The Gliding Federation of Australia Inc

(ABN 82 433 264 489)

Winch Launching Manual

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WINCH LAUNCHING MANUAL

(INCORPORATING AUTO-TOWING)

Issue 6

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FOREWORD

Winch launching is an effective and safe method of launching a glider, but it is less tolerant of gross pilot error than almost any other phase of a glider’s flight. In other words, it is only safe if all the well-established principles and methods are closely followed.

This manual covers all aspects of winch launching, including basic techniques, pilot training and checking, winch driver training and checking, wire and other equipment standards, driver protection and all potential failure cases.

Auto (motor-car) launching is similar in principle to winch-launching and most of the procedures designed for winch-launching are directly applicable to auto-launching. Any divergence from winch practice will be found in a table of differences at the end of the manual.

Where the requirements of this document differ from those contained in The Gliding Federation of Australia Inc (GFA) Operational Regulations or other Legislative documents, the GFA Operational Regulations and other Legislative documents shall take precedence.

Once printed, this is an uncontrolled version of the manual which will not be updated by GFA; it should not be relied upon for any regulatory purpose. The current manual can be viewed at any time via GFA's website at "http://www.glidingaustralia.org".

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GLOSSARY OF TERMS USED IN THIS MANUAL

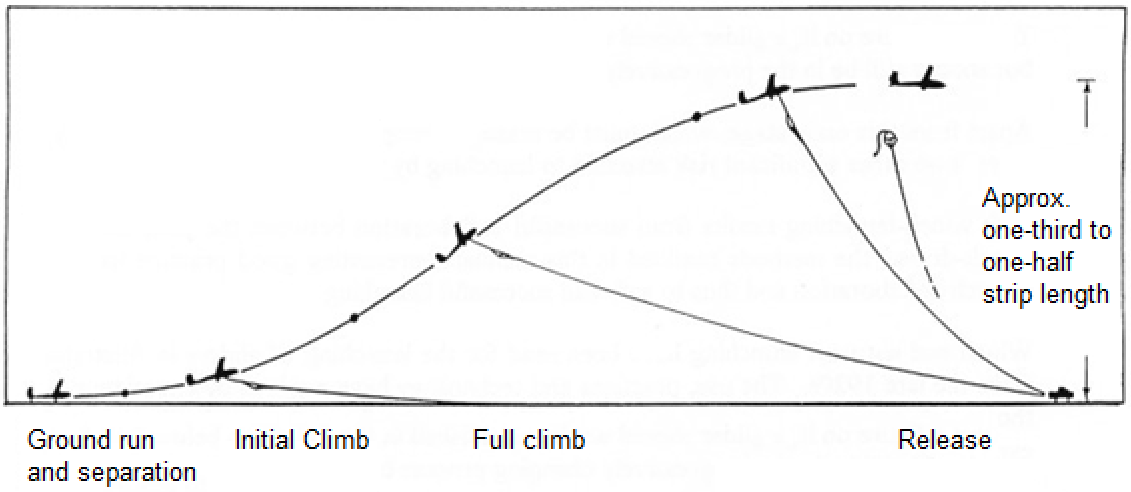
CG	Centre of Gravity.
CTAF	Common Traffic Advisory Frequency.
‘g’	G-force (with g from gravitational) is a measurement of acceleration felt as weight. It is not a force, but a force per unit mass and can be measured with an accelerometer.
FROL	Flight Radiotelephone Operator's License issued by CASA.
MOSP 2	Manual of Standard Procedures, Part 2 – Operations.
RM/O	Regional Manager, Operations
RM Plan	Risk Management Plan which provides a structured way of identifying and analysing potential risks, and devising and implementing responses appropriate to their impact.
SMS	Safety Management System. A system for the management of safety within the GFA, including the organisational structure, responsibilities, procedures, processes and provisions for the implementation of gliding safety policies by the GFA.
Vs	Stall speed of the glider in level flight.
Vw	Maximum winch launch speed.

1 BASIC WINCH LAUNCH PRINCIPLES

The basic principle of a winch launch is simple. The glider is attached to a cable which is wound back into the winch at such a speed that it provides the glider with flying speed. Most winches are fitted with powerful V8 petrol engines and automatic transmissions. Although popular in Europe, diesel winches are rare in Australia, as are manual transmissions in this application.

As the winch accelerates the glider toward its safe launching speed, the glider is flown in such a way that it follows a gradually steepening flight path, gaining height rapidly until it is almost overhead the winch, whereupon the cable is released and the glider goes on its way.

This is simplified description, but it will suffice for a starting point. For those to whom a picture is worth a hundred words, the following diagram may help.



The minimum strip length for winch launching is 1,200 metres (refer MOSP 2, Section 16.1.2).

The guideline given in the diagram, that a glider should achieve about one-third to one-half of the strip length as its launch height, is notional. The exact height will vary with pilot and winch driver technique, as well as with wind velocity and aircraft characteristics.

Referring to the winch launch diagram, it will be noted that the flight path followed by the glider in the early stages is progressively steepened as height is gained. This should be a smoothly executed process, with the accent on the word “progressive”. There should be no “steps” in the process of transitioning from the separation into the full climb and no sudden changes of climb-angle at any time.

This “graduated” early stage of a winch launch is a crucial point and a gross deviation from a graduated profile, either in the form of climbing too steeply too close to the ground or making a sudden change to climb-angle, is the biggest single cause of winch launch accidents all over the world.

That said, the profile does not have to be followed with millimetre accuracy. There is a built-in tolerance to enable pilots to make the minor errors which are inevitable in learning a new skill, without them being at risk. Provided that the recommended climb profile is followed in principle, and the glider is never allowed to climb too steeply at a height from which recovery from a failure cannot be made, there is no reason why winch launching should demonstrate a higher accident rate than any other kind of launching.

Sometimes a launch is criticised for going too EARLY into a steep climb, when what was really meant was that it was too LOW into the climb. If a launch accelerates rapidly, the glider will attain climb speed rapidly and will transition through the early stages quickly. In this case the glider may indeed be early into the climb, but because it achieves a safe height quickly, it is quite safe provided the “progressive” principle is followed. If it is allowed to enter the full climb at too low a height, the “progressive” principle is violated, and the process tends to become unsafe.

To put a figure on it, a glider should not be established in the full climb below 200 feet but should still be in the progressively changing process below that height.

Apart from this early stage, which must be managed properly in order to ensure safety, there is no other significant risk attached to launching by winch.

Safe winch-launching results from successful collaboration between the pilot and the winch-driver, the methods outlined in this manual representing good practice leading to such collaboration and thus to safe and successful launching.

2 GLIDER CONSIDERATIONS

2.1. HOOK POSITIONS AND LAUNCHING CHARACTERISTICS

When winch-launching a glider, an ideal situation is that the glider's attitude should be able to be controlled accurately by the pilot without any unwanted pitching moments from the glider, or from a combination of the glider and the cable pull.

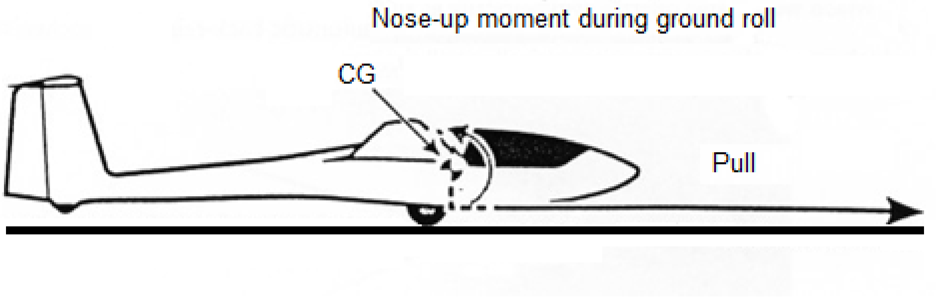
2.1.1. The "belly" release hook

The accepted method for winch-launching in Australia is a single hook placed under the belly of the glider. Winch launching should only be carried out using the "belly" hook and never using the nose hook. The position of belly hooks varies from one glider type to another, some being under the pilot and others being further forward.

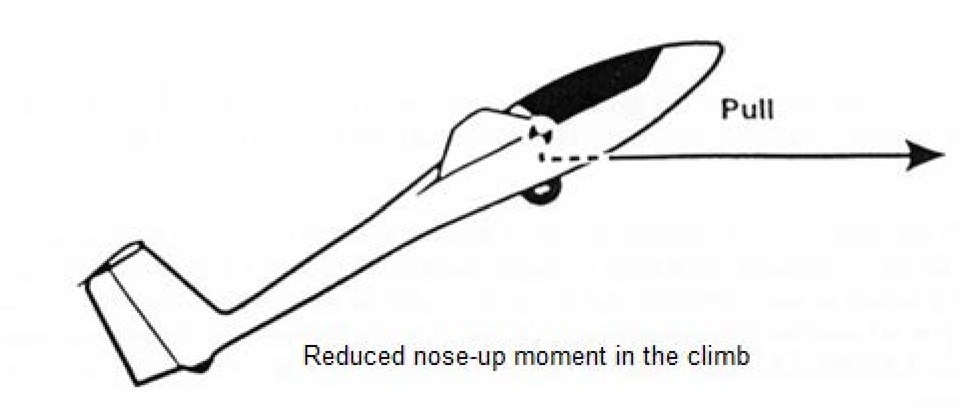
2.1.2. Unwanted pitching moments

Any belly-mounted hook must be displaced some distance underneath the glider's CG. Therefore, a belly-mounted hook will, due to the glider's inertia, impart a nose-up pitching moment about the glider's CG under winch acceleration during the time when the glider is substantially level and not in a climbing attitude (e.g. during the ground-run and initial separation). The factors affecting the amount of pitch-up which will be imparted to the glider, and the extent to which any such pitch-up will be able to be controlled by the pilot, are :-

- How far in front of the glider's CG the hook is mounted. The further back the hook, the more the pitch-up tendency.
- How far underneath the glider's CG the hook is mounted. High-wing gliders, with high CG positions, tend to be the worst offenders.
- The rate at which the glider is accelerated at the start of the launch. The greater the acceleration, the greater the tendency to pitch up.



The diagram above, reproduced with acknowledgement to "Sailplane and Gliding", shows the effect of winch pull at the start of the launch. The line of the pull is very low with respect to the glider's CG, imparting a strong pitch-up moment.



This diagram (again with acknowledgment to "Sailplane and Gliding") shows the situation in the climb. The line of the winch pull now passes much closer to the CG and the pitch-up tendency is considerably reduced. In addition, acceleration has now ceased and the glider is at a steady speed, therefore inertia is no longer a factor.

Any pitching moment which may be present is resisted by a lift force from the horizontal stabilizer. A short tail-arm lessens the effectiveness of the horizontal stabilizer in controlling any pitch-up which does occur. Winch-drivers launching gliders like this should be briefed to ease the power on and not accelerate too rapidly.

Some degree of pitch-up tendency imparted by a belly-hook is not necessarily a bad thing, as the pilot will need quite a lot of forward stick to control the glider's initial launch profile. Therefore if the cable breaks or the engine fails, the pitch-up moment is removed and the pilot already has down elevator to restore the glider to its normal nose attitude for a safe landing. It is also important that pilots realise the implications of their weight on pitch-up tendencies. The lighter the pilot, the more marked the pitch-up tendency.

If the belly hook is mounted a long way forward, there will be little or no pitch-up as the launch accelerates. In this situation the pilot may well have to use some "up" elevator to obtain the required launch profile. If a failure occurs, the glider will be in a nose-up attitude, but this time with the elevator up instead of down. The pilot will need to move the stick forward quickly if the glider is to be restored to the required attitude for a safe landing.

2.1.3. "Porpoising" on the launch

A forward mounted belly hook creates another problem. From about the half-way point of the launch onwards, as the cable pull becomes increasingly downward, the pilot needs a lot of back stick to keep the nose up. The horizontal stabilizer reaches a critical angle and stalls the "wrong" way round (i.e. inverted) in the downwash from the wing. This sets up a pitching oscillation, or "porpoising", which grows progressively more violent if the pilot keeps the stick back. It is a most unpleasant phenomenon, but can be fixed immediately by easing the stick forward a little.

2.1.4. Other unwanted moments

Some gliders are fitted with a belly-hook offset to one side (e.g. gliders with nose skids). Pilots flying gliders with offset hooks are advised to be well prepared to use rudder to keep the glider straight on take-off.

CAUTION: Even though the hook may be displaced only several centimetres off the centreline of the glider, a surprisingly large swing can be produced if the winch accelerates very rapidly at the start of the launch.

2.1.5. Automatic back-release

There is an important design feature built into belly hooks. This is an automatic over-ride, or "back-release" mechanism, which will function if the glider flies too far overhead the winch. Thus, even if the main release mechanism is disabled inside the glider (for example, if the connection between the release knob and the belly hook should break, not entirely unknown), the back-release mechanism will function and automatically release the launching cable when the glider gets overhead or nearly-overhead the winch. If there is such a thing as a fool proof device, the back-release mechanism is as close as we are going to get.

WARNING: Nose-mounted aerotowing hooks generally do not have back-release mechanisms, although there are exceptions. It is best to assume that a back-release is not fitted to ANY nose hook and on that basis to ensure that you never attempt a winch launch using one of these hooks. If you do, your last line of defence against a defect in the hook or its installation is removed.

2.1.6. Predicting likely launch characteristics

A pilot can predict the likely launch characteristics of a glider by standing back from it and looking at its general shape and hook position. A deep fuselage (implying a rather high centre of gravity) and aft-mounted hook equals a strong pitch-up on launch. Check out the tail-arm too - a short-coupled glider that also has a deep fuselage and a very aft-mounted hook is likely to be quite a handful on a winch take-off, especially with a lightweight pilot aboard. Make sure winch-drivers are briefed not to give such gliders very rapid acceleration. A shallow fuselage and hook not so far back will not produce so strong a pitch-up on take-off.

2.1.7. Useful tips

Do not use soft cushions

Ensure that no soft cushions are placed behind pilots for winch-launching. Under acceleration, such cushions compress and allow the pilot to move back in the cockpit. This has three effects:

- It moves the CG back, maybe only slightly but can be enough to cause pitch control trouble.
- The pilot may involuntarily move the stick back as they move back.
- The pilot may be unable to reach the release knob after moving back.

Minimum pilot weight

CAUTION: If a pilot is on or near the minimum permissible weight to fly the glider, it is wise to add some extra cockpit ballast, especially if the glider is known to be demanding in its pitching characteristics.

Careful attention to seating position

Choose the seating position carefully. There is merit in positioning the pilot's seat one notch further forward than appears to be necessary, anticipating a small amount of movement under acceleration. For gliders without adjustable seats, the rudder pedals could be brought back one notch.

Awareness of poor harness design

Some gliders may allow the pilot to slide backwards and upwards along the seat once the glider is established in the full climb. This is a function of the very smooth seat and the particular design of the seat harness. The effects are the same as for compressible seat cushions. A simple modification, such as fitting some Velcro to the seat pan to increase friction, may help to prevent this disturbing tendency.

2.1.8. Final reminders

It is the **PILOT'S** responsibility to ensure that the launching cable is attached to the correct tow hook. Pilots should not try to blame the ground-crew if an error is made.

Use the "C" in CHAOTIC to set up the cockpit exactly as required to ensure safety in winch-launching (i.e. 'Control Access' - Seat adjustments secure and positioned to allow for comfortable access to all flight controls, panel switches/knobs and the tow release. Rudder pedals adjusted for reach if applicable).

2.2. WINCH-LAUNCHING LOADS AND LAUNCH-SPEED BOUNDARIES

Winch launching is potentially stressful for a glider's structure. The reason is not particularly obvious and needs a detailed explanation.

2.2.1. Winch-launching loads

When a glider is rotated into the climb, the wings produce much more lift than in straight and level flight. This is at the command of the pilot, who eases the stick back to pull the nose up (thus producing more lift by increasing the angle of attack of the wings).

As the wings produce this greatly increased amount of lift, they naturally bend upwards under its influence. This places considerable stress on all components in the wings, but especially at the wing roots, where all the forces generated in flight accumulate. The bending stresses at the wing roots of a glider during a winch launch are quite high.

2.2.2. Wing bending relief

Consider a looping manoeuvre in free flight. During the loop the wings bend upwards when the lift increases and the pilot feels 'g' loads as the manoeuvre develops. The 'g' forces (pulling in the opposite direction) try to straighten the wings out again and thus produce a measure of bending relief for the wings, which is very useful in protecting the structure from being overstressed. With lift pulling in one direction and being directly opposed by 'g' forces pulling in the other direction, it will be seen that the forces, acting on the wings during a looping manoeuvre, although more stressful than in stable flight, are quite capable of being absorbed by the glider as 'g' forces tend to prevent the glider's wings from being bent beyond their limit. This is obviously only true if the glider is flown within its placarded limitations.

2.2.3. The relevance of bending relief to winch-launching

On a winch-launch the speed is at least 1.3 Vs and is usually higher than that. The angle of attack in the full-climb phase of the launch may be as high as 9 or 10 degrees. The combination of the two produces plenty of lift, enough to give a peak rate of climb during the full climb part of somewhere between 2,000 and 3,000 feet per minute (20 to 30 knots).

During a winch-launch, the glider is tethered by its belly, being attached to the launching cable by the belly hook. Tethering the glider prevents it from moving into a curved "looping" manoeuvre, which it would naturally want to do if it were untethered. As the glider is not following a curved path around a loop, there are no 'g' forces being produced and this is borne out by the fact that a pilot feels no 'g' during a winch launch.

If there is no 'g', there is no bending relief for the wings. They are producing about the same amount of lift as they would for a 2 to 3 'g' looping manoeuvre, but the looping manoeuvre is being prevented by the cable and the glider follows a more or less straight climbing path. Thus the wings bend, and are not being straightened out again by any 'g' forces.

The net result of this is twofold: -

1. The bending moment around the wing roots is unrelieved and is therefore rather high.
2. The pilot feels no additional G forces and tends not to realise that the wings are being subjected to these higher bending moments.

Refer to diagrams 1 and 2.

