the leaflet:

"*immediately* lower the nose to the correct recovery attitude"

Lowering the nose quickly is critical to a safe recovery. Every 0.5 second counts. Pilots need to anticipate power loss on every launch and be ready to lower the nose without delay.

A glider with an L/D of 25 that suffers power loss in a 25º climb at 55 knots might not appear to be vulnerable if the pilot lowers the nose at 0g to a 10º recovery dive. However, delay in beginning to lower the nose may result in a stall. If there is no delay the airspeed at the beginning of the recovery dive when the 1g stalling speed is restored is a healthy 49 knots. With a one second reaction time that speed will be 41 knots. With 2 seconds delay the glider will be at its stalling speed of 34 knots and will probably crash.

With a 1.5 second reaction time and good technique a glider in a 15º climb will stall if the airspeed at the moment of power loss is 44 knots. In a 25º climb it will stall if power is lost at 51 knots.

To avoid operating too near the unrecoverability boundary it has been suggested in the leaflet that in addition to lowering the nose immediately to avoid a stall, pilots should endeavor to have enough energy to permit recovery to level flight at ground level at 55 knots. This can be achieved with about 55 knots at 20ft or 50 knots at 50ft.

Lowering the nose too much can typically cost another 30 ft of height.

These simulation results demonstrate that after power loss below about 70 ft a single mistake of lowering the nose too little or too much, or being one second too late in lowering the nose, can make a crash inevitable. This is what happened in many of the instructing accidents. The student made a mistake and it was not possible for the instructor to recover.

Leaflet advice:

- If the launch fails, immediately lower the nose to the appropriate recovery attitude. *Minimising the reaction time is crucial.*
- Do not use the airbrakes unless the glider has attained an appropriate attitude combined with a safe speed.
- Instructors: simulated power loss with less than 50ft and 55kt by instructor demonstration only

Power loss >100ft

About half the fatal winch launch accidents occur after power loss in mid launch.

The main hazard is a spin after having failed to restore a safe airspeed.

After power loss in a steep climb at several hundred feet the attitude of the glider at the beginning of the recovery dive may look satisfactory but the airspeed may be at or below the stalling speed. It is essential to maintain the recovery dive until the approach speed is restored. If the glider is manoeuvred before this acceleration has taken place it may stall and spin.

Leaflet advice:

- Adopt the recovery attitude; do not turn or use the brakes until the approach speed is attained
- Land ahead if it is safe to do so

Many lesser accidents arise after a successful recovery to controlled flight followed by a circuit to a crash from an undershoot, an overshoot, or hitting something during landing. The solo accidents of this type usually result from an inability to conduct a safe circuit from a few hundred feet. The instructing accidents, which comprise 50% of the group, result from the instructor allowing the student to continue with a poor circuit plan until recovery is impossible.

Leaflet advice:

- Plan provisional circuit options before taking off.

High speeds
The launch technique recommended above should not lead to excessive speeds during the early part of the launch.

The relatively low placarded maximum launch speed of many gliders is to protect the glider from undue stress near the top of the launch where the lift opposes a large tension in the cable, there is no bending relief as there would be in a high g manoeuvre in free flight, and the stress from a gust is greater than in free flight.

During the first third of the launch, however, the stresses on the structure are moderate and the placarded maximum launch speed may safely be exceeded during this phase.

Leaflet advice:

- If the speed is excessive near the ground, climb gently to several hundred feet and release, or signal if the excess speed is now moderate. Releasing below 100ft could be hazardous, not least from hitting the cable. Signalling could overstress the tail. Pulling back to control the excessive speed may break the weak link leading to a difficult recovery.

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