2017
Winch Launch Training Guidelines

Utah Soaring Association

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Our thanks to Bill Daniels and Don Ingram for their time and efforts preparing the original documents.

Introduction

Training manuals for winch launch are difficult to write for universal use due to the many possible differences between launch sites, winches and gliders.

This document will try to present as close to a universal viewpoint as possible, but each site should develop a winch training syllabus specifically addressing the requirements of their orientation.

Any group setting out to provide winch training should understand that a winch launch is very short duration compared to aero tow.

Things happen very quickly, too quickly for the traditional instruction methods to be used. The student should be briefed thoroughly on the items to be demonstrated or practiced before the launch. Review or critique should be reserved until after release or even until after landing if a low release height demands that the glider enter the pattern for landing immediately after release.

The short duration of the launch makes it reasonable for the instructor to fly the first three or more launches in order for the student to become familiar with the physical sensations and views from the cockpit. This allows the student to observe, and hopefully adopt, the instructor's good technique.

The training syllabus should plan four consecutive flights with each student in each session. Most students will be informationally saturated after four launches and little can be gained from additional launches without rest. Fewer launches will not advance the student's skills as much.

The bulk of winch launch flight training rightly focuses on potential hazards and their avoidance. This document will do that as well.

It should become clear from reading this document that winch launch demands a level of precision from the pilot that might not have been taught in aero tow training. This is both a challenge and an opportunity. Pilots who master the winch launch will become better at almost everything else. Certainly, they will become expert at accuracy landings and soaring away from low altitudes.

Although challenging, winch launch is highly repetitive and the list of skills demanded is short. After the 30 or so flights in a transition course, any pilot will be the better for it.

Equipment - Winches

Winches generally fall into two categories: Speed Controlled (SC) and Automatic Tension Controlled (ATC), with the vast majority of existing winches being SC types.

Flight training is highly specific to a particular SC winch and the characteristics of that particular winch. SC winches use automotive engines and transmissions which, in their original role, were designed to accelerate and maintain the road speed of a heavy donor vehicle. In the new role, the powertrain still tries to maintain drum RPM. After a brief initial acceleration a glider winch must slow down, leading to a mismatch between gear ratios and power demands. Acceleration, speed and tension are difficult to control accurately.

ATC winches use Continuously Variable Transmission (CVT) drives and tensiometers which control rope tension using a microcontroller or a Process Logic Controller (PLC). This provides far more precise control of the launch allowing standardized training.

In the case of the SC winches, the winch operator controls the glider airspeed with the winch throttle. If the pilot wishes to change airspeed, they must signal the winch operator to increase or decrease speed. Although the winch operator is charged with controlling the glider airspeed, there is no direct way to know it. Thus they must proceed on "feel" signals from the pilot.

The pilot can only control the steepness of the climb by controlling the angle of attack. If no angle of attack indicator is installed in the glider, the pilot is also relying on "feel".

Changes in climb steepness will have an effect on glider airspeed. The exact effect will depend on the power of the SC winch. If the winch is exceptionally powerful, the additional pull of a steeply climbing glider will have little effect on winch speed in which case the glider airspeed will increase. If the winch is less powerful, increased climb steepness will load the engine and slow the winch resulting in decreasing airspeed.

SC winches may present both speed and tension behaviors in the same launch. The pilot may find that early in the launch there is little control over the airspeed, but it becomes controllable as the glider climbs. Pilots should expect unusual behaviors.

ATC winches, on the other hand, provide a tailored launch profile to each glider type. The winch controls rope tension as measured by a tensiometer and the pilot controls airspeed with elevator input, just as in free flight.; i.e. nose up reduces airspeed and nose down increases airspeed. Both the winch operator and the pilot have instrumentation that displays the variable each is charged with controlling. The results are highly predictable and much safer than with SC winches. No speed signals are needed between the pilot and an ATC winch.

Winch design is undergoing a shift from SC towards ATC, which will make the whole winch training experience easier, safer and more pleasant. Training can be standardized.

Equipment - Gliders

Various glider designs introduce further complications. Modern glider designs tend to behave very well during launch, but older designs may have issues. Modern gliders have a CG release location and elevator authority balanced such that little elevator input is needed to achieve an ideal launch profile.