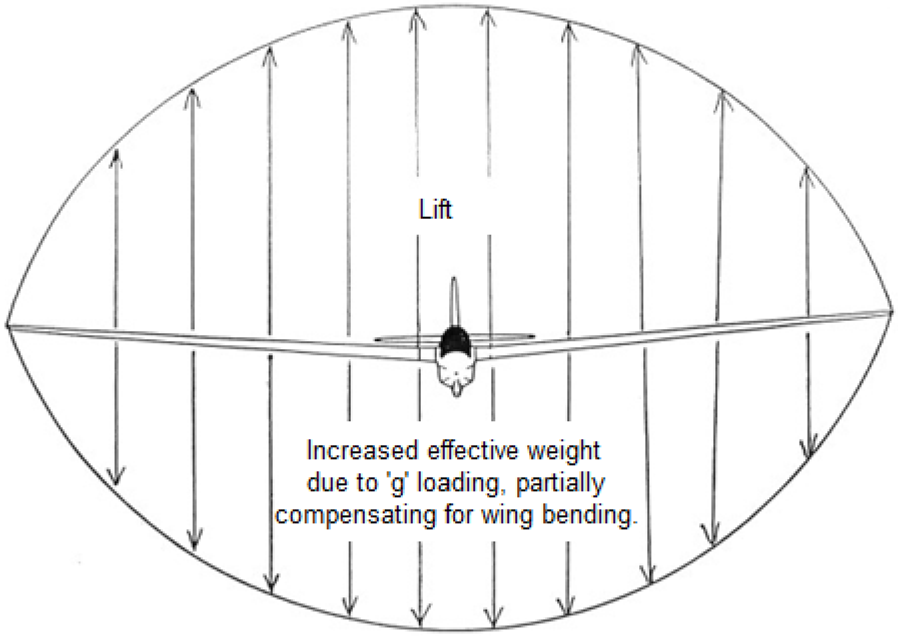


Diagram 1 Free flight, pulling up into a looping manoeuvre. About 2½'g's-worth of lift being produced, tending to bend the wings upwards. 2½'g's-worth of wing-weight, creating a relieving force tending to straighten wings out again.

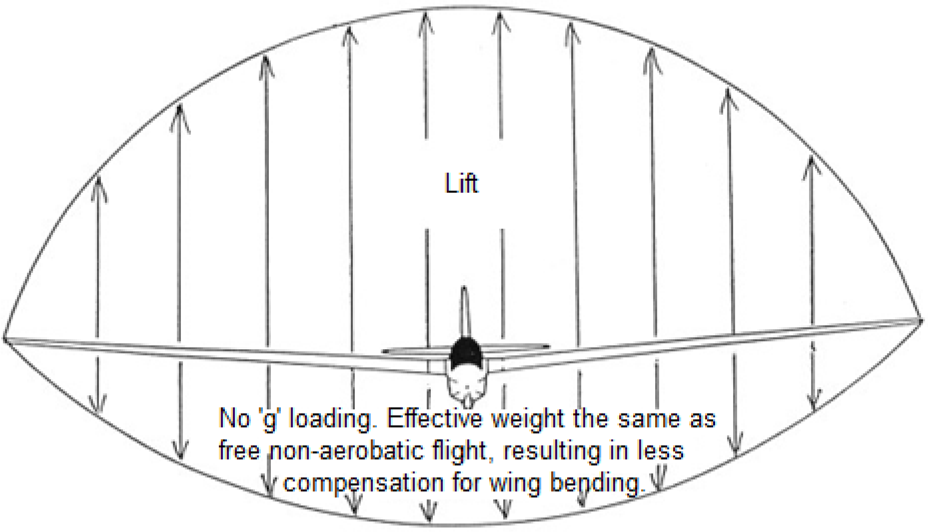


Diagram 2 In full climb on a winch-launch. About 2½ 'g's-worth of lift tending to bend wings upward. Because glider is tethered by its belly and thereby prevented from entering a looping manoeuvre, there is only 1'g's-worth of wing-weight trying to straighten them out again. In addition, the cable is being pulled into the winch, creating a downward force which is acting centrally on the fuselage and is reacted by "up" elevator. The overall result is a more severe bending moment about the wing roots.

2.3. THE PURPOSE OF THE WEAK-LINK

Because of these two points above, it would not be difficult for the pilot to produce bending moments about the wing roots which are higher than those intended by the designer. Excessive bending moments may be produced by flying the glider in excess of its placarded maximum launch speed or by pulling back hard on the stick, or by a combination of the two.

To guard against this eventuality, it is a feature of the certification of gliders that a “weak link” be fitted in the launching cable for the protection of the glider against overstress. The maximum breaking strength of the weak link is placarded in the cockpit and repeated on an external notice near the belly hook.

WARNING: Failure to use a weak link of the specified maximum breaking strength compromises the certification of the glider and, more importantly, puts the pilot at risk through overstressing of the glider to the point of structural failure.

The weak link fulfils the same function as a fuse in an electrical system.

2.4. LAUNCH-SPEED ENVELOPE

2.4.1. Maximum speed

The permissible **maximum speed** for winch-launching is quite restricted and is usually the lowest of all the speed limitations imposed on the glider. The reason, as explained in the previous section, is because the glider is tethered by its belly, thus allowing more wing-bending to take place than in normal flight. Limiting the maximum speed during winch-launching puts an upper limit on the amount of wing-bending which is likely to occur. The maximum winch-launch speed (known as Vw) is placarded in the glider cockpit.

A word of clarification is appropriate in relation to the maximum speed limit. We know that this limit is imposed for structural reasons, specifically wing load. The conditions conducive to wing loading are at their worst in the second half of the launch, where cable-pull is added to gravity and the pilot may need a lot of back stick to produce enough lift to counteract the combination of the two forces and keep the glider climbing. If the maximum placard speed is exceeded at this point, enough force will be generated to break the weak link. If a weak link stronger than specified is being used, or even worse if no weak link at all is fitted, the glider can easily be overstressed. The maximum placard speed must never be exceeded once the glider has passed about the half-way mark of a launch.

There is a bit more freedom lower down. At the beginning of a launch, with the cable-pull almost parallel with the ground, there is very little extra load on the wings over and above the loads applied in normal flight. Even at cable-to-ground angles up to about 25º and the glider in full climb, it can be shown that the loads remain acceptable. It is therefore safe to exceed the maximum placard speed by a small tolerance (say 10%) in the initial stage of the climb, and then progressively steepening the climb angle while the winch-driver sorts himself out and adjusts the speed. If excess speed remains when the full climb has been attained, the standard “too fast” signal can be given or the launch abandoned if it appears to be really getting out of hand.

Glider pilots sometimes climb steeply while close to the ground, offering as an excuse one of three reasons, viz:-

- “I had plenty of speed, so it was safe to climb steeply”. **WRONG!**
- “I am experienced and current, and would instantly recognise a failure. **WRONG!**
- “I had too much speed, so I pulled back to try to kill it”. **WRONG!**

Climbing excessively steeply near the ground is never acceptable, whatever the excuse. It is much safer to allow small inroads into the maximum launch speed in the early stages, while controlling the climb angle so that it steepens progressively in the normal way, than to pull the nose up close to the ground.

History shows that pilots do not recognise launch failures as quickly as they think they do. The known delay in realising that a failure has occurred can prove fatal if the nose is so high, and the ground so close, that recovery cannot be made in time.

2.4.2. Minimum speed

The permissible **minimum** speed for winch-launching is not placarded and is based on a value of 1.3 times the stall speed (1.3 Vs). The stall speed to be used is the one applicable in the configuration in which the glider is being launched. As well as varying with glider weight, stall speed also varies with flap settings in the case of gliders fitted with these devices.

Going back for a moment to the cable-pull discussion in the previous section, this has an effect on the minimum speed too. In the early stages of the launch, with the cable-pull nearly parallel with the ground, the wings are not loaded much above normal flight and the stalling speed is pretty much the same as in normal flight too.

As the launch progresses and the cable pull approaches closer and closer to the vertical, the loads on the wing increase and the stalling speed increases accordingly. Near the top of the launch the increase can be as much as 30%, which takes the stall speed to 1.3 Vs. This just happens to be the speed we choose as our minimum speed to fly a winch-launch.

It follows that the logical action to take is to reduce the back-pressure on the stick as the top of the launch is approached. In fact we go even further and modern winch-launch training calls for a gradual forward movement on the stick towards the top of the launch. This is in contrast to the technique holding the stick back, where it was considered the right thing to do to get the last inch of height out of the launch. In reality, it is probably only an inch that will be gained, because the biggest proportion of the total height obtained on a winch-launch is gained in the early stages, immediately after the full climb has been attained. This is not an argument for excessively early rotations into full climb, but for trying to persuade pilots that holding the stick back at the top of the launch will not make any difference to the height gained.

For those pilots who might still be tempted to use this old-fashioned technique, think about this. Even if the risk of stalling on the wire is considered to be worth taking at that height, and even if you don't really believe that you won't get a bit of extra height out of it, think about the poor old winch-driver when the glider breaks the weak link and sends hundreds of metres of very badly-behaved spring-steel wire hurtling downwards. Even if the winch's protective devices work and the driver is unharmed, it is likely that he will spend the next hour sorting out the mess the pilot created.

3 PILOT CONSIDERATIONS

3.1. CORRECT LAUNCH TECHNIQUE

As the glider moves forward, the pilot must keep the wings level using the ailerons, balance the glider on the main wheel using the elevator, and keep it straight by using the rudder. When the glider achieves flying speed, it will take-off by itself.

The correct launch technique allows the glider to separate from the ground in a natural flying attitude and then (provided the speed is above the minimum 1.3Vs) to smoothly enter a graduated climb profile, becoming steeper as height is gained.

3.1.1. Ground-run and separation

The "natural flying attitude" on the ground varies from type to type, as does the means by which the pilot uses the controls to adopt that attitude.

3.1.1.1. "Taildragger" gliders

Most gliders of "taildragger" layout are already at or very close to the natural flying attitude on the ground and the only action needed by the pilot is to be ready for separation to occur and anticipate any minor corrections that may be needed to either prevent an excessively steep climb developing or give some assistance to the glider to enter a gentle climb, depending on a number of factors such as rate of acceleration, etc.

Some pilots prefer to raise the tail off the ground during the ground run, then use a small back movement of the stick to get the glider into the natural flying attitude, following which it will usually lift off cleanly. The advantage of doing this is that enables the pilot to feel at what point during the ground-run the elevator becomes effective. The disadvantage is that it requires a fair degree of finesse to return the glider to the natural flying attitude. It can also, if mishandled only slightly by a pilot who over-reacts to the nose going down too far, cause the glider to "over-rotate" into an excessively steep climb at too low a height, especially if the acceleration is rapid.

The essential point is that the glider should leave the ground in a natural attitude and should not be allowed to steepen its climb until the speed is confirmed to have risen to the minimum safe value.

3.1.1.2. "Nosedragger" gliders

Gliders of nose-heavy layout, will usually "self-rotate" into a tail-down attitude under winch acceleration. If the acceleration is fierce, the tail might bang down very hard. The pilot should anticipate this and start the take-off run with the stick well forward in this type of glider. When the actual acceleration starts and the pilot has felt what it is like, the control actions can be refined to get the glider into the natural flying attitude.

The same comments apply to the nosedragger as for the taildragger, with respect to the glider leaving the ground in a natural attitude and only being allowed to steepen once the speed has increased to the minimum 1.3Vs.

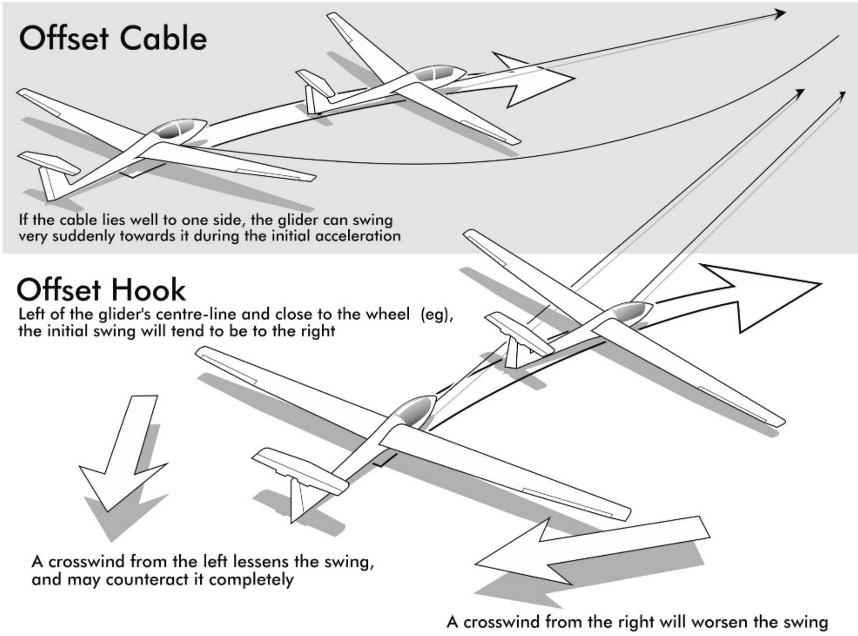
3.1.1.3. Wing Drop during ground run

A potential cause of a serious accident at the commencement of a winch launch is a wing drop leading to loss of directional control and a ground loop or cartwheel.

If a wing drops and the tip contacts the ground the resultant drag may cause the glider to commence a ground loop which will become a cartwheel. Once this process has commenced it can be so rapid that safe recovery is impossible even if the release is activated immediately. The end result of the cartwheel on winch launch will almost inevitably be the glider rolling toward inverted and impacting the ground.

WARNING: Pilots must anticipate the possibility of a wing drop and keep their hand on the release. If the pilot is unable to keep the wings level the release should be pulled immediately (and before the wing touches the ground).

A wing drop will potentially result from any yaw applied at the start of the launch. This can be anticipated by considering which direction the wind is coming from, whether there is an offset hook, where the cable is going to pull and even which wing is being held. In a cross wind it is best to run the downwind wing.



The wing runner should keep the wings level for as far into the launch as reasonably possible. This should involve moving forward with the glider until speed picks up, not just letting the wing go as soon as the glider moves.

3.1.2. Initial climb

Once the glider is clear of the ground, differences in undercarriage layout are no longer relevant and all gliders are treated identically for the remainder of the launch.

In the initial climb phase the pilot controls the glider in such a way that the climb attitude progressively increases as height is gained, the speed being somewhere between the minimum of 1.3 Vs and the maximum placarded value.

The natural tendency of the glider at this stage of the launch will vary depending on its design features, the CG position (mainly a pilot weight consideration), the rate of winch acceleration and whether or not there is a wind-gradient. Some gliders will try to "self-steepen", in which case the pilot will need to resist this tendency and restrain the climb angle to achieve the necessary graduated profile. Other designs may be more reluctant to steepen and such gliders may need a little help from the pilot to steepen the climb in order to achieve the required profile.

The main point is that the initial climb attitude must be positively controlled by the pilot, unless by happy coincidence the glider is following exactly the correct profile of its own accord. This is not often the case, but unfortunately too many pilots allow the glider to "do its own thing" without exercising the required amount of control over it.

The more height you have, the steeper you can afford to be. If the pilot steepens the climb progressively as height increases, and if the speed remains at a safe value, the initial climb technique is correct. Keep doing it this way.

Correct initial climb: Glider attitude accurately controlled and speed greater than 1.3Vs. Do not climb steeply at too low a height. Make changes to climb angle smoothly and progressively, gradually steepening the climb as height builds up. It is permissible to exceed the placarded maximum by about 10% at this point in the launch.

3.1.3. Stall during rotation

Accidents from a stall during rotation are very rare but often fatal. 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. If a stall occurs during rotation it will be 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. You must anticipate and pre-empt this hazard. 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. Advice to avoid a stall during rotation:

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

3.1.4. The maximum speed placard and the initial climb

Previous sections of this manual referred to the maximum placarded winch/auto speed (Vw) and the fact that this speed is intended to protect the structure against being overstressed on the launch. The point was made that the loads on the glider during the early part of the launch are not much more than in level, untethered, flight.

If too much speed is noted during the initial climb, it is better to continue graduating the climb until the glider is established in the full climb at a safe height than to climb the glider too steeply near the ground in an attempt to “load up” the winch engine. When the glider is safely established in the full climb, the pilot can then take stock and see whether action (e.g. signals, abandoning the launch) is then necessary. The only proviso here is that the speed has not become intolerably high during the initial climb, say more than 10% higher than Vw. If the speed does get intolerably high, the decision has to be made whether to give a “too fast” signal before the full climb or abandon the launch there and then.

If the launch is abandoned during the initial climb phase, two things apply:

1. The winch/car driver may not be able to “feel” the glider on the end of the wire in the early stages of the launch before the full climb has been reached. If the launch is abandoned, the driver may not realise it straight away and may not cut the power promptly. Drogue parachutes (if fitted) can become quite unstable under these conditions and their behaviour is unpredictable. If the drogue decides to oscillate, the glider may become entangled.

2. The winch/car driver may not be able to see the glider because of ground clutter and/or strip curvature. This adds to the lack of feel and offers another opportunity for entanglement in a cable drogue.

All things considered, it is best to stay on the wire if possible (provided of course that the speed is not trending towards too SLOW, or is not outrageously fast), and grade the climb carefully until the driver can see and feel the glider's presence, then assess the options and act accordingly.

3.1.5. Full climb

The full climb presents no great difficulties. Direction is monitored by looking each side of the glider's nose (clouds are handy for this too), climb angle is determined by looking under the wing, and the wingtips are checked in turn to see if the glider is level laterally (but see 3.1.8).

It is quite safe to climb steeply once the glider is properly established in the full climb. The principal height gains are made in this early part of the full climb, so get the maximum benefit out of it by optimum utilisation as soon as you safely can. You won't be able to make up for any losses higher up the launch.

As the glider gains height in the full climb, more up elevator is needed to counteract the downward pitching moment caused by the cable. As the launch proceeds, the angle of the cable relative to the glider increases, as does the 'downward pull'. This requires a gradually increasing back pressure on the stick to try and **maintain** the climb attitude. At the same time, the stalling speed also increases progressively, reaching a peak close to the top of the launch. Therefore, speed should be kept between the minimum (1.3Vs) and the placarded maximum, the region known as the "working speed band".

CAUTION: Glider speed is basically determined by the winch-driver; with pilot technique making relatively little difference. However, there are exceptions to this, such as a very low-powered winch, where pulling back on the stick results in engine revs decreasing and the speed decaying. While there are not many low-powered winches in service nowadays, it is a mistake to think that launch speed can be controlled in this way. Rather, the opposite is the case. Pulling the stick further back in the full climb when being launched by a powerful winch can result in the speed actually increasing. This is the "arc of a circle" argument familiar to water-skiers, where following a line outside that taken by the ski-boat will cause the skier to increase speed because of the longer distance which has to be travelled.

As height is gained and we pass the half-way point of the launch, we enter the region where there is an increasing downward pull on the cable. This results in an increase in stalling speed and an increasing amount of stress on the wings. From this point onwards, we need to be more conscious of the loads applied to the glider and ensure that speed limits are conscientiously observed.

Near the top of the launch, the cable gradually pulls the nose down so that the climb angle reduces. The pilot should relax the backward pressure on the stick, especially if the glider starts to 'buck' or 'hunt' in pitch. It is important to remember that despite the attitude of the glider the angle of attack can be very high.

The top of the launch is the most likely place to break the cable or weak link. Cable pull combines with gravity to maximise the strain in the wire. Poor pilot technique in the form of keeping the stick right back will very likely cause a break at this point. This is the kind of break which is very hazardous to winch-drivers as the spring-steel wire descends upon him.

The top of the launch can be recognised by one or more of the following: -

- The glider's position in relation to ground features (assuming no launch failure);

- the nose of the glider gradually being pulled down by the wire;
- a reduction in noise from the winch through the cable and/or a reduction in airspeed when the winch driver cuts the power; and
- the rings back releasing due to the drag of the cable/drogue chute. The same effect can be caused in no wind conditions by the glider over flying the winch. As this usually leads to the cable falling onto the winch, it should be avoided.

3.1.6. The maximum speed placard and the full climb

Do not exceed the placarded maximum winch/auto tow speed. Above this speed the glider is vulnerable to overstressing and **there are NO sensations by which the pilot can accurately judge the loads it is experiencing.** The risk of overstressing is greater towards the top of the launch where the cable angle to the glider is largest.

3.1.7. The release

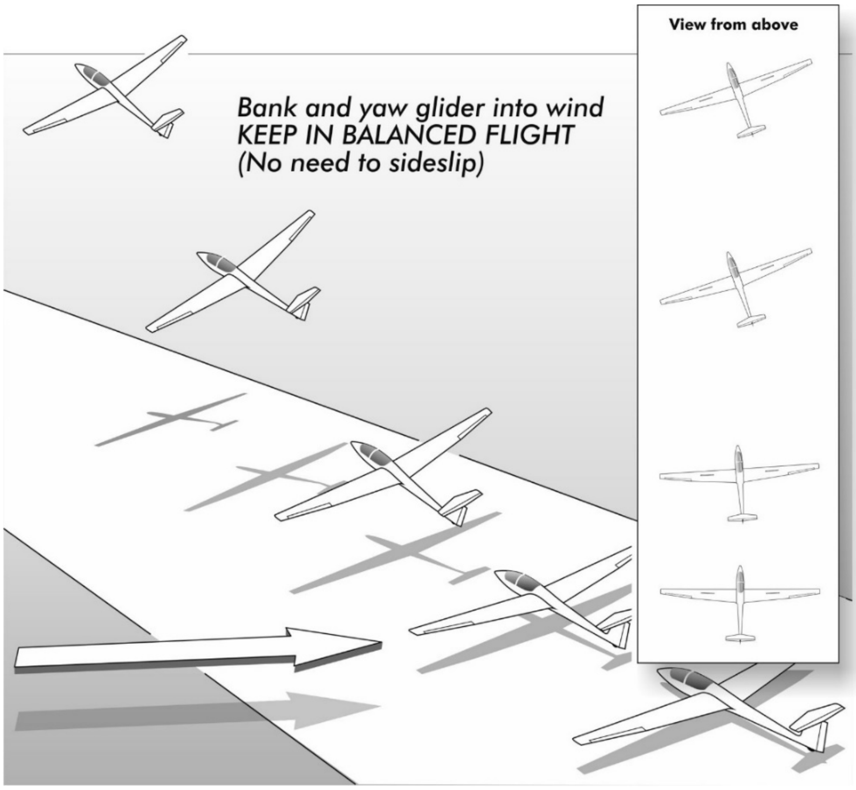
At the top of the launch the winch driver will close the throttle quite noticeably and one of two things will happen. Either the cable will back-release or the launch speed will fall-off with no more upward progress. In both cases, the pilot's action is to establish a normal flying attitude and pull the release TWICE.

Use of the back-release in normal launching is quite acceptable. However, pilots must ALWAYS be taught to pull the release twice, to be certain the cable has released from the glider.

3.1.8. Winch-launching in crosswinds

The maximum height on a winch-launch is obtained if no correction is made for crosswinds and the glider is allowed to drift with the wind. However, this technique will earn the pilot no friends and may be dangerous if there are power lines in the vicinity. It is normal practice to make some kind of correction for crosswinds.

The usual method is to lower the glider's into wind wing and apply rudder in the same direction, thereby altering the glider's heading so as to offset the drift (refer diagram below, courtesy of the British Gliding Association).



An alternative method is to lower the glider's wing into the wind and use a touch of opposite rudder, thus effectively sideslipping the glider into the wind. The first method is usually more effective, especially in strong crosswinds.

Crosswind correction should be applied as soon as the glider is clear of the ground. If you wait until the full climb, it will usually be too late and the cable will probably drift outside the airfield boundary after release, the winch-driver being powerless to prevent it.

3.1.9. Launch speed signals (refer MOSP 2, Section 16.1.9)

Radio communication between the pilot and the winch/vehicle is now common practise at many winch sites, thus enabling the pilot to give direction to the winch/vehicle driver to speed up or slow down during the climb. The alternate method is for the pilot to signal the winch/vehicle driver by manoeuvring the glider in the following manner:

Too slow

For safety reasons there is no signal for "too slow". If the launch speed starts to fall off, reduce the angle of climb. If there is no response and the speed continues to fall toward minimum safe speed of 1.3Vs, treat it as a launch failure and release the cable. Adopt ***'safe speed near the ground'*** before manoeuvring. Land straight ahead if possible.

Too fast

If the speed is showing an upward trend and does not appear to be stabilising, and while still below the placarded upper speed limit, the glider is yawed from side to side until a response is obtained from the winch/vehicle driver. If there is no response and speed continues to rise toward the upper limit, the pilot releases the cable and adopts the flying attitude.

When abandoning the launch due to excess speed, pull the release twice with the cable under tension. This produces a clean separation between the cable and the glider and reduces the chance of colliding with the cable, parachute or strop assembly.

3.1.10. The effect of the weight of the wire

The nominal mass of 3.15mm range 2 spring steel wire is 0.0611 kgs per metre. The weight of a 1500 metre length of wire is therefore 92 kgs. By the time the glider is near the top of the launch, there will be somewhere between 500 and 700 metres of wire hanging from its belly, which amounts to an extra weight of 31 to 43 kgs added to the fuselage.

The figures for the slightly thinner 2.8mm range 2 spring steel wire are between 24 and 34 kgs for the same wire lengths. For 5mm 7 x 19 wire rope (stranded cable), the figures are between 48 and 67 kgs.

3.1.11. Kiting during winch-launching is prohibited

Because of the hazard to the general public, the "kiting" of gliders on a winch launch (i.e. the paying out of cable in order to increase launch height) is prohibited (refer MOSP 2, Section 16.1.13).

3.2. INCORRECT LAUNCH TECHNIQUES

3.2.1. Holding the glider down

We know that a good launch starts by climbing gently away from the ground after separation, with the glider's climb angle (or flight path, if you prefer) being progressively steepened as height is gained.

We have discussed the pitfalls inherent in climbing too steeply too close to the ground. There is no need to labour that point any further here.

Another common fault in learning the winch launch is to separate normally, then hold the glider's nose down in an excessively flat attitude immediately after separation. This is usually done in error, while a pilot develops the "feel" for the correct attitude and how to achieve it. Such errors in learning are quite understandable and instructors and winch-drivers have no great problem in overcoming them.

However, there are some pilots who genuinely think that holding the glider down, then "rotating" into the climb, is the correct technique to use. This is a mistake, for the following reasons:-

1. The winch-driver cannot feel the glider in the early stages of the launch because negligible load is being applied to the winch. They therefore do not know whether too much or too little power has been applied.
2. The winch-driver usually cannot see the glider because it has not risen above ground clutter. This is especially true if the background consists of high ground or trees or in the "mirage" effect typical of summer conditions.
3. In most cases, it will almost certainly guarantee that the glider will grossly over speed.
4. If a climb is then suddenly commenced, the excessive speed and consequent sensitive elevator control will make it very difficult for the pilot to control the glider's attitude accurately and a very steep climb may occur very suddenly, especially if the glider is known to be pitch-sensitive and/or has a very aft-mounted hook.
5. A combination of 3 and 4 above will probably result in a low-level cable break due to the sudden application of load to the cable.

It will therefore be obvious that a smooth, progressive transition into the full climb is preferable to the stepped technique, from both the pilot's and the winch-driver's viewpoint.

3.2.2. Allowing the glider to "self-rotate"

Another common problem relates to the tendency of some gliders to pitch-up of their own accord under the influence of winch acceleration. We know the reasons for this from the first section on glider considerations.

A pilot who fails to counteract this tendency, by "restraining" the climb angle with forward pressure or even a definite forward movement on the stick, will find the glider climbing more and more steeply as speed builds up. This will often occur before sufficient height has been gained for a steep climb angle to be considered safe.

The trap here is that it feels so natural for the glider to be entering the climb of its own accord that the pilot may not identify the developing problem and take some action to restrain it. Some of this "self-steepening" is rather subtle and must be monitored very carefully by the pilot. Others are very obvious and should be readily detectable before things get out of hand.

Each launch is a little bit different from the one before. Winch-driver technique, wind velocity and wind-gradient are just some of the factors making for variety in launches. There is no alternative but to closely monitor the climb profile of EVERY winch take-off and not assume that the next one will be similar to the last one.

The tendency to allow the glider to take charge of the pilot during this critical phase of flight is known to have been responsible for a number of accidents, some of them fatal, in Australia and overseas. The Germans, the most experienced winch-launch pilots in the world, call this particular error "letting the winch take-off happen to the pilot".

NOTE: It is possible for the driver of a powerful winch (refer paragraph 4.2.2) to apply too much acceleration at the initial stage of the launch. In gliders that have a release mounted close to the CG (refer paragraph 2.1.2), too fast an acceleration can result in the glider rotating uncontrollably into the climb despite full forward stick. To prevent uncontrolled rotation, winch drivers should apply power progressively.

3.2.3. The "Kavalierstart"

We look to the Germans again for an apt expression to describe excessively steep winch take-offs. The "Kavalierstart" term was coined after a very bad run of winch-launch accidents in Germany in 1995, during which there were 32 accidents in this phase of flight, 12 of which were fatal.

A Kavalierstart means simply treating the winch take-off in a cavalier manner (i.e. an unconcerned, arrogant or "an accident can't happen to me" attitude).

The remedial treatment for pilots who do this kind of winch take-off is to bring the matter to their attention. This should be repeated, ad nauseam if necessary, until the pilot gets the message. It doesn't matter who brings it to the pilot's attention. It doesn't have to be an instructor; in fact it is probably more effective coming from a pilot's peers. It is a serious mistake to let these things go without comment.

If the pilot does not get the message and persists in using the Kavalierstart technique, that pilot is living on borrowed time and will eventually have an accident which will probably be serious or fatal.

If it proves impossible to reason with the pilot and neither advice nor check flights do the trick, it is kinder to refuse to launch that pilot until they see reason than to turn a blind eye and run the risk of a terrible accident.

3.3. LAUNCH FAILURES - PHILOSOPHICAL AND TRAINING CONSIDERATIONS

3.3.1. Introduction

No system is foolproof. Aircraft engines fail, pilots run aircraft out of fuel and they also make simple errors of judgement or skill. Similarly winch problems of various kinds occur from time to time.

Winch cables break from time to time. Winch engines also run out of fuel, just like aircraft engines do. Such occurrences should not in themselves result in a serious accident, as all the failure cases are well-known and training strategies are in place to deal with them. Nevertheless accidents do occur and we are forced to ask why.

The answer is twofold. Part of it lies in human factors; the other part lies in the training system itself and whether this provides an adequate level of protection for a pilot when something abnormal occurs.

In this section, the philosophical approach to launch failures will be examined, as will all aspects of the training of pilots and winch drivers.

3.3.2. The mental approach to launch failures

In the early days of light aircraft, when aero engines were rather unreliable, there were many failures, but the good side of the story was that almost every forced landing was successful because the pilots got plenty of practice. A similar pattern emerged with the advent of ultralight aircraft, the original unreliable two-strokes giving pilots ample forced-landing practice and resulting in a relatively low injury and fatality rate.

Nobody would seriously argue that poor, unreliable equipment forms the basis for a high level of safety. Nevertheless, when equipment is of a good standard and breakdowns are few, there is a temptation to avoid deliberately inducing failures, as they cause inconvenience, and some would say they negate the effort put into making it reliable in the first place.

The ideal training system consists of reliable equipment which is used in a sensible way to create realistic simulations of failures. Pilots then get used to the idea that all the failure cases will be covered during training and revisited during periodic check flights.

There is another aspect of launch-failure training. It is possible to partially simulate the behaviour of a glider following a launch-failure by diving to gain excess speed, pulling up to a simulated winch-launch angle, say 40 degrees, then pushing over and (a) seeing how long it takes to achieve a safe speed after the pushover and (b) how readily the glider spins if an attempt is made to manoeuvre at this point.

Valuable as this exercise is, it is not a complete simulation of all aspects of launch-failures. It is a GFA requirement (refer MOSP 2, Section 16.1.12) that launch-failures are simulated DURING THE LAUNCH, and reliance must not be placed on the dive-pull-up-pushover exercise alone.

3.3.2.1. Detecting a failure

One of the most common excuses given by a pilot to justify a very steep take-off is the fact that they are experienced and in current flying practice. This is translated in the pilot's mind into an automatic ability to detect any failure the very instant it occurs and produce the correct response to it, thus saving the situation.

In reality most pilots do not react as quickly as they think they will to emergencies such as launch failures. The human "computer" is rather slow; studies[1] show that the average time from engine failure to brake application in an aborted take-off situation is between 4 and 5 seconds. This time is taken up by mental realisation, physical reaction and control response. It takes no account of aircraft inertia.

The time taken to recognise a launch failure can be readily confirmed by check flight, where the failure can be contrived under controlled conditions. Without going into detail of all the various failure cases, which are the subject of another section of this manual, it is sufficient to say here that, to be safe, pilots must accept that there will be a delay between a failure occurring and the pilot realising that it has occurred.

3.3.2.2. Expecting a failure

This is a key point; a skilled pilot always EXPECTS a failure on each take-off. Nowadays this extends to incorporating the expectation of a launch failure into the pre-take off check, the "O" in CHAOTIC standing for "Options" as well as "Outside".

Expectation of a failure on each launch creates a mental preparedness to deal with it, the primary action and the various options having been considered before take-off. If the failure occurs, there is no mental barrier to overcome; if it doesn't occur, the pilot can feel pleased with a successful launch.

Only if a pilot is expecting a launch failure can the reaction time be reduced to manageable proportions. This is known as defensive flying and it is the answer to safety management in winch-launching.

> **CAUTION:** Always be prepared for a launch failure. No-one is immune from the time delay inherent in detecting a failure and reacting to it.

[1] Kentley (1975) and Van Es (2010)

3.4. THE PHYSICAL CHARACTERISTICS OF LAUNCH-FAILURES

Launch-failures fall into two main categories, cable-breaks and engine-failures. They both rather obviously result in termination of the launch, the cable-break being an abrupt occurrence, the engine-failure perhaps being more subtle.

3.4.1. Cable breaks

Regardless of the type of wire, cable or rope being used, breaks can occur suddenly and randomly. Solid wire is prone to fatigue due to constant bending and straightening and gives no warning of impending failure. Stranded cable (wire rope) gives a bit more of a hint by revealing loose strands or an incipient bird's nest, but this can only be of use as a warning if it happens to occur where someone on the field can see it. The suddenness of cable failure, together with the lack of warning, accounts for why the mental approach to launch failures places so much emphasis on always being prepared and never assuming that it won't happen to you.

The other aspect to consider is that the weak link may break. This is designed to protect the structure, but the result is a sudden failure of the launch which is identical in all respects to a cable-break.

Because the speed margin above the stall is small and the climb angle may be steep, the pilot must react promptly to a cable-break and lower the nose smartly to at least the "approach to land" attitude and allow the speed to build up to a safe value. The two types of cable-break to consider are as follows:

3.4.1.1. Low-level

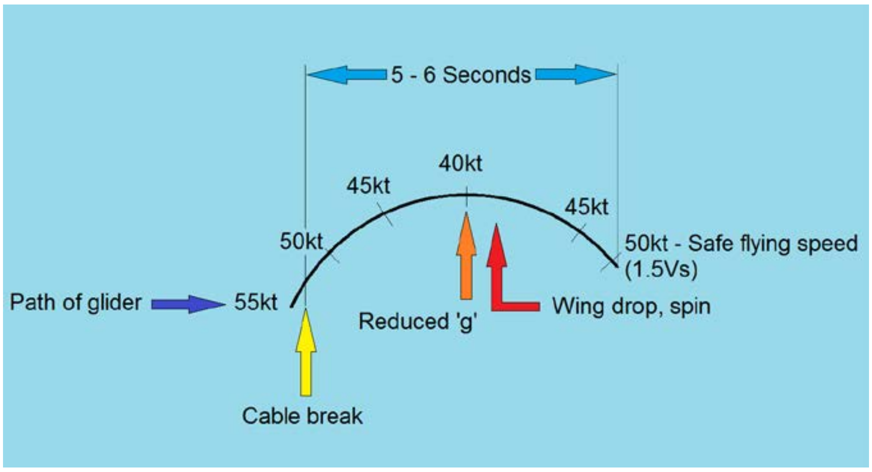
If the failure occurs low down, below say 200 feet, the climb angle will not be (or should not be) very steep and the lowering of the nose is not an extreme manoeuvre. The speed should not decay very much during the "pushover" from the climb to approach attitude and there is no great inertial problem to overcome, as the glider does not have to climb to the apex of a steep "hill" then come down the other side to build up speed. This is the very reason the glider is not allowed to climb steeply during this phase. There is, however, one fly in the ointment, which is wind-gradient.

If there is a wind blowing, there will be a wind-gradient, the severity depending on the wind-strength. As the glider climbs, it enters an increasing wind strength and this effectively adds to the airspeed on the launch. This is a good bonus at this stage of the launch. However, if the cable breaks at this point and the glider's nose is lowered, it has to descend through the wind-gradient and the speed will start to fall again. The pilot will need to control the glider's attitude very carefully to strike a balance between maintaining an adequate margin of airspeed, yet not diving into the ground. Do not open the airbrakes until an adequate speed has been regained and they should not be opened at all if the glider is very low, or you will be rewarded with a heavy landing.