Gliders without CG releases are totally unsuitable for winch launch. Gliders with deep fuselages, a high wing and limited down elevator authority present special problems as well. These types of gliders have their CG far above the release such that a strong nose up couple is created by the pull of the rope. When combined with a small horizontal tail, the pilot may find it impossible to limit pitch-up if strong acceleration is used. These gliders, if launched at all, must be handled with extreme care. If the characteristics of a glider are unknown, use gentle, low power launches until its behavior is learned.

Equipment - Winch Rope

Traditionally winches have used stranded steel cable or solid wire, but UHMWPE (Ultra High Molecular Weight Polyethylene) rope is rapidly replacing it. Spectra and Dyneema are two brand names of UHMWPE. This type of rope offers so many advantages there is little reason to consider steel. This document assumes the use of UHMWPE rope.

Pre-Launch Preparation

Before accepting the rope, the pilot must be ready, and glider must be ready launch. Extra care must be taken to ensure there are no loose objects in the cockpit. Any seat cushions must be firm enough so that the pilot will not sink into them under the force of acceleration. If the pilot sinks into the seat back, unintended control stick movement or failure to reach the necessary controls may occur.

Although it would seem obvious, it is critical to stage the glider pointing exactly at the winch. If this is not done, the lateral pull can cause a ground loop.

The pre-launch checklist should be done carefully to ensure air brakes and canopy(s) are locked. The pilot must ensure the correct weak link as specified in the POH is used and the ring set is attached to the CG release (not the nose release).

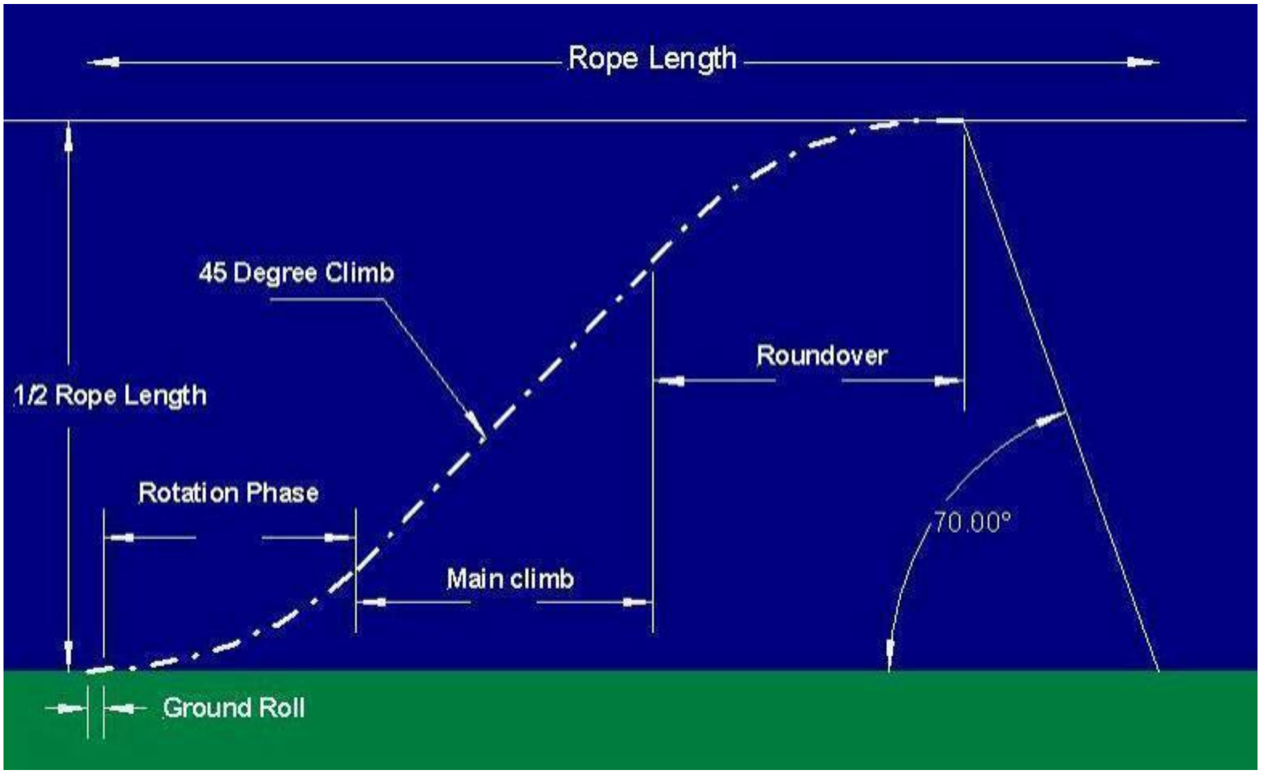
The pilot should have a target airspeed in mind and know the POH maximum winch launch airspeed. The pilot should have selected a critical altitude below which there is sufficient runway to land straight ahead and above which there is enough altitude to circle back to the departure runway.