3.4.1.2. High-level

The full climb stage of the launch is characterised by a very high climb rate, typically in excess of 2,000 ft/min (20 knots). Height is obviously gained very rapidly and it is quite safe to climb steeply during this phase, provided of course that the speed is safely within the working band. If a cable-break occurs during this phase, the bad news is that the pilot has to take prompt and positive action to ensure that the glider's nose attitude is changed from the steep climb attitude to the "approach to land" attitude necessary for re-establishing a safe speed. The good news is that there is sufficient height to do this safely, so there is no need to rush things. Prompt and positive is not the same thing as panic-stricken.

There are however two additional factors, jointly the most important of all and persistently responsible for causing winch-launch accidents year after year. The factors are inertia and time. Study the following diagram:



From the time of the cable-break (at the left of the diagram) and the immediate application of forward stick to commence the recovery to the "safe speed" attitude (Recovery Attitude), a minimum of 5 seconds may elapse. This is due to the inertia of the glider (there is no significant lag in an airspeed indicator) and it is essential to let the glider's speed stabilise at the new, nose-down, attitude, and CONFIRM that the build-up in speed has occurred, before opening the airbrakes or attempting to manoeuvre. Remember that the 5 second recovery time is ADDED to the detection/reaction time. If an attempt is made to manoeuvre during the curved part of the diagram, in other words while the glider is slow and has not been allowed to stabilise in the nose-down attitude, there is a likelihood of loss of control, usually a spin. There are many accidents on record from this cause and they are all entirely preventable.

To mitigate this risk of a cable break a pilot should **TREAT ALL CABLE-BREAKS AS LAND-AHEAD CASES IN THE FIRST INSTANCE**, regardless of the height at which they occur. If this is done, it means two things.

1. The recovery action becomes a CONDITIONED RESPONSE and the pilot will always react automatically to a cable-break in the safest possible way (Rule of 'Primacy').
2. The glider will always have sufficient speed to manoeuvre safely, if it becomes apparent after a moment's analysis of the actual situation that a modified circuit is in fact possible.

Given that the entire elapsed time for the recovery manoeuvre is several seconds, there is ample time for the pilot to release the remaining piece of cable attached to the glider and this action must always be carried out as part of the conditioned response mentioned in 1 above.

When the aforementioned actions have been carried out, the glider is as ready to land as safely as it ever will be. It is now time to refine the judgemental aspects of the launch-failure to determine just where it is most appropriate to land it.

3.4.2. Land ahead or circuit?

This is one of the most crucial decisions a pilot will ever be called upon to make. However, the fact that it is crucial does not mean that it must be difficult. It is purely a product of training.

Many accidents result from a decision to turn immediately after a cable-break, with the intention of joining some kind of circuit. The glider, short of speed because of its own inertia, does not have enough energy to attempt such a manoeuvre unless the correct recovery action has been taken and enough time has elapsed for it to take effect. The pilot, who may be under a fair bit of stress at this time, turns the glider as a kind of reflex action before the establishing the glider has achieved 'safe speed near the ground'. It is worth examining how this reflex action became embedded in the pilot's mind, to come to the surface at the worst possible moment.

There are several possibilities, any or all of which may be relevant.

1. An obsession with getting back to the launch point, based either on a feeling of shame associated with landing anywhere else on the field ("real pilots always get back to their take-off point"), or an underlying feeling that the launch point is familiar and safe and anywhere else being strange and threatening.
2. A feeling that landing down the field will cause much inconvenience and will prevent launching another glider for some considerable time.
3. The pilot lacks confidence that they can safely land ahead in the space available.
4. The pilot may feel that, although a landing ahead might be possible, it will need full airbrake and they have never done that before.

With respect to the first two points, a feeling of shame at landing anywhere other than at the launch-point is often a function of peer-pressure. People who ridicule any pilot for putting safety before convenience have a lot to answer for. Apart from remonstrating with the pilot's "friends" who apply this kind of pressure, the only way to proof a pilot against behaving in this way under pressure is through correct and conscientious training.

The third point, lack of confidence to land ahead in the space available, is purely a function of training. If a pilot has never had to do this exercise during training, it is not surprising that confidence will be lacking when the real thing occurs. The answer is obvious and again depends on proper, and conscientious, training. Convenience does not enter into it.

The fourth point, fear of using full airbrake, is more common than might be thought. It will be overcome through proper and conscientious training.

Both the lack of confidence in landing in the space available and the fear of full airbrake can be covered in a useful simulation exercise, not related to launch failures but providing the necessary background to create confidence and remove fear. The simulation can be carried out during an ordinary routine circuit, where the instructor will define a space to be landed in, with particular emphasis on defining the end-of-roll, and then require the pilot to approach as closely to this area as they dare on final approach, without using any airbrake. It will get to the stage of looking impossibly high and steep, to the extent that a gross overshoot seems inevitable. It is at this point that the approach looks remarkably similar to what a pilot sees when a cable breaks in the full climb at, say, 400 feet, and the pilot has just pitched the nose down.

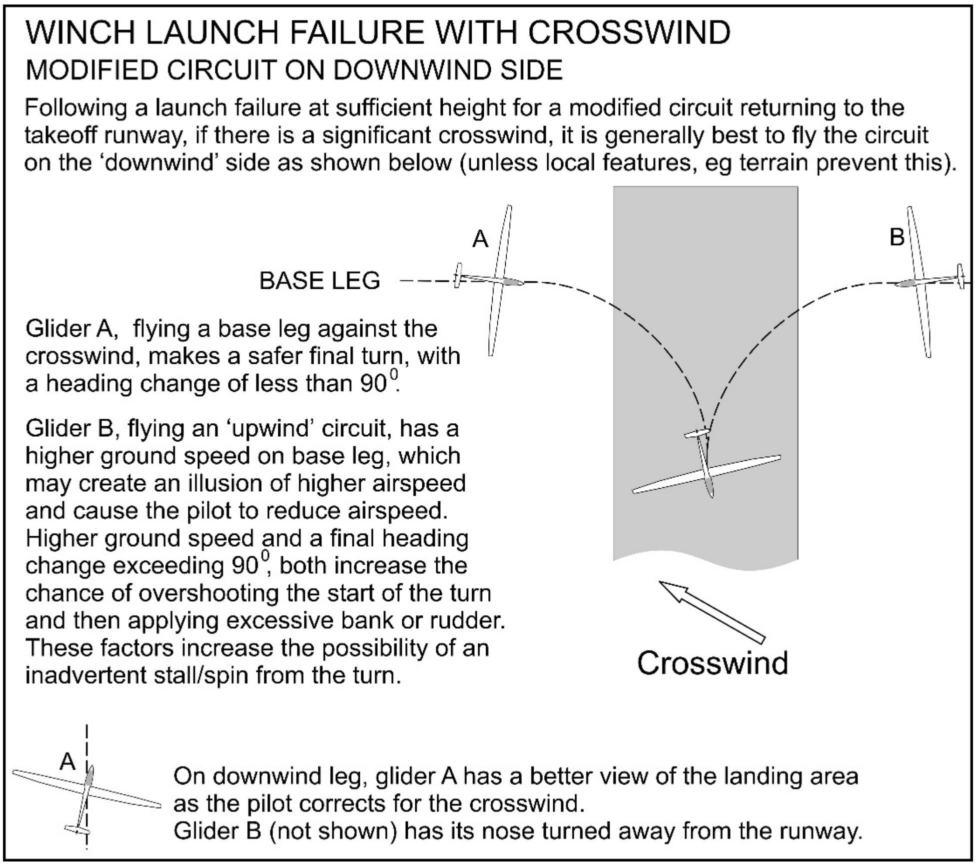
Once 'safe speed near the ground' is attained the airbrakes can be fully opened while the nose is simultaneously lowered to counteract the increased drag, whereupon the rate of descent builds up to the extent that a task which initially looked impossible is now looking much more feasible. As the exercise is completed, and is preferably repeated a number of times, the pilot finds that they can in fact land in spaces previously thought unlandable. And all because the pilot had never done a full airbrake approach before, or at least not within recent memory.

It should be stressed to pilots that they are not expected to carry out every approach this way. It is another string to their bow if they should ever need it in an abnormal situation. As well as launch-failure, it could be beneficial in an outlanding, for example.

Although this exercise is very successful in most gliders, there are a few types which have ineffective airbrakes/spoilers that makes this demonstration of little benefit to a pilot.

3.4.3. Strong Crosswinds

If it is impossible to land ahead, decide which way to turn. This decision will have been considered at the 'Options' stage of the pre-take-off checklist prior to launch based on the crosswind component, the airfield layout, and the terrain.



In most cases, an upwind turn is not the best decision because the glider is committed to turning through more than 360° to line up into wind. Also, when flying with a tailwind component there is a high risk that the pilot may over-rudder the base or final turns, leading to a stall/spin accident; or risk overbanking in a low-level wind shear. If the crosswind is strong and the cable break is at an awkward height, it may also be impossible to land on the airfield.

A downwind turn first is best, unless local features prevent this. Turning downwind offers more options and the angle through which the glider has to turn is smaller, but care needs to be taken to prevent the glider being drifted away from the runway. Furthermore, the glider's heading on downwind will be into wind, thereby affording the pilot a better view of the landing area. If you decide to turn downwind, be aware that your airspeed may not match your apparent ground speed and may tempt you to try and slow down. Frequently scan the ASI for the correct airspeed.

3.4.4. Energy Management

The notion that airspeed indicating systems have a significant built-in lag is a fallacy. On a Daily Inspection, if someone blows gently into the pitot head, the effect on the ASI needle is instantaneous. The lag in speed indications during the recovery from a cable-break is not caused by the instrument, it is caused by the glider. Provided there is no slip or skid present (these can cause pitot/static errors), if the airspeed indicator says you are slow, you ARE slow. Do not manoeuvre, or open the airbrakes, until the airspeed indicator confirms ‘safe speed near the ground’.

3.4.5. Preference for landing ahead

Numerous accidents have occurred over the years because pilots have elected to make a turn immediately following a cable-break.

It is preferable to land ahead if possible, and it is possible on more occasions than pilots think. The answer lies in proper training, so that a pilot has the confidence to land ahead and avert an accident, rather than turn and lose control.

3.4.6. Briefing versus training

It has already been stressed (section 3.3.2) that “live” training is necessary for proper coverage of this exercise and is in fact a GFA requirement. The same principle applies to the use of words instead of actions during a launch.

To explain this “words instead of actions” phrase, some instructors say to their students during a launch “where would you go if the cable broke now” or “tell me the last time you would be able to land ahead”. This technique might seem to work quite well, but this is often because the student is telling the instructor something he knows he wants to hear. The technique in fact has no training value whatsoever **unless** the pilot has experienced some real or simulated failures and can relate to what the glider can actually achieve. It is unfair to pilots to have them believe that words are as effective as actions in preparing them for possibilities like launch-failures. It is probable that pilots supposedly trained in this way harbour an underlying fear of launch-failure throughout their lives and they are likely to perform poorly when it happens to them in earnest.

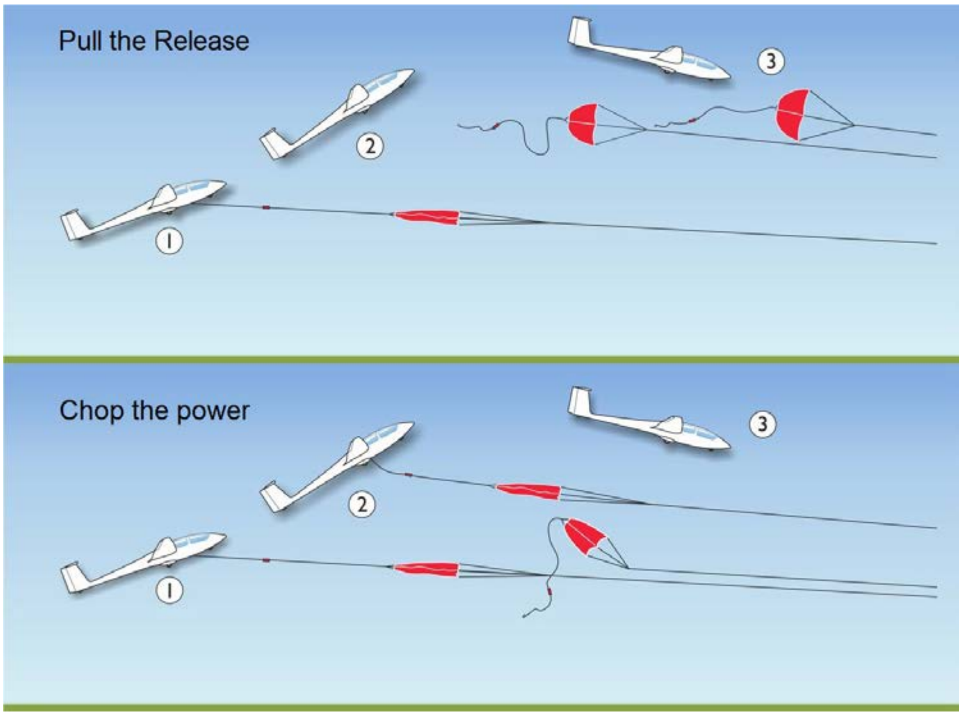
3.4.7. The non-manoeuvring area

Although not strictly a failure cause, a similar judgemental problem may confront a pilot who gets caught in this area. The non-manoeuvring area (NMA) is an area of sky which, if entered by the glider during a launch, results in the glider being unable to land ahead within the airfield if a launch-failure occurs, but the glider is also too low to make a safe turn-back into a circuit. In practice this means that a launch with very poor acceleration, taking a glider a long way down the field without much height being gained, is the likely cause of such a situation.

The obvious answer to the NMA is not to let the glider get into it. If a launch is not accelerating quickly enough, release before there is any risk of entering the NMA.

The shorter the strip, the more acute the NMA problem. The GFA strip minimum of 1,200 metres is designed specifically to prevent NMA problems from occurring.

3.4.8. Simulating launch failures



When practising simulated launch failures below 200ft, do this by arranging for the winch driver to reduce power. If you pull the release while under power there is a risk that the drogue chute will open in front of the glider, whereas if the power is cut by the winch driver, the cable and chute fall to the ground and do not pose as great a hazard (refer diagram, courtesy of the British Gliding Association).

If you are simulating a launch failure by releasing the cable at 200ft or higher, release under tension to ensure the glider and cable separate. Do not lower the nose before release.

If you are driving the winch and see the cable detach from the glider in the early part of the launch, chop the power and let the cable fall onto the ground. Only wind it in when you are sure it is safe to do so.

3.4.9. Engine failures

When a cable breaks, the pilot does not have to make a decision on whether a failure has occurred - the launch stops dead and that's that. An engine failure may be like that too, but it is also possible for it to be quite different. A vapour-lock in the fuel system on a hot day, for example, may cause coughing and spluttering of the engine, giving the pilot a slow decay of airspeed and forcing a decision on whether this is the early stage of a failure or a misjudgement of speed by the winch-driver. In the full climb, with the nose pointing up at about 40º, it is essential that a pilot is trained to fly defensively to counteract this kind of problem.

"Flying defensively" means:

(a) detecting that a problem has occurred; and
(b) reacting correctly to the problem, erring on the side of safety if there is any doubt. We know that most pilots do not detect a problem as quickly as they think they will, and this introduces a delay which can be critical if the problem is itself difficult to detect. Engine failures often fall into this category.

Referring back to the curved-line time/speed diagram; it was based on a sudden failure, which forced the issue very clearly in the pilot's mind. Imagine how much more difficult it would be if the failure is slow and difficult to detect. In the slow engine-failure case, more than any other, a pilot has to be alert in order to stay safe in winch-launching.

4 WINCH DESIGN CONSIDERATIONS

4.1. GENERAL

Most Australian winches are designed so that no two are alike. They come in all shapes and sizes, single-drum, double-drum, petrol, diesel, automatic and manual. There is no standard Australian winch, just as there is no standard German or British winch.

The tendency in recent years has been towards a steady increase in the size of winch engines and the amount of power they produce. This is no surprise, because we have seen a comparable increase in the weight of gliders over the same period.

4.2. HOW MUCH POWER?

4.2.1. Low-powered winches

In the early days of winching, low-powered engines were common, mainly because they were readily available. Gliders tended to be light at that time, single-seaters grossing at about 300 kgs and two-seaters at about 400 kgs. These gliders also had old-fashioned wing-sections and low stalling-speeds, all of which suited them to being launched at relatively low speeds. Low-powered winches had little trouble launching such gliders.

Modern laminar-flow wing sections, heavier gliders and higher stalling-speeds made low powered winches ineffective and it was found that the glider pilot could control the speed of the launch - pulling back on the stick reduced the speed, easing off a bit allowed the speed to increase.

From the driver's point of view, there was not much skill or finesse attached to driving these winches, as much of their time was spent running flat-out and all the driver did was open the throttle and wait for the glider to appear above the horizon.

The low-powered winch was responsible for instilling in pilots and winch-drivers some habits which were found to be quite inappropriate when applied to the higher-powered winches which were a logical development to cope with the increasing glider weights.

Low-powered winches have nothing going for them and there is no excuse for a club to continue with one.

4.2.2. High-powered winches

Most winches today are driven by powerful V8 engines with an automatic transmission. The biggest danger with high-powered winches occurs when the power is misused to produce too much acceleration at the start of the launch. Of course, this is not the fault of the winch. Just because there is plenty of power on tap, it doesn't have to be used all at once.

Problems which may occur due to excessive acceleration are:-

1. Uncontrollable nose-up pitch, due to a combination of glider inertia and hook position.
2. Sideways swing on gliders with an offset hook.
3. Backward movement of the pilot, especially if soft cushions are in use.
4. Banging of the tail in "nosedragger" gliders, risking structural damage.

The power of the winch should be applied in such a way that the glider does not have an excessively long ground-run, but is not accelerated so rapidly that any of the above-listed problems occur. This is a function of winch-driver training.

When full climb is established and the speed falls, easing the stick forward a little will cause the speed to rise again. This is the correct initial response to a falling speed on any winch launch. However, if the speed is too high, pulling the stick back will not slow a high-powered winch.

On a high-powered winch, pulling the stick back is likely to cause an increase in speed, because of the “water-ski” phenomenon mentioned in section 3.1.4. Pilots and winch-drivers should clearly understand this.

There is every reason to fit a powerful engine to a winch, provided that it is used properly. If a change has been made from low to high power, some education of winch-drivers and pilots will be necessary to ensure a continued safe operation.

4.3. CAR RETRIEVE OR SELF-LAY?

If a double-drum winch is in use, there is a choice of how the cables are laid between launches.

Some clubs use a vehicle to pull the cables back to the launch-point from the winch after each pair of launches. This is effective and is the only method which can be used if the ground is a bit rough.

If the ground is smooth enough for a heavy vehicle to be driven on it, a self-laying winch can be used and is popular in some clubs. After each pair of launches, the winch is driven to the launch-point, both cables securely anchored and the winch driven back to its own end. This method has the advantage that there is no wear of the cables during the retrieve. The downside is that it is slower in operation than using retrieve cars. Clubs which use two self-laying winches report very high launch-rates while benefiting from the advantage of the self-laying system.

There is probably no point in using the self-laying system with a single-drum winch, as it will be too slow for anything but the smallest clubs with only one or two gliders. However, if car retrieve is used, a single-drum winch can be almost as quick in operation as a two-drum winch.

4.4. PROTECTION OF PERSONNEL

Moving high tensile winch wire has great potential to cause serious injury or death. We have learned the lesson that a cage alone may not be sufficient to protect the driver when things go wrong, and in some winch designs the additional protection of polycarbonate or safety glass is also needed.

The more the wire can be isolated from the occupants of the winch (by basic design), the better. The German “Tost” winch, for example, is completely enclosed, the drums being underneath the bodywork and the wires not seeing the light of day after they enter the front of the winch via the rollers. It is not difficult to provide some covering for the wire in most winch designs, but plenty of them are wide open, with the end of a broken wire able to flail around posing all kinds of hazard.

A means of cutting the cable in an emergency shall be provided that can be operated from inside the cab to enable the winch driver to cut the cable in the very unlikely event of it failing to release from the glider (refer MOSP2, Section 16.1.4). The cable-cutting device must be periodically tested. Recommended routine checks for cable cutting devices are described at APPENDIX 2 - GUILLOTINE SYSTEM - ROUTINE CHECKS.

An earthing spike is a useful, if not an essential, item of equipment. If a thunderstorm approaches a winch-launch site, flying should cease before the storm gets too close. As a storm approaches, a surprising amount of static electricity can build up in the winch and it is prudent to earth this static build-up.

If the winch is to be used for training another driver, both occupants of the cab should have:-

(a) equally good protection against the ingress of flying cable and other odds and ends; and

(b) equally good visibility from the cab to enable the glider to be kept directly in sight by driver and tutor during the entire launch. It is not good enough to rely on rear-view mirrors to attempt to train new drivers.

4.4.1. Cable Cutting Device Exemptions

Note: *In January 2005, several winch Clubs were issued with a GFA letter of exemption allowing them to continue to operate a winch in service at that time that was not fitted with a functional cabin operated emergency cable cutting device. Those clubs that are still active and operating a winch under this letter of exemption are:*

- *Adelaide University Gliding Club Inc*
- *Alice Springs Gliding Club Inc*
- *Balaklava Gliding Club Inc*
- *Bordertown-Keith Gliding Club Inc*
- *Bundaberg gliding inc.*
- *The Central Queensland Gliding Club Ltd*
- *The Geelong Gliding Club*
- *Grafton Gliding Club*
- *Grampians Soaring Club Inc*
- *Millicent Gliding Club*
- *North Queensland soaring centre inc.*
- *South Gippsland Gliding Club*

The winch must be operated by the Club on the following conditions:

1. *No alternative emergency cable cutting device or method requiring the winch driver to leave the safe confines of the cabin is to be provided;*
2. *Winch drivers are to be instructed that they are not expected to leave the cabin during a launch emergency whenever they are at risk of personal injury;*
3. *Winch drivers are to be instructed that in the case of a launch emergency they should shutdown the winch, leave the drum free to rotate and wait until all danger has passed; and*
4. *Pilots must be made aware, and accept, that during a launch emergency the winch cable will not be severed at the winch end.*
5. *The GFA letter of exemption is not transferrable. Clubs or Operators acquiring a winch subject to a letter of exemption must fit them with a cabin operated cable-cutting device before introducing them into service.*
6. *Clubs requiring an exemption to the GFA winch cutter policy should request a waiver by submitting a safety case to the GFA Operations Panel for consideration and approval.*

4.5. WEARING OF HEADSETS

Headsets serve a dual purpose in providing hearing protection whilst improving communications and it is therefore highly recommended that winch drivers wear and use a quality headset. Noise exposure can affect safety by impacting on our ability to perceive hazards, reducing vigilance and thereby result in more accidents. It also affects our ability to communicate and can have physical (e.g. tinnitus or pain at high levels of intensity) and psychological effects.

The radio is also a valuable safety tool that should be switched on with volume and squelch set as required and tuned to the appropriate frequency. It is important during launch that the driver monitors and can hear his radio. Experience suggests that if there is an emergency situation and the winch driver is maintaining a radio watch, an external observer may be able to communicate the impending emergency situation alerting the driver, thereby enhancing operational safety.

The winch driver also has a part to play in maintaining operational safety, and should have a good overview and understanding of what is happening in the circuit including what aircraft have departed or are inbound.

5 AIRFIELD REQUIREMENTS FOR WINCH-LAUNCHING

5.1. STRIP LENGTH

The minimum strip length for winch-launching is 1,200 metres. The purpose of this minimum length is to minimise the effects of the non-manoeuvring area (NMA), to create a buffer against density altitude problems in summer and to discourage any tendency to enter excessively steep climbs while too low.

Although the RM/O in each region has discretionary power to permit winch operations on a shorter strip than the permitted minimum, it is difficult to imagine a logical case for it and there are no known examples of such a concession anywhere in Australia.

5.2. STRIP SURROUNDINGS

The most hazardous obstacle in the vicinity of a winch-launching strip is a powerline. In spite of this, some clubs have operated safely for years with a powerline close at hand. In some cases, very careful drift correction has kept clubs out of trouble. In other cases, wire-rope has been chosen instead of solid wire, thus enabling a drogue chute to be eliminated and thereby minimising the chances of a cable drifting into a powerline after release. Polypropylene rope can also be used without a drogue chute and has the additional advantage of being non-ferrous and therefore less dangerous if it does contact a powerline.

When assessing a strip's surroundings for suitability as a winch-launch site as part of the Club's SMS RM Plan, it pays to be imaginative and take all possibilities into account, especially on the approaches, behind the winch and to each side in all useable wind directions. A particular hazard is launching close to a line of trees or buildings where a clear view of the approach cannot be achieved. Where such obstacles exist, the launch point should be displaced into the field to ensure airspace can be adequately cleared by the launch crew.

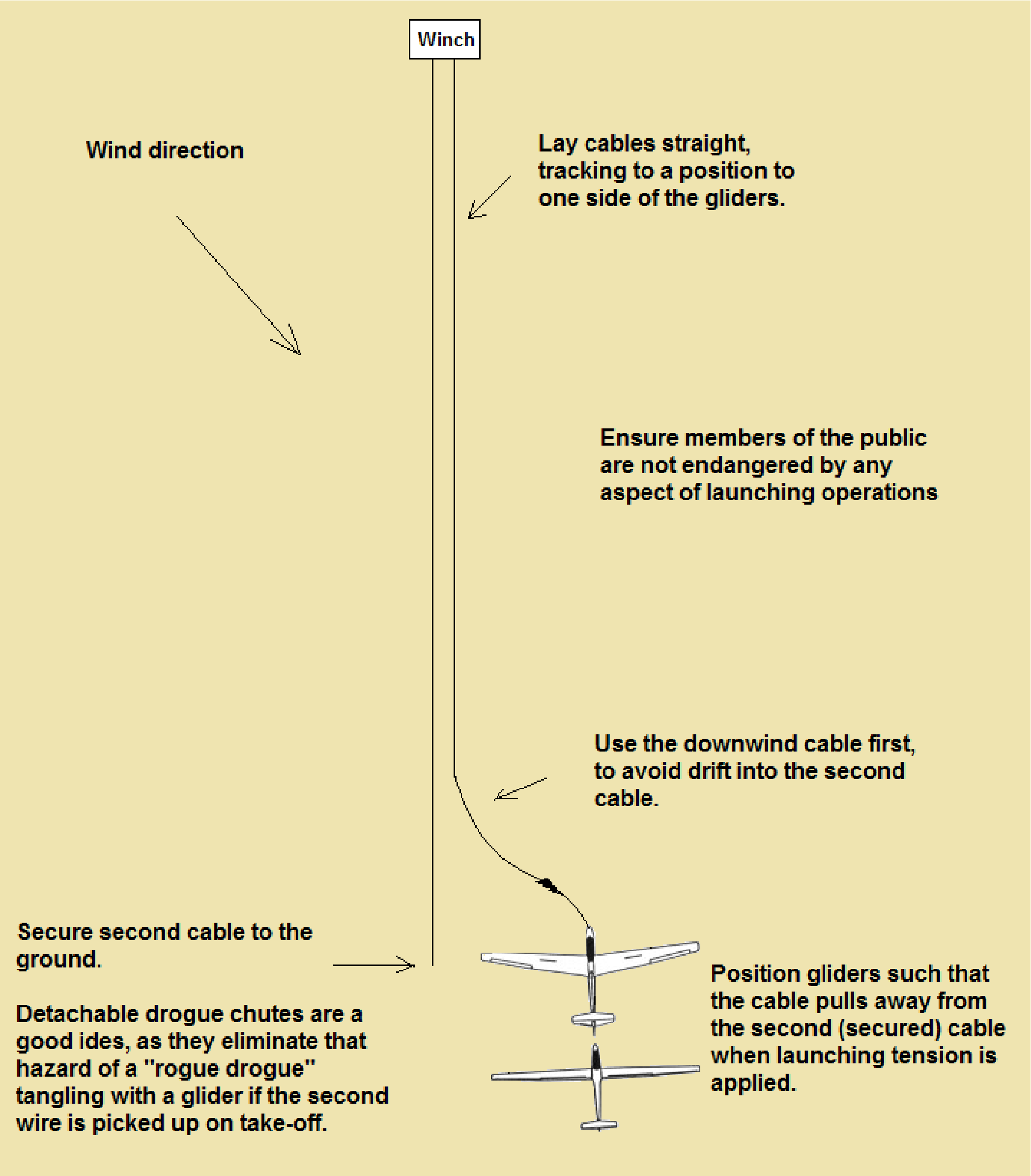
It is not unknown for an RM/O to refuse operations on a site which met the minimum length requirements but had too many potential hazards for reasons such as power lines or trees too close to one edge of the strip or turbulence in the lee of a hill in the most common wind directions.

5.3. CIRCUIT JOINING

The winch end of the runway should be considered a potential hazard and be given a wide berth. It is recommended that pilots stay outside a 500 metre radius of the winch. Circuits should be joined at a place giving as much clearance from the winch as practicable, and pilots should never approach and land at the winch end unless in an emergency or operationally necessary.

5.4. STRIP LAYOUT AND CABLE SAFETY

The following diagram illustrates the recommended strip layout and provides safety precautions.



If more than one cable is in use, there is the possibility that the cables may become crossed on the ground. This is usually because the driver of the retrieve car has not driven in an absolutely straight line between the winch and launch-point.

Crossed cables can be extremely dangerous, because it is possible for a glider to take off on one cable and pick up the second cable during the take-off run or early climb. This can result in a variety of problems, from simple crossing of the wires to entanglement with the aircraft.

It is virtually unknown for cables to become crossed when self-laying winches are used. Almost all the problems occur where vehicles are used for retrieving cables and are driven by untrained, inexperienced or careless drivers. Retrieve drivers need to be trained for their task just like any other member of a gliding crew. They should not be allowed to just jump in and retrieve cables without knowing what is expected of them

As gliding fields vary in the shapes and sizes, hard and fast rules are difficult to formulate. However, recommendations based on hard-won experience are easy to make and it is strongly suggested that the recommendations illustrated on the diagram above are adhered to in principle, only being altered in detail to suit the characteristics of individual strips (and documented in the Club's Standard Operating Procedures).

6 CABLES AND ANCILLARY EQUIPMENT

6.1. CABLE TYPES (refer MOSP 2, Section 16.1.5)

6.1.1. Solid wire

The recommended wire to be used for glider-launching is range 2 spring steel. Fencing wire, even of the high-tensile type, is not recommended for the launching of gliders. Range 2 spring steel wire is strong, durable, has good abrasion resistance and is impervious to dust. It is somewhat prone to fatigue and is sensitive to the diameter of drums, pulleys and rollers around which it passes. The bigger the drum and other rotating devices used to control the wire, the less problem will be experienced with fatigue. It is difficult and awkward to repair when it breaks, the normal methods being to tie a knot of either the "figure 8" or "reef" type or to use a steel ferrule with the ends of the wire passed through it. See also Section 8.2.1.2 "Cable inspection".

Range 2 spring steel wire is readily available from spring manufacturers in two sizes, 2.8mm or 3.15mm diameter. It is usually sold by weight, a 300 kg reel of 2.8mm wire easily providing over 4,500 metres, or well over three drum's worth.

Range 2 spring steel wire is not easy to handle. It never forgets the coils in which it was born and it must be kept constantly under tension when in service. If it breaks, both ends recoil away from each other and they can take much effort to locate and retrieve. If even mild tension (such as pulling by hand) is applied to this type of wire without checking very carefully that all loops are out of it, the wire will kink. One of the few certainties in this life is that, if more tension is then applied (such as attempting to carry out a launch), it will definitely break.

When sorting out a tangle following a breakage of solid wire, the crew absolutely MUST carry out a full kink check over the entire length of the wire. It is false economy and potentially dangerous to take a chance on it. Kink checks are time-consuming, but it is even more time-consuming to spend the whole afternoon involved in a kink-break, kink-break cycle because the job wasn't done properly in the first place.

The life of solid wire (measured as a function of how many breaks occur before it is no longer a safe proposition to keep repairing it) varies from less than 1,000 launches at a club operating on a rough, flinty surface to over 1,500 on a smoother, more forgiving surface.

The arguments for and against this kind of wire can be summed up as follows:-

For - cost-effective, readily available, unaffected by dust, good durability and strength/weight ratio.

Against - difficult to handle, potentially dangerous to bystanders when a break occurs, needs expert handling to avoid kinks, awkward to repair but the technique is effective once it is learned.

6.1.2. Stranded cable (wire rope)

Stranded cable tends to fail progressively, warning the operators of impending failure by producing "bird's nests" of failed individual strands. However, the impending failure will only be spotted if regular inspections are carried out during the day.

Joins are usually made by swaging with alloy or copper ferrules, compressed in a pair of special pliers or a small hydraulic press. These joins are virtually as strong as the original cable and the ferrules pass through winch rollers without causing havoc. For expediency, stranded cable can be joined with a reef knot and the ends taped with electrical insulating tape.

Stranded cable does not return to coils when not under tension. It lays quite flat and is much easier to handle than solid wire, provided industrial gloves are worn, as there can be invisible spikes sticking out in all directions and these can cause nasty cuts and scratches.

Because of its more predictable behaviour, it is possible to launch with stranded cable without using one of the usual drogue chutes at the glider end. This can be an advantage if the airfield is close to public roads or other hazards such as power lines, as the cable does not drift in the same way that a drogue-equipped cable does.

6.1.3. Polypropylene rope

Advantages of poly rope for winch-launching are as follows:-

1. It is much easier to handle than any kind of wire.
2. It is considerably safer for all concerned than any kind of wire.
3. It is readily available via marine suppliers at reasonable prices.
4. It needs no drogue and no swivel.
5. It is very easy and quick to repair, provided the club members have splicing skills. If necessary, to keep things going during a day's operations, a reef knot is quite acceptable until the rope can be spliced later in the day.
6. It gives a particularly smooth launch, with none of the bumps and grinds typically associated with wire-launching.

Disadvantages of poly rope are:-

1. The large diameter of the rope means that a larger diameter drum is required in order to accommodate the length required for launching.
2. There is some stretch in the rope when it is first used. This can cause a "bungy" effect at the start of the launch, resulting in a loss of speed when the stretch is taken up at about 100 feet AGL. It seems that the stretch goes out of the rope after about a dozen launches and the behaviour of the rope is normal from then on.

6.1.4. Ultra-high-molecular-weight polyethylene

Ultra-High molecular weight polyethylene (UHMWPE) fibres yield very high strength and cut resistant ropes often facilitating replacement of steel cables at one tenth their weight. Trial of 5mm x 8 strand UHMWPE rope (e.g. Dyneema®) has proven to be an easy material to use and handle and has very good wear properties. However, it is more expensive than wire cable. It is also very light and may not always sit flush with the ground, especially if there are hollows in the surface, thereby posing a danger of being picked up by vehicles or aircraft.

6.2. THE CABLE END

6.2.1. Trace

The "trace" is the piece of material connecting the weak link to the rings which attach to the glider (refer MOSP 2, Section 16.1.5**)**.

Traces should not have any elasticity at all, otherwise weak-link failure will result in catapulting the trace and any attachments back through the glider. Polypropylene rope is unsuitable; ordinary sisal rope is better and very strong stranded cable is ideal.

To minimise the risk of the trace wrapping itself around an axle during an overrun on take-off, it should either be very thick itself or (in the case of cable) be covered with garden hose or similar material to build up its thickness. This helps to prevent it getting up alongside the wheel.

The minimum distance between the weak link and the glider is 5 metres. It can with advantage be considerably longer than this.

6.2.2. Drogue parachute

The weak link should be attached to the drogue by a non-elastic cable (wire or sisal rope) at least 10m in length. This is to ensure there is sufficient clearance between the drogue and the glider in case of premature deployment of the drogue during a launch-failure in the early stages of the take-off. If the drogue is too close to the glider, it could result in entanglement with the glider during launch.

The purpose of the drogue is to stabilise the cable after release from the glider. It is an essential item on solid wire, optional on stranded cable and poly rope. Additional requirements of a drogue are that it should fall away from the glider initially before opening (not pop open immediately the winch throttle is closed), that all its shroud-lines should be load-bearing to ensure that the drogue does not deploy during the take-off and still provides a controlled descent after release. The latter point is not easy to achieve and demands careful design. Cases have occurred where glider canopies have been completely obscured by a poorly-designed drogue following a launch failure with the glider just off the ground.

Many drogues are home-made but good quality, well designed and effective drogues are available commercially. Should home-made drogues be considered, they need to be carefully designed and constructed. Home-made drogue designs are numerous, most of them using farm fertiliser bags or woolpacks. Most of them work quite well, but must not be too large, which can cause problems. The drogue should be only just large enough to provide stabilisation but not so large that entanglement with the glider is possible if the launch fails shortly after take-off or a student pilot does not follow a correctly-graded take-off profile.

A further problem with a large drogue, this time in the full climb, may be disturbance of the airflow over the glider's tailplane with the possibility of causing a tailplane stall.

A small drogue should be used with lightweight rope (e.g. Dyneema®) to ensure it falls away quickly after release or following a cable break.

6.2.3. Weak link (refer MOSP 2, Section 16.1.6).

A weak-link is a necessary part of winch-launching equipment and is installed to protect the glider from overstressing on the launch. The airworthiness certification of the glider depends on the use of a weak-link which falls within the specified range of breaking loads on the glider's cockpit placard (refer OAN 01/13 Weak Links).

The weak link must be placed on the glider side of the drogue, so that the drogue is pulled well clear of the glider in the event of a weak link break.

6.2.4. Types of weak-link

These vary from lengths of poly rope, through some very effective shear-pin designs, to the "Tost" series of purpose-built weak-links from Germany.

6.2.4.1. Polypropylene rope.

Lengths of poly rope are subject to the vagaries of quality-control suffered by this material. A piece of, say, 8 mm poly rope (commonly used as an aerotow weak-link) may vary in its breaking strength by up to 100 kgs from one batch to the next. Almost always it is stronger than specified.

In addition, many synthetic polymers are attacked by ultraviolet radiation, and ropes made from these materials may crack or disintegrate if they are not UV-stable. The problem is known as UV degradation, and is a common problem in ropes exposed to sunlight.

This material is not recommended for weak-link use.

6.2.4.2. Shear-pin weak-links.

A shear-pin weak-link consists basically of two concentric pieces of cylindrical steel, a solid inner sliding in and out of a hollow outer. A hole is drilled right through the entire assembly at right-angles to the direction of sliding. A pin is then inserted into the hole. When the specified breaking load is reached, the pin shears, the inner core slides out of the outer shell and the link is broken. There are suitable brackets at each end for attaching to shackles which connect to the cable.

The most common material used for the shear pins is welding-rod. Black gas-welding rod of 1/8” diameter breaks at 500 kgs in double shear. High-tensile gas-welding rod (copper-coloured) breaks at 710 kgs in double shear. In both cases the breaking load is independent of the rate of load application.

If material different from the above is used, it must be tested. In all cases, whatever material is used, the links must be suitably marked and the facts recorded within the club for future reference. There is advantage in colour-coding weak links in accordance with the international practice established by the Tost Company. Alternatively it is easy to stamp the breaking load on the body of the weak-link.

One advantage of the shear-pin weak-link is robustness, being able to withstand being constantly dropped to the ground from great heights without distortion occurring. A further advantage is that the pin may be partially sheared and the weak-link will still hold, the barrels pulling apart slightly to enable the next person attaching a cable to a glider to detect it and replace the pin.

The main disadvantage of this type of weak-link is that even minor burrs on the inside of the concentric barrels of metal can greatly increase the load required to break the link. Corrosion can also affect the breaking load and this type of weak-link has to be deliberately broken open at regular intervals (say, once a month) to lubricate and ensure freedom of operation.

6.2.4.3. The Tost system.

The "Tost" weak link system is recommended. This system, manufactured by Tost Flugzeuggerätebau in Germany (the well-known maker of release hooks), uses two metal fish-plates in parallel, mounted to the cable and trace by a shackle at each end. A protective steel sleeve must be used over the fish-plates to prevent wear. Use of the correct shackles will prevent the weak link and the steel sleeve from twisting.

The method of protection is simple. One of the fish-plates has oval holes at each end and the other has round holes. If the weak-link is taken very close to its breaking strength but does not exceed it, the fish-plate with the round holes will break and the fishplate with the oval holes will remain in place allowing the launch to continue.

When the cable is inspected prior to the next launch, the person attaching the cable will notice the two ends of the first fishplate hanging down and will realise that the system has been strained but did not break fully. The broken fishplate is then replaced. Of course, if the system is taken right to its limit, both fishplates break and the glider is protected.

There is one very serious warning with Tost weak-links. Care is needed to replace the broken fishplate with EXACTLY the same item as the one that broke. Never use two equal inserts, e.g., both with round holes, as the breaking load of the weak-link will be doubled, completely defeating its purpose. Check that the replacement fishplate is of the same colour but has DIFFERENT end-holes from the remaining one.

TOST recommends that the fish-plates be replaced after 200 launches.

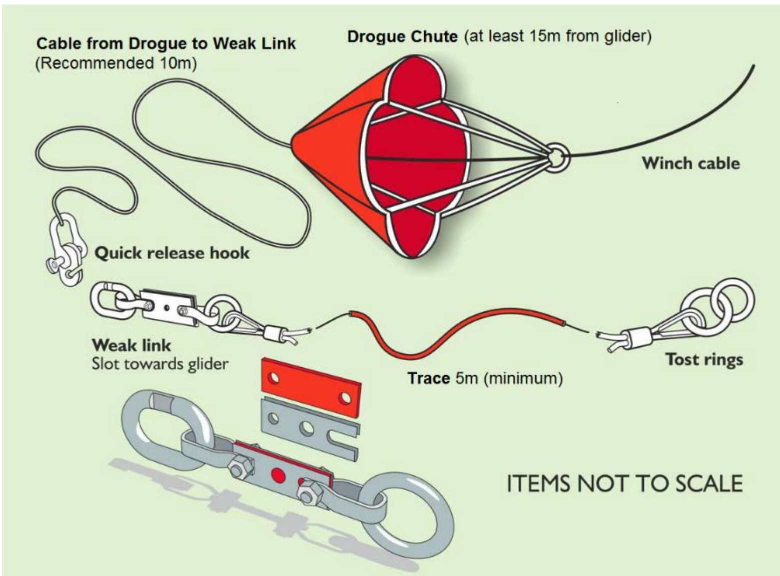
Use only the weak links stipulated in your aircraft's 'Type Certificate Data Sheet' or flight manual. Tost weak-links are colour-coded according to breaking load. The complete range is listed below:

No.	Colour	Strength
1	**Black**	1000 ±100 Kgs
2	**Brown**	850 ±85 Kgs
3	**Red**	750 ±75 Kgs
4	**Blue**	600 ±60 Kgs
5	**White**	500 ±50 Kgs
6	**Yellow**	400 ±40 Kgs
7	**Green**	300 ±30 Kgs

6.2.5. Recommended Cable Set-Up

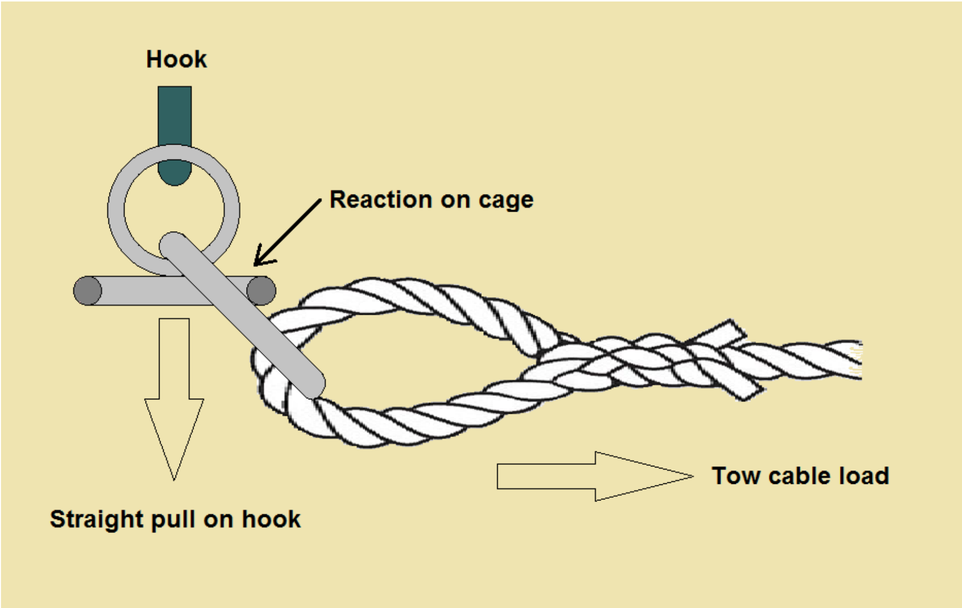
The following set-up places the weak-link in an intermediate position between the drogue-chute and the glider, minimising the mass of material on the glider side of the weak-link. The system is known to work well in practice.

An optional extra is a brightly-coloured flag attached to the trace to assist in finding it after a weak-link break during a launch.



6.2.6. Rings

The cable terminates in two linked rings; one large and one small. The reason for using two rings, instead of just one, is to ensure that the force applied to the hook by the pull of the cable is always as close as possible to a straight pull, with no side load. This is achieved by the larger of the two rings bearing up against the "cage" of the belly-hook.



The only rings approved for the launching of gliders in Australia are those of the "Tost" design, as described in OAN 01/13 Weak Links. Rings of the older "Ottfur" design are not permitted on gliders, as they may cause some types of releases to jam under certain conditions.

Tost rings are not cheap, but they are absolutely reliable and are therefore good insurance against launching problems. As such, they are very cost-effective.

7 SIGNALLING SYSTEMS

Because of the distance between the glider and the winch, a clear and unambiguous signalling system is essential. There must be no doubt about the exact signal being given and no possibility of confusion.

Conventional take-up-slack/all-out/stop hand signals are given by the wing-tip holder, a system common to all launch methods. These are passed on to the winch by the chosen method of long-range signalling in use by the club.

Signalling systems may be visual or aural. There are pros and cons for both types.

7.1. AURAL SIGNALLING SYSTEMS

7.1.1. Radio (MOSP 2, Section16.1.8.1)

Aeronautical band VHF radio

Aeronautical VHF systems broadcasting on the CTAF (or local frequency) is used so that all aircraft in the vicinity of the aerodrome are able to hear the launch signals, thereby giving rise to greater situational awareness (refer also to MOSP 18.10). However, radio operators must hold a FROL or a GFA Radiotelephone Operator Authorisation. Use of the glider's radio to give the launch commands is not permitted (refer 7.1.3), although the pilot may communicate 'too fast' or 'too slow' to the winch driver during the climb.

Pro - Cheap to buy, easy to install, reliable in operation.

Con - Engine noise can drown out speech during take-off and it is usually necessary to provide a loudspeaker or headset to ensure the driver can hear the launch signals. It is especially important to be able to hear a stop signal, which may be given after full power has been applied.

27 MHz and UHF CB radio

Equipment for 27MHz can generally be bought cheaper than that for UHF. At the cheap end of the scale, you can buy an AM only 27MHz CB, which would be fine for chatting between the launch point and the winch. AM (Amplitude Modulation) here refers to the method your voice is 'impressed' onto the radio waves. The big drawback of AM is that it is very susceptible to noise, and is not a very efficient way of transmitting your voice; only one eighth of the power of your transmitted radio signal is actually used to carry your voice to the other end. The bonus for AM is that it is simple and cheap, and sets can be made quite small.

If you want to overcome this drawback, you could buy a 27MHz CB with SSB (Single Side Band) as well as AM. Single side band is a different, more efficient way of transmitting your voice. It is less susceptible to noise than AM, and regulations governing the allowable output power of CB radios allow a higher output power using SSB, thus allowing a longer reach for your signal. The drawbacks of SSB is that the equipment is not as compact, more expensive, and the voice quality while very understandable, has a slightly unnatural quality to it.

Antennae for 27MHz are, generally speaking, considerably larger than their UHF counterparts.

UHF CB equipment is generally more expensive, but not tremendously so. Unlike 27MHz equipment, UHF CB comes in one flavour only: FM. Frequency Modulation, or FM, is a very crisp, clear and efficient way of transmitting your signal, and suffers less from the affects of noise than does AM or SSB.

The higher frequency, and thus, shorter wavelength of UHF CB (477MHz at about 0.6 meters' wavelength as opposed to 27MHz at about 11 metre's wavelength) means shorter, more convenient sized antennae which can lead to building practical antennae that offer 'gain' and much less atmospheric and man-made noise. On the other side of the coin, UHF signals do tend to suffer more attenuation, that is, the signal becoming weaker, when passing through buildings, trees, or passing over difficult terrain.

Pro - Cheap to buy, easy to install, reliable in operation.

Con - Prone to interference by (a) legitimate CB traffic such as truck drivers and (b) hooligans who listen and mimic launch transmissions for fun. It may be necessary to shop around on any given day to find an interference-free channel. Generally not a big problem away from the main highways.

A headset or loudspeaker should be used to ensure the driver can hear the launch signals. It is especially important to be able to hear a stop signal, which may be given after full power has been applied.

7.1.2. Field telephone (MOSP 2, Section16.1.8.2)

Pro - Reasonably foolproof method of communication, provided all the connections are properly made and decently looked after.

Con - Engine noise can drown out speech during take-off and it is usually necessary to provide a loudspeaker or headset to ensure the driver can hear the launch signals. Can be maintenance-intensive after a few years, especially if a fence-wire or earth-return are used to complete the circuit. This can erode the inherent reliability of the basic system.

7.1.3. Particular requirement when using radio for launch signals

If radio is used for launch-point signalling, it must be EXTERNAL to the glider. Use of radio directly from the glider to the winch is not permitted (MOSP 16.1.8.1). The reason for this is to cover the situation where an emergency occurs and the pilot may not have seen it develop. Such a case might be an overrun, where the trace has become entangled with the wheel or skid, or a small child escaping from a parent's supervision and suddenly running out behind the wing and in front of the tail.

7.2. VISUAL SIGNALLING SYSTEMS

7.2.1. Lamp signals (MOSP 2, Section16.1.8.5)

These may take the form of car headlights or a separate system such as an Aldis signalling lamp. The signals are as follows:-

Take up slack. Morse dashes of about two to three seconds duration, separated by similar intervals.

All out (full power in some regions). Morse dots of about one second duration, separated by similar intervals.

Stop. Lamp(s) continuously illuminated.

Pro - The system is simple and a member's car can easily be used for the purpose. Little or no training is required, beyond knowing the actual signals.

Con - The "mirage" effect during summer can make it difficult to distinguish which signal is which. A continuous light can appear to shimmer and could be mistaken for "all out". Some clubs counter this by varying the number of lights (e.g. one light for take-up-slack, two lights for all-out).

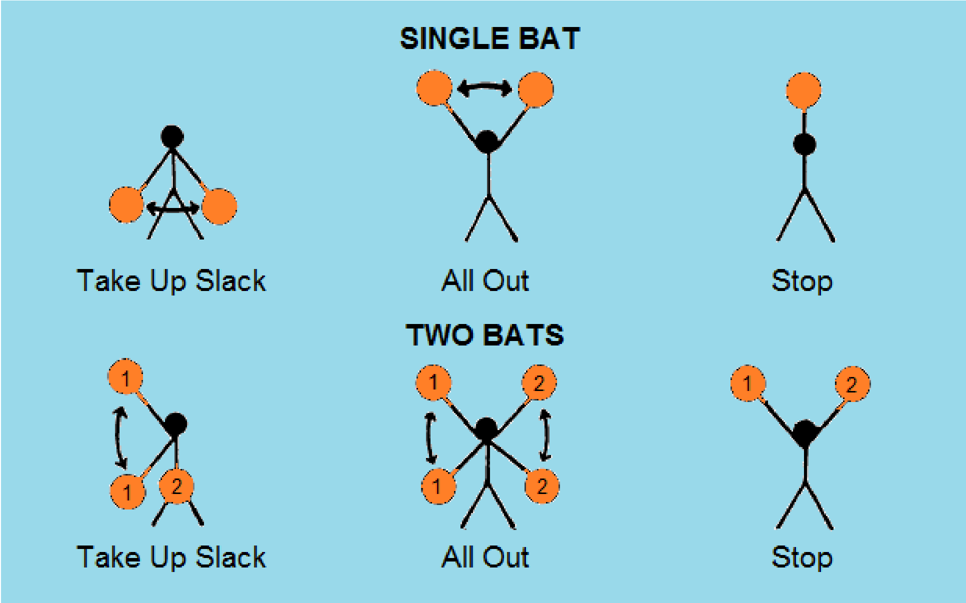
It is not a "fail-safe" system, the Stop signal demanding a continuous light. This means that winch-drivers MUST be trained to automatically stop the launch if signalling stops for any reason (lead falling off battery, blown bulb, etc.). No assumptions can afford to be made.

Lamp signals obviously do not work at sites where strip curvature prevents the winch from being seen from the launch-point. The problem can be overcome by using a mid-field signaller to relay signals to the winch, but it adds too much complication to what should be a simple system and is not recommended.

Also, the "Dashes" and "Dots" must be long enough to allow the bulb to light up clearly for the "Dots" and for there to be a distinctive difference between the two signals. A definite difference in rhythm will also help to make the signals easier to read.

7.2.2. Bat signals (MOSP 2, Section16.1.8.3 & 16.1.8.4)

This is still popular in some regions and is more satisfactory than lights, because it is less susceptible to mirage effect. There are two types of bat signals, as follows:-



7.2.3. Wing-waggling (MOSP 2, Section16.1.8.6)

This is sometimes used in the absence of any alternative. For "take-up slack", the wings are rocked by the wingtip holder over as big an arc as possible, for "all out" the wings are held level and for "stop" the wingtip is placed on the ground and left there (the pilot having released the cable, of course).

7.3. SPECIAL PRECAUTION FOR ALL WINCH-LAUNCH SIGNALLING SYSTEMS

After the "all-out" ("full power") signal has been given and the launch has commenced, the signaller should watch the glider at least until it is established in the full climb, standing by to give a "stop" signal if necessary. The reason for this precaution is to guard against an emergency occurring during the early part of the launch.

The most likely occurrence is, in multiple cable operations, the glider picking up the "dead" cable, which becomes entangled somewhere in the airframe. This is a potentially hazardous situation, which the pilot may not know about, and the launch must be stopped. The habit of closely observing every take-off and stopping the launch if necessary is a very real contribution to safety in winch-launching.

8 WINCH-DRIVER TRAINING

People are not born with any special talent for launching gliders - as with any skilled task, they have to be trained. The programme outlined here is designed to ensure an adequate level of understanding of all the factors which need to be considered when launching gliders.

8.1. SELECTION OF SUITABLE WINCH-DRIVERS

Some clubs require a person to be solo pilot before being allowed to drive the winch. Others take the opposite view, that a person cannot go solo until they have mastered winch-driving. Some say there should be a lower limit in the age for winch-drivers, other clubs would grind to a halt if the kids who drive the winch were not allowed to do so.

Out of this incredibly diverse range of personalities, it is not surprising that some difficulty arises in trying to establish some guidelines. However, it should not stop us trying.

8.1.1. Mechanical aptitude

There would probably be general agreement that there are some people who should not be allowed near a winch. These are the people who seem to cause endless fumbles, never get the speed right and usually bang the glider's tail down on every take-off. Perhaps these are the people who lack this hard-to-define quality of "mechanical aptitude". On the other hand, they may just be the kind of people who deliberately drop the dishes during washing-up so they don't get asked to do it again.

In the context of driving a winch, mechanical aptitude has less to do with the ability to wield a spanner or probe the mysteries of an internal combustion engine than to have some appreciation of events on both ends of the wire and an aptitude for smooth, competent handling.

8.1.2. Solo pilot or not?

If it is true that some appreciation of both ends of the wire is helpful, it would appear that being a solo pilot is a reasonable requirement for winch-driver training. However there is no evidence to show that people who are qualified solo pilots are any better at winch-driving than people who aren't and there are plenty of people all round the world who drive winches professionally without ever setting foot in a glider. The real answer is proper training.

Note that, if the person driving the winch is not a GFA member, the protection of the Broad-Based Liability and Contingent Liability insurance policies will not apply.

8.2. THE TRAINING SYLLABUS - NORMAL PROCEDURES

8.2.1. Preparing for launching

A winch-driver should be trained to properly carry out a daily inspection of the winch, its cable and attachments (refer MOSP 2, Section 16.1.11**)**.

8.2.1.1. The winch inspection

The winch must be checked for sufficient fuel, oil and water. More than one accident has been caused by the winch running out of fuel shortly after take-off. If a fuel gauge is not fitted, or is unserviceable, a dipstick must be used to check fuel contents and kept in the winch for periodic checks during the day.

To start the winch daily inspection, the basic "POWER" mnemonic, used to check a vehicle before going out on the road, works just as well on a winch. The items are:-

Petrol - Contents sufficient. Top up the tank if necessary.

Oil - Contents sufficient. Top up the tank if necessary. Check auto-trans fluid when engine hot.

Water - Contents sufficient. Top up the tank if necessary.

Electrics - Check electrolyte level in battery, condition and security of connections, condition of ignition harness and connections to coil, distributor and spark plugs.

Rubber - Check tyres for serviceability.

Some of these items will not apply if the winch has a diesel engine, but the basic principle of using a mnemonic is sound and should be used in preference to relying on the vagaries of human memory.

The condition of driver protection items must be checked. This includes the protective cage for the winch occupants and any additional polycarbonate or armoured glass panels which should be in place. Remember that if a winch is used for training, **BOTH** occupants need the same high level of protection from the wire.

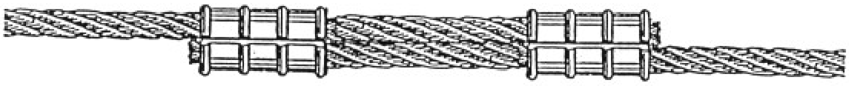
> **CAUTION:** When inspecting a winch, never neglect items of importance to the safety of the occupants - it is foolish to take a chance on someone's life.

8.2.1.2. The cable inspection

The cable(s) should be pulled out from the winch (or the winch driven down the field with the cable-ends anchored) and each cable checked for serviceability over its entire length at the beginning of each day's operations. This entails either driving along the cables or winching them in slowly, inspecting the general integrity of the wire for signs of wear and/or work-hardening and inspecting knots or suspect parts as they come in. There is no short cut to this - it just has to be done.

8.2.1.3. Checking and re-making joins in cable

Swages in stranded cable and knots in solid wire are easy to inspect. In both cases, if there is any doubt as to their integrity, cut them out and remake them. It is time-consuming, but well worth it in terms of safety and convenience.



Stranded cable (wire rope) - standard swage

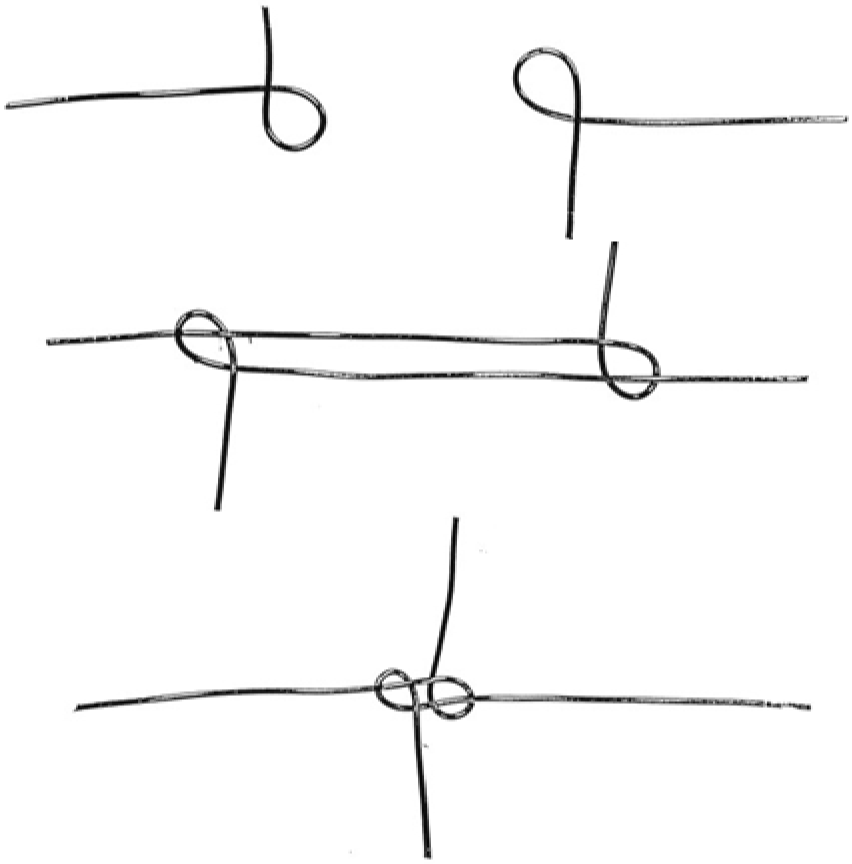
Knots may deteriorate in one of two ways, abrasion or fatigue, or a combination of both. Abrasion is detectable by obvious "flats" where the knots run along the ground. Fatigue is a little more awkward, the most obvious sign being a narrowing or "waisting" of the wire at the stress-points of the knot.

According to Australian Wire Industries P/L, the figure-8 knot in solid wire is a little less prone to fatigue failure than the reef knot.

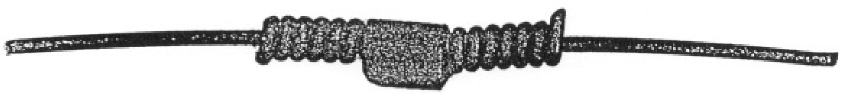
Reef knots are made by passing the ends of the wire through each other in a "left over right - right over left" sequence, then tightening as much as possible. The ends are then wrapped around the wire up to about six times. Trim the ends as close as possible to the wire.

Figure 8 knots require no wrapping after they are made, but it will be necessary to trim any protruding ends after the first launch on the new knot has taken place. Otherwise the ends may catch on the rest of the cable on the drum.

Solid wire - sequence of making figure 8 knot. The knot is shown before final tensioning.



An alternative method of joining solid wire is to use a steel ferrule, through which the wires are passed and then wrapped around several times on each side. The advantage of this kind of joint is that the ferrule protects the wire from abrasion and the joints have proved to be longer lasting than knots for this reason.



However, the internal dimensions of the ferrule are critical, otherwise the wires will pull through. It is necessary to drill out the ferrule to exactly twice the wire diameter, then partially counter-bore from each end to produce a taper. The ferrule may then be squashed, to allow the two wires to lay alongside each other when they are passed through.

The ferrules are small enough to pass through roller and pulley systems and if each end of the ferrule is chamfered, there is no tendency to catch on any fittings. Because there are no “tails” sticking out from the knots, snarl-ups during cable-retrieves do not occur.

8.2.1.4. Polypropylene rope

If polypropylene rope is used for winch-launching, the same inspection requirements apply. The only difference is that joins are made by splicing, so the club needs to have as many people as possible who are proficient at this. To keep things going during a day’s operations or until the resident splicing expert can be found, a reef knot is quite satisfactory, but a watchful eye needs to be kept on wear due to abrasion.

8.2.1.5. Cable-end fittings

The integrity of the weak link assembly, drogue-chute, trace and rings must be checked during the inspection. Don't launch a glider if there is any doubt about any component - fix it or replace it. If you are worried about the cost of replacing bits which look as if they might keep going a bit longer, remember the old saying "if you think preventative maintenance is expensive, try having an accident".

When the winch and all items of launching equipment have been inspected and are satisfactory, the system is ready for launching.

8.2.2. Safety precautions and emergency equipment

Appropriate risk management precautions should be taken in accordance with the Club's RM Plan. Some basic measures include:-

1. Positioning the winch in such a way that it poses no threat to members of the public.
2. Ensuring unauthorised persons are kept at a safe distance from the winch when launching is in progress.
3. Ensuring the brakes are applied to the winch wheels, or chocks are placed under them.

8.2.3. Laying the cables

Unless a self-laying system is in use, the winch driver should keep in mind that safety of bystanders is just as important while the cables are being towed out as it is during launching. Tangles on the winch can (and do) occur during towing-out and these sometimes achieve epic proportions if the tow-out speed has been too fast. In such circumstances, injury due to flying ends or broken pieces of cable is quite possible and the driver is primarily responsible for the prevention of such injury. Keep people well clear.

Opinions vary as to the best tow-out speed, some clubs using 30 km/hr as a basic guideline, others being enthusiastic about speeds considerably higher than this. Although towing cables out at high speeds often seems to work quite well, problems caused by tangles at the winch end get rapidly worse as the speeds increase and the risk of personal injury increases proportionally.

8.2.4. Launching

8.2.4.1. Pre-launch

Ensure that the signalling system in use is serviceable and, in the case of a radio or telephone system, test it before launching.

Note the wind speed and direction and anticipate whether there is likely to be any wind gradient.

Make sure the engine has been properly warmed up and ready to accept the load before launching. Launching a glider with a cold engine could result in a completely unnecessary launch failure at a critical stage.

8.2.4.2. Taking up slack

When the "take up slack" signal has been given, engage the drive system (or the most appropriate gear, depending on glider type and wind velocity) and commence taking up the slack. This should be done at not more than idle speed, as taking up slack at any speed higher than this often results in the glider over-running the cable. This is potentially dangerous, because the cable can back-release and wrap itself around the glider's wheel or other protuberance. If the launch is continued, the pilot is unable to release the cable and a serious accident is a real possibility. Drum speeds must be kept low when taking up slack, to the extent that the brake may have to be used to keep it under control if the engine's idle speed is on the high side.

Note: The assumption has been made here that the winch has automatic transmission. If manual transmission is fitted, the same principle, of keeping the drum speed low when taking up slack, must be adhered to, if necessary slipping the clutch to achieve this objective.

8.2.4.3. All out (full power)

This is the most critical part of winch-driver training and the one with the most potential to cause problems which lead to serious accidents. This is especially the case with high-powered winches.

There are in fact two critical points to be considered in the safe and efficient launching of a glider. They both demand a degree of pre-planning on the part of the winch-driver, who must carefully note the wind speed and direction immediately prior to the launch and who should be informed as to the glider type by the signaller at the launch point.

The first critical point is the rate at which the throttle is opened. There is nothing whatsoever wrong with high-powered winches, provided the rate at which the power is applied is spread over a reasonable time-span. Three to four seconds between idle and launch power is probably close to the mark, this giving good acceleration and enabling the glider to achieve flying speed without a long ground run.

Applying power too quickly (anything less than 3 - 4 seconds) does not significantly improve the glider's acceleration to flying speed. All it achieves is to cause a massive nose-up pitch (remember the glider has considerable inertia), which gives the pilot far less control over the nose attitude at the most critical stage of the launch. In the case of "nose-dragger" gliders, it also bangs the tail down hard, which must cause cumulative damage to the structure. There is every reason to apply the power smoothly and progressively over a 3 - 4 second period and there is no valid reason to shorten that period.

So much for the rate of power application. The second critical point is how much power to apply. Full power may not be needed, depending on glider weight, speed limitations and wind conditions. It is at this point that the expression "full power", common all over the northern part of Australia, proves itself to be a misnomer, "all out" being the better expression (meaning "all the slack is out of the wire"). If the power required is known by experience, open the throttle smoothly and progressively to the known point and wait for the glider to appear in the climb. If the exact power required is not known, and in any case in a training situation, keep opening the throttle until the glider is seen to be in the full climb attitude and then hold that throttle setting until a signal indicates otherwise.

Having dealt with the problems associated with excessive acceleration, the opposite case should be considered, that of taking too long to apply the power on take-off. If power is applied too slowly, there are two undesirable effects:-

1. The glider suffers unnecessary wear and tear on the long ground run and may suffer stone damage from the drogue chute.
2. More importantly, the pilot may become frustrated with the low rate of acceleration and use a lot of back stick to try to make the glider fly. When flying speed eventually builds up, the glider leaves the ground at the absolute minimum speed and enters a rather steep climb with the stick a long way back. In such circumstances the glider is extremely vulnerable to an accident caused by even a minor hiccup at

the winch or, just as likely, a departure from controlled flight due to the excessive angle of attack.

8.2.4.4. The full climb

Once the glider has arrived safely in the full climb and provided there are no signals from the glider indicating the pilot is unhappy with the speed, as a general rule the driver maintains pretty much the same throttle setting until the glider is about half-way up the launch, in other words at about a 45º cable angle estimated from the winch-cab, although this will vary somewhat with wind conditions. No two launches are exactly the same.

Once the glider is in the full climb, its speed can be estimated by the winch-driver by observing the amount of droop in the wire. If the glider does not appear to be climbing very well and there is a noticeable droop in the wire, the launch is almost certainly too slow and this situation is usually confirmed by the pilot lowering the nose. If the glider seems to be climbing really rapidly and the wire is obviously very tight, the chances are that the launch is getting a bit fast and this will be confirmed by a “too fast” signal (glider yawing). The driver should react to these signals smoothly but positively, otherwise the pilot may be forced to release.

From the halfway point on, the throttle is progressively closed, otherwise the glider will get faster and faster as it approaches the top of the launch. “Too fast” signals are common towards the top of the launch and failure to reduce the power in the winch is likely to result in one of the following:-

1. The pilot releasing the cable under tension in response to a rising speed, which could lead to the cable jumping over the side of the drum and wrapping itself around the axle.
2. The weak-link breaks, resulting in the glider pilot having to take immediate recovery action and the cable falling to the ground and potentially becoming a hazard to people and structures on the ground.

Accurate grading of the power as the launch progresses past the halfway point is an essential skill which a winch-driver must have. This means a good standard of training to instil that skill into a driver.

8.2.4.5. The release

Only on a strong wind day will the throttle be anything like fully closed at the top of the launch. Such days are relatively rare. In all other circumstances the winch-driver should terminate the launch by fully closing the throttle when the glider has reached an angle estimated at about 70º upwards from the winch. Once the throttle is closed, the cable goes slack and the pilot feels that the launch has come to an end. At this point one of two things will occur.

1. The pilot will lower the nose slightly below the horizon and pull the release twice to release the cable, or
2. The cable will back-release of its own accord when the throttle is closed. In this event the pilot always pulls the release in any case, as a precaution.

When it has released, the cable will fall clear of the glider and the drogue chute (if fitted) will deploy.

8.2.4.6. Post-release

When the driver is certain that the cable is clear of the glider, the throttle may be progressively opened to maintain tension and bring in the cable as rapidly as possible.

The driver must monitor any tendency of the cable to drift with the wind. If there is a crosswind and the pilot's correction has not been adequate, the cable will drift quite a long way. In this case the driver will need to make the effort to increase the speed of the cable to keep it within the airfield.

If it is apparent that the cable is going to fall outside the airfield, the driver will need to stop the cable completely if they cannot see where the cable is actually going to fall. It may, for example be obscured by tall trees and it may not be possible to determine whether the cable has fallen on or close to persons or property. The cable must not be moved until someone has checked that it is safe to do so and has communicated that fact to the winch-driver.

In any case, even if the cable can be clearly seen when it falls outside the airfield, it is often necessary to call for help to lift the drogue chute over barbed-wire fences, etc., to avoid the possibility of shredding it (or wrecking the fence) as it is winched over.

8.3. ABNORMAL PROCEDURES

8.3.1. Cable breaks

As soon as a cable break is detected the brake should be applied and the transmission selected to neutral.

Once the transmission has been disconnected from the engine and the cable is no longer being winched in, the exact rate at which the brake is applied is not really critical. It is probably better to apply the brake progressively than suddenly, because the momentum of the cable spooling onto the drum could cause quite a mess if the drum were abruptly stopped under it.

The important thing is to terminate the launch as soon as you reasonably can to ensure that, if the glider should become entangled with the cable for any reason, the cable is stationary or nearly so. Otherwise there is a strong chance that the cable could pull the glider into an attitude from which it might be difficult or impossible to recover.

A particular problem is the cable going over the wing of the glider after a cable-break. This can occur if the climb has been very steep and the pilot pitches down very quickly after the cable-break. If this coincides with the winch-driver not removing power quickly, or the drum brake is not very efficient, the drogue deploys and oscillates. When the winch-driver eventually slows things down, the glider catches up with the oscillating drogue and flies underneath it. It may not cause too much of a problem if the winch driver is in the process of bringing the cable to complete stop, as the glider will probably be able to be landed safely, even with a cable draped over it, unless the pilot is really unlucky and the cable snags on an obstacle on the ground.

However, if the winch-driver continues to winch the cable in, even at reduced speed, the cable can pull tight and either it or the drogue may catch in part of the glider structure, limiting the pilot's control and contributing to an unnecessary accident. Typical parts of the glider's structure which have been targets for cables in this situation are tail-skids, nose-skids, aileron gaps and wingtip fairings.

8.3.2. Engine failures

Engine failures may be abrupt, due to say an electrical fault or progressive, due to a fuel pressure problem. A thorough daily inspection of the winch should prevent potential failures due to loose wires or belts or split hoses.

Vapour locks in the fuel lines are common in summer. They tend to produce a progressive type of engine failure which is more difficult to detect than a sudden failure. The existence of vapour-lock will often not be apparent during the take-up-slack, but will only appear under conditions of high fuel-flow when the throttle is opened. The glider will be at a rather critical stage of the launch when the engine begins to falter and the pilot has to decide whether to abandon the launch or sit it out and hope it improves. The correct decision if in doubt is to abandon the launch.

From the winch-driver's perspective, if a progressive failure occurs it is better to stop the launch than to try to keep it going. A properly trained pilot can be expected to take the appropriate recovery action from a failed launch and it is not the winch-driver's fault if that pilot fails to do so.

If the winch-driver tries to keep things going despite evidence that all attempts are not succeeding, it could in fact be encouraging the pilot to hang on and thus contribute to the eventual accident. Furthermore, if the pilot does decide to abandon the launch and the winch-driver is busy trying to trouble-shoot the problem instead of stopping the launch, it could lead to the glider becoming entangled with the cable as described previously.

Apart from cable-breaks, which are quite common, the most likely occurrence is engine failure due to fuel exhaustion. Not fuel starvation, but fuel exhaustion, which means nothing in the tank. Running a winch out of fuel is about as inexcusable as running a tug aircraft out of fuel and just about as common. The result may be anywhere between a sudden total stop and a slow death of the engine. Of all the causes of failed launches, this one has to be the most easily preventable.

CAUTION: After any kind of launch failure, always bring the drum to a complete stop and disconnect the drive from the engine. Do not recommence spooling the cable in until cleared to do so by someone who has physically checked that it is clear.

8.3.3. Excessive drift on the launch

If the glider pilot makes no attempt to correct for drift during a crosswind launch, the winch-driver may have to make a decision to terminate the launch in the interests of the safety of third parties.

Such a decision will not be taken lightly. Nobody actually wants to engineer a deliberate launch-failure, unless asked for one as a training exercise by an instructor. However, in the case of a winch-launch site close to a public road or power-line, it may not be possible for the winch-driver to prevent the cable drifting outside the airfield after it has been released and this could place members of the public at risk from physical injury due to falling cables or electrocution if the cable falls across a power-line.

The decision to deliberately terminate a launch is not an easy one to make. Naturally the winch-driver will want to give the glider pilot a safe height, rather than stop the launch at low-level. There is no doubt that this is a good decision from the glider pilot's point of view. The difficulty is that the higher the launch is allowed to go, the greater will be the problem in getting the cable back inside the airfield if the pilot is careless about drift correction.

Most clubs are lucky enough to have sufficient space each side of their operations to make deliberate stopping of the launch a remote probability. Clubs operating at sites with more cramped surroundings must give some thought to the strategy to be used if the glider drifts excessively during the launch and drivers must be trained to have a definite cut-off point in mind and to use the option if necessary.

(Photo Courtesy of Anthony Smith)

9 AUTO-TOWING

Auto-towing is a method of launching a glider by means of towing it with a powerful vehicle. It is a simple and straightforward method of launching, provided a smooth strip of at least 1,600 metres is available (refer MOSO 2, paragraph 16.1.1).

9.1. PILOT TECHNIQUE - TABLE OF DIFFERENCES

From the pilot's point of view, the basic principle of auto-towing is similar to winching. The same hook is used, the same number of launch stages exist and the same principle is followed of progressive steepening of the climb as height is gained, until the full climb is achieved. There are however some significant differences in detail and these are covered in the table below.

WINCH	*AUTO-TOW*
Ground run	
Rapid acceleration, flying speed reached very quickly. Some tendency to pitch nose-up, banging the tail down on "nosedragger" types.	Less acceleration, because tow-vehicle has to accelerate its own weight as well as that of the glider. Pilot needs to make a conscious effort to keep the glider straight, balance it on the wheel and maintain wings level.
Separation	
Separation occurs after quite a short ground-run. Because of continuing rapid acceleration, there may be a	Much longer ground run, pilot must guard against any tendency to premature separation and ensure that glider lifts off

tendency for the glider to pitch up too steeply at this stage.	only when flying speed has been gained. Little or no tendency to pitch up steeply.
Initial climb	
Careful control needed to ensure correct graduation of initial climb, especially to ensure glider does not become too steep at too low a height.	Equally careful control needed, but this time to ensure there is no tendency to enter the climb at too low an airspeed. Initial climb feels more leisurely and covers more ground in comparison with a winch-launch.
Full climb	
As steep as the pilot wishes to climb, within the working speed band.	No point in climbing very steeply, as wire/rope length is fixed and there is no benefit in "pole-bending".

9.2. DRIVER TECHNIQUE - TABLE OF DIFFERENCES

WINCH	*AUTO-TOW*
Crew requirements	
Provided driver is trained and qualified, only one crew member is necessary to conduct winch-launching.	Because the driver of an auto-tow vehicle is facing in the opposite direction to the glider, a second person is essential to watch the glider during the launch and relay any signals to the driver. Auto-towing should not be carried out without someone riding "shotgun" on every launch.
Strip Length	
Because the winch is stationary, strip length is not a factor, provided it meets minimum GFA requirements.	The driver must keep a careful eye on remaining strip length during the launch, as it is necessary to terminate the launch while there is still enough strip to keep tension on the wire during its fall to the ground. The distance required for this purpose can be as much as 300 metres, although this can be considerably reduced if rope is used instead of wire.
Acceleration	
Acceleration limited only by available engine power. Training needed to ensure power is applied at the correct rate and adjusted for each glider type.	Regardless of available engine power, acceleration can be limited by wheel spin and care is needed to get the power to the wheels without losing traction. See also section on auto-tow vehicle requirements.

9.3. AUTO-TOW VEHICLE REQUIREMENTS

Although winches are constructed for the sole purpose of launching gliders, the same is not true of auto-tow vehicles, all of which are some kind of adaptation of a vehicle designed for an entirely different purpose.

The requirements for an ideal auto-tow vehicle are to some degree conflicting, because there is an obvious need for as high a power/weight ratio as possible but also a need to get as much weight as possible onto the driving wheels in order to minimise wheel spin.

The best compromise seems to be somewhere along the following lines:-

- A light truck or Ute is better than a sedan or panel van, because of the need to add weight over the driven wheels, usually the rear wheels. Although there is no engineering reason to exclude front-wheel-drive vehicles (if one can be found with sufficient power), adding weight over the wheels might be difficult.
- Provision must be made for the release of the cable from the vehicle and this must be possible without the driver having to stop the vehicle and leave the cab.
- The attachment point for the release should be as close as possible to the centre of the vehicle. Rear-mounted releases are no good, because the pull of the glider in full climb will reduce the traction of the driven wheels. Immediately behind the cab of a light truck or Ute is a recommended attachment point as this fulfils the traction requirements and also enables a simple mechanism to be made for the release of the cable from inside the cab.
- Assuming rear-wheel drive and a sealed surface for auto-towing, the normal road tyres should be removed from the rear wheels and treadless “slicks” substituted, preferably of wider than normal profile. This results in a significant increase in traction.
- Weight should be added over the rear wheels to increase traction during the critical period of initial acceleration. Concrete blocks or sandbags are useful for this purpose.
- Consideration should be given to turning the passenger seat back-to-front to enable the “shotgun” rider to easily keep the glider in view during the launch. It may also be necessary to cut a panel out of the roof to improve visibility of the glider, but this should not be done unless protective material such as polycarbonate is inserted into the panel to protect the occupants of the cab from the ingress of flailing wire in the event of a cable-break.

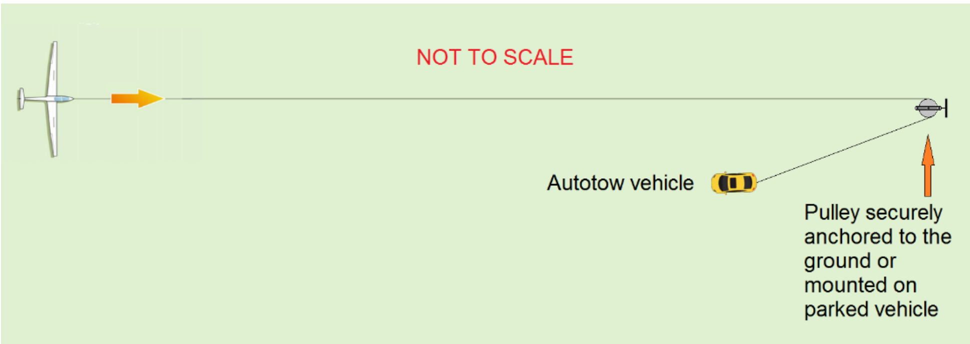
Additional note: Rather than start the launch by driving straight down the strip, it has been found best to train drivers to start off at 45º to the launch direction, gradually lining up with the strip as speed builds up. This seems to combine a satisfactory rate of acceleration without causing wheel spin, although care is always needed to maintain traction during the take-off, especially if the vehicle is very powerful.

9.4. AUTO-TOW VARIATIONS

All the descriptive material in the section so far has concerned “straight” auto-towing; in other words the tow-vehicle maintaining a straight path towing the glider behind it. However there are some interesting variations on the basic theme and three are described here.

9.4.1. PULLEY LAUNCHING, 1ST VARIATION

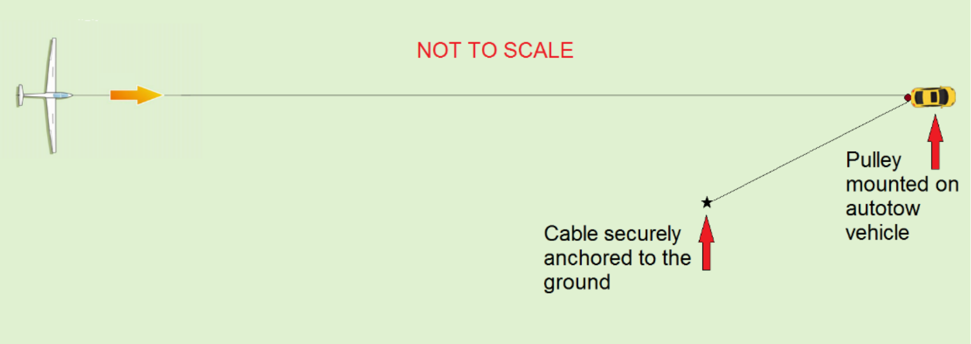
In this method, known as “reverse pulley”, the launching cable or rope is passed around a pulley which is anchored to the ground (or attached to a vehicle) some distance in front of the glider. The vehicle travels towards the glider during the launch.



The advantages of this method are (i) it can be used on a much shorter strip than that required for "straight" auto-towing, and (ii) the glider can be seen by the driver during the launch, obviating the need for an assistant.

9.4.2. PULLEY LAUNCHING, 2ND VARIATION

In this method, the pulley is attached to the tow-vehicle itself, then anchored to a secure attachment on the ground. See below.

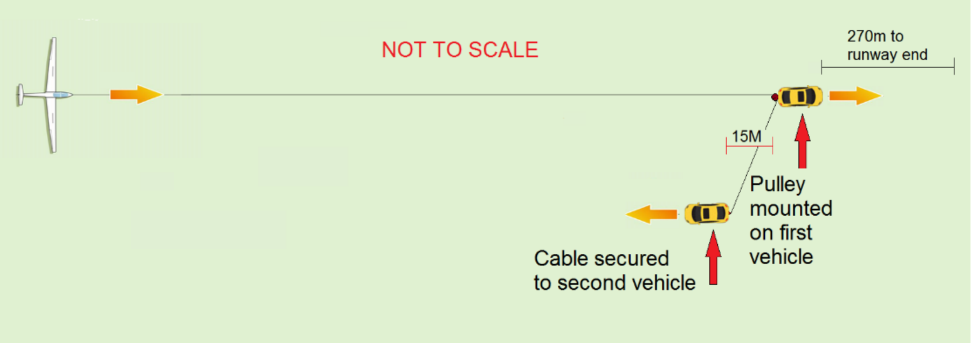


In the 2nd variation, the vehicle's speed is halved, another way of effecting a useful saving on strip length. However an assistant is once more required in this variation, as the vehicle is travelling in the same direction as the glider.

The disadvantage of both variations is that they erode the simplicity which is the "straight" auto-tow's great attraction. However, if the strip length necessary for auto-towing is not available, one of these options could be considered.

9.4.3. PULLEY LAUNCHING, 3RD VARIATION

In this method, the pulley is attached to one tow-vehicle itself, then anchored to a second tow vehicle pulling in the opposite direction. See below.



This method requires two vehicles. One vehicle travels towards the glider and one away from the glider connected by 5 mm or 6 mm Spectra type rope and a pulley. The weight of the vehicles, and use of a tension meter ensures power is moderated to the glider's needs. The minimum strip length is 1,200 metres.

Clubs wishing to use this method need to develop procedures detailing suitable types of vehicle, towing speeds and communication methods to the satisfaction of the RMO.

10 AUTO-TOW SAFETY

10.1. PILOT SAFETY

Although it might be thought that the more leisurely rate of acceleration of the auto-tow would result in accidents caused by low-speed loss of control in the critical stages near the ground, the record shows that such is not the case. Although the exact reason for this is not easy to determine, it is probably because the speed does not increase at such a rate as to encourage "kavalierstart" take-off.

10.2. DRIVER AND GROUND-CREW SAFETY

Despite the absence of whirling machinery and the likelihood of high-speed wire entering a stationary device, the safety of drivers and ground-crew is just as important with auto-towing as it is with winch-launching.

Protection must still be provided for drivers and operators. While the behaviour of spring-steel wire is unpredictable, the use of rope can reduce some of the hazards. Nevertheless, the safety of all persons involved in the operation remains paramount.

It goes without saying that nobody should be permitted to ride on the vehicle outside the safety of the cab when a launch is in progress. Even when using rope a person could be seriously injured given the right circumstances.

10.3. SAFETY OF THE PUBLIC

As far as members of the public are concerned, their safety is enhanced if rope is used. Being non-ferrous, it is much safer if accidentally dropped over a powerline. However, whatever material is used for auto-towing, the same precautions against dropping it outside the airfield must be observed as for winch-launching, in the interests of protecting innocent bystanders who are not involved in our sport.

APPENDIX 1 - KEY RISK AREAS IN WINCH LAUNCHING

The advice contained hereunder highlights the key risk areas in winch launching and offers simple but effective guidance on how to minimise these risks. Site specific factors may need to be taken into account. Pilots should consider the risks summarised below before every winch launch.

STAGE	RISK	CONTROLS	ADDITIONAL CONTROLS	RISK RATING		
				LIKELIHOOD	CONSEQUENCE	RISK
GROUND RUN	**Wing touches the ground, glider cartwheels or ground loops violently.**	• **Start the launch with your hand on the release.** • **If you cannot keep the wings level, release immediately.**	• **Strap in tightly.** • **Be aware of the second cable and release if the glider swings too close to it during the ground run.** • **Anticipate yaw.** • **Monitor that wings are level.** • **If a wing drops, release before the wing touches the ground.** • **First flight on type should be conducted in benign conditions.** • **Wingtip holder should run with the tip and hold the wings level. In a crosswind it is advisable to hold the downwind wing.**	POSSIBLE	CATASTROPHIC	**EXTREME**
ROTATION	**Stall/spin during rotation.**	• **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 35 degrees) is controlled, progressive, and lasts at least 5 seconds.**	• **Do not pull back to reduce ground run over rough ground or with tail wind.** • **Be prepared to use whatever forward stick may be necessary to maintain a shallow climb until speed is adequate.** • **Monitor the airspeed and reduce the rate of rotation if appropriate.**	POSSIBLE	CATASTROPHIC	**EXTREME**
	Stall or heavy landing after launch failure below 100ft.	• **If the launch fails, immediately lower the nose to the appropriate recovery attitude. Minimising the reaction time is crucial.** • **Do not use the airbrakes until 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.**	• **Do not correct for crosswinds below 300ft.** • **If speed is excessive, do not release but maintain a shallow climb to a few hundred feet and then release or signal.** • **Beware habitual opening of airbrake; use airbrakes with care or not at all after launch failure.**	POSSIBLE	SIGNIFICANT	**HIGH**

CLIMB	**Stall or spin, after launch failure.**	• **Adopt the recovery attitude; do not turn or use the brakes until 'safe speed near the ground' is attained.** • **Land ahead if it is safe to do so.**	• **If airspeed reduces, unload the wing; consider releasing if airspeed approaches 1.3 times stalling speed.** • **It typically takes 5 seconds in the recovery dive to accelerate to 'safe speed near the ground'.**	POSSIBLE	CATASTROPHIC	**EXTREME**
	Controlled flight achieved after launch failure but subsequent stall, undershoot, overshoot, heavy landing, or collision.	• **Plan modified circuit options before taking off.**	• **If instructing and the student makes a mistake, take over early.**	POSSIBLE	SIGNIFICANT	**HIGH**

APPENDIX 2 – CABLE CUTTING DEVICES - ROUTINE CHECKS

The cable cutting device is a vital safety feature of any winch and it is essential that the cable cutting equipment is maintained so that it will work efficiently, if needed in an emergency. There is a wide range of types and it is vital to protect and preserve the cutting edge in order to maintain effective operation.

SERVICEABILITY CHECK

To ensure correct operation, the cable cutting device should receive a serviceability check as and when required. It is advised that this check is performed at least once every month.

The frequency of this check is dependent, amongst other things, upon the dirt and debris collected upon the cable cutting mechanism from the passing cable, it will therefore vary according to the state of the ground over which the cable passes.

Check full range of movement and operation of the cable cutting device assembly and mechanism (without cutting cable).

FULL FUNCTIONAL TEST (WITH CABLE)

The cable cutting device full functional test is to be carried out as often as considered necessary to ensure correct operation but at a minimum frequency:

a) as recommended by the winch manufacturer; and
b) after any repairs to the guillotine.

Operate the cable cutting system from the winch cab. Ensure that the cable is severed cleanly. If the cable is not severed completely, dismantle the cable cutting system, clean and if necessary, replace worn or defective parts with sound parts, reassemble and carry out a further functional test.

GFA recommends a record of cable cutting device inspection and testing should be maintained.