The launch must not proceed if the crosswind component exceeds that allowed by the POH. Most operating handbooks will also specify a maximum allowable tailwind component. Normally no tailwind is allowed.

Finally, just before the launch begins, the pilot should place one hand on the release, firmly without gripping, so it may be pulled without delay. The pilot should fully understand that any call to abort prior to the takeoff requires a release. Immediately communicate to the winch that the launch has been aborted.

The Normal Launch

With rope winches and modern gliders, it is rare to have problems. However it behooves a pilot to approach each launch with the mindset that a failure is likely and prepare mentally to manage it. If the launch goes as expected, the pilot may be congratulated on preparation, skill and good luck.

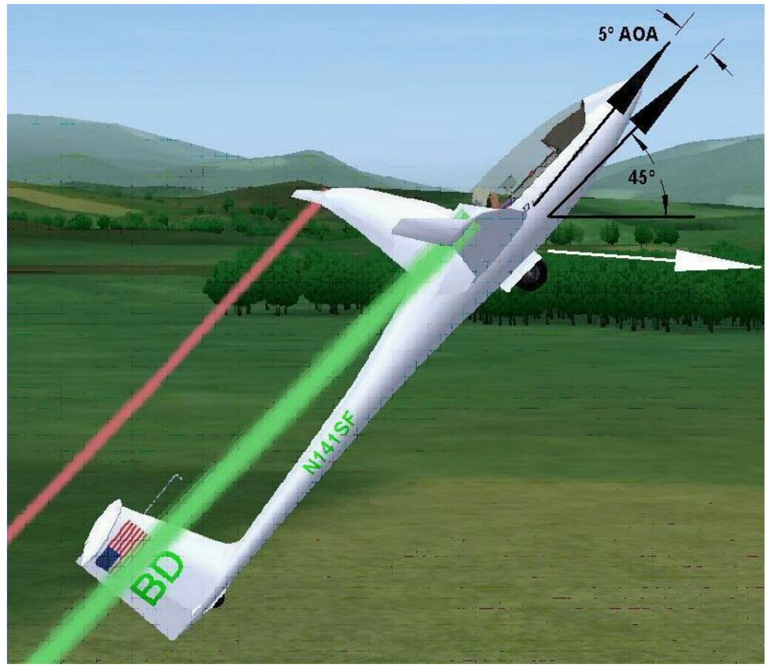


With an ATC rope winch and a modern trainer like an ASK-21, the launch will begin with an acceleration of one G, or 32 feet per second, per second. After one second the glider will have traveled 16 feet and will have reached a velocity of 32 feet per second (19 knots). At this speed the pilot will have firm control authority. After two seconds, the glider will be at 38 knots and ready to leave the runway surface. The acceleration will continue for another second or so as the glider begins its rotation into the full climb.

Many pilots will find the initial one G acceleration startling, but it is exactly the same sensation as lying on one's back. Most automobiles are capable of one G acceleration for brief periods.

The pilot will be controlling the pitch rate and attitude with reference to the ASI such that the glider will stabilize at a pre-selected climb airspeed of about 65 knots and a deck angle of about 45 degrees nose up. This will be at a height of about 150 feet.

Note that this approach relies on the pilot using airspeed information and not simply timing the rotation. This is because rotation times vary significantly with density altitude and glider weight. Airspeed provides useful information about stall margin, but an angle of attack indicator would be much better.



At no time will the combination of airspeed, attitude and altitude (AAA envelope) be such that the pilot cannot pitch over and land straight ahead with generous safety margins should a launch failure occur.

As the launch continues, the pilot will make small adjustments to pitch attitude to maintain the target airspeed. The pilot should also include the wingtips in the scan, as well as the pitch attitude. Lateral deviations from the required track can be picked up by noticing unintentional bank.

As the glider reaches the top of the launch, the angle between the rope and the longitudinal axis of the glider will approach about 70 degrees. Tost CG releases are designed to automatically release (back release) the rope at this angle. Good winch operator technique is to cut winch power just before the automatic release occurs so there is little tension on the rope. Cutting power will increase the sag of the rope so the automatic release is triggered. The pilot will pull the release anyway to assure rope separation.

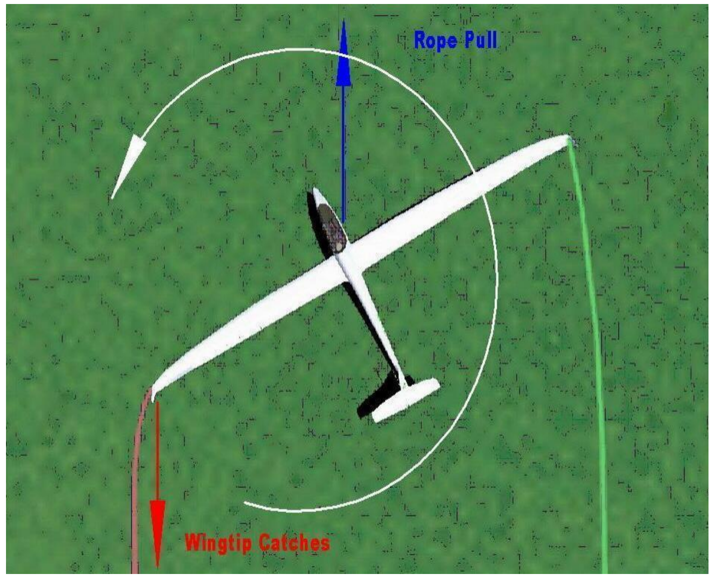
As the ring set leaves the release mechanism, the winch launch is over and the flight will continue as any other. The pitch attitude at release will be slightly nose-high so the pilot must lower the nose to achieve a normal glide.

The glider will be at a height above the ground equal to about half the length of the rope used. If launching into a headwind, the height will be greater.

Ground Roll Technique & Hazards

The first seconds of a winch launch are critical and the pilot must be completely involved on to be able to deal with it. If at any time the pilot feels things are not precisely normal, an immediate release is called for. The ground roll is the last opportunity to abort before the glider is airborne.

More so than with aero tow, it is critical that the glider track straight with wings level. As noted in the section on normal launch, roll and yaw control will be achieved in less than a second, so it is difficult to imagine a wing dropping to the ground unless the pilot is not holding the controls centered. As part of the pre-flight check, the pilot should consciously center the ailerons and rudder. The only exceptions are rudder input when the CG release is located in the fuselage side, as with the K-13. A crosswind may also require some pre-launch rudder input, but it must be removed before the ground roll ends.

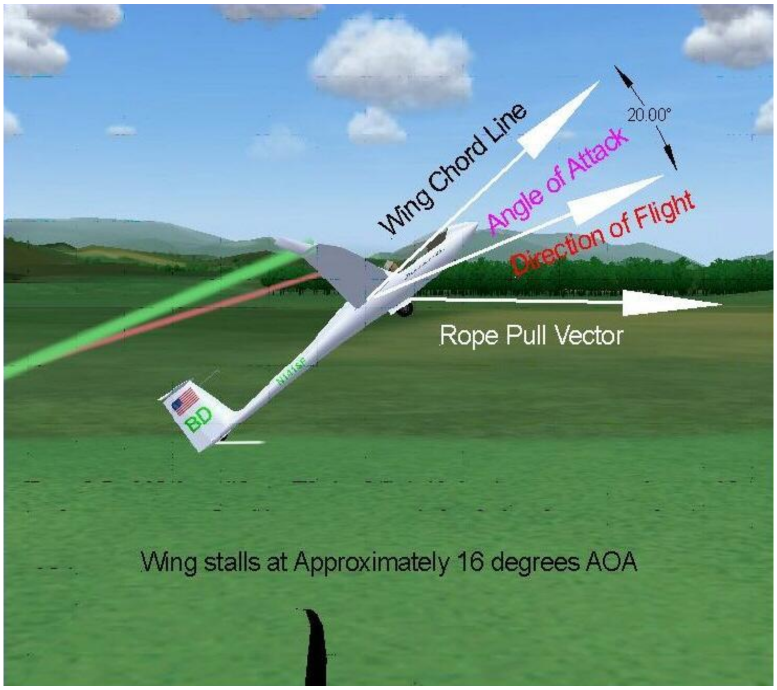


If it is seen that a wing tip will touch the ground despite corrective aileron input, the pilot should release and not try to "save" the launch. Failure to do so may result in a particularly ugly ground loop which may end with the glider crashing inverted. The CG release does not help keep the glider rolling straight as does a nose hook.

Before the ground roll begins, the pilot should place the left hand on the release control without gripping it so the release can be used without delay. If the pilot grips the release control, acceleration in the initial stage of the launch may cause an inadvertent activation. The pilot must have a plan in mind for dealing with any such eventualities.

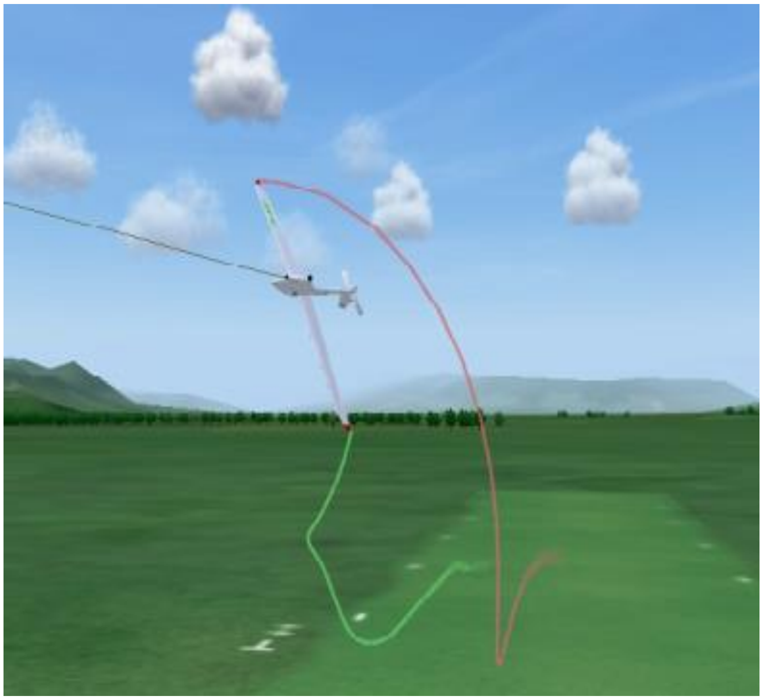
The vast majority of winch launch accidents occur due to wing drop during the takeoff roll or a stall spin after a launch failure. Do not continue the launch if **anything** abnormal occurs. Above all else, when a launch failure occurs, FLY THE GLIDER!

Liftoff and Rotation Techniques & Hazards



The stall margin is at a minimum during the rotation phase. The wing is loaded by the need to accelerate the glider to a vertical speed of over 4500 feet per minute in only a few seconds even as it is beginning to take on a load of the rope pull.

The increased load on the wing causes a significant increase in the stall speed as well. This occurs at the same time the aircraft is rotated into the climb attitude. If a stall does occur while there is left-right asymmetry in the control inputs, a snap roll may ensue with fatal results. To avoid a stall/spin during rotation, avoid taking off with a significant amount of yaw (rudder input) and maintain a shallow climb until adequate speed is seen with continuing acceleration. Consider adequate speed to be 1.5 times the stall speed. Also ensure the transition from initial lift off to full climb is controlled and progressive. The pilot should be trying to achieve a smooth rotation with airspeed increasing to a stable climb speed.



Most gliders will exhibit a tendency to pitch up due to the low CG release location. Any such tendency must be opposed with down elevator during the ground roll to prevent too rapid rotation.

Depending on the glider type, down elevator may be needed through the first half of the launch. Many glider manuals prescribe full down elevator for the ground roll.

Stall hazard may be avoided by carefully monitoring airspeed during the takeoff roll. Rotate into the full climb while resisting any tendency to rotate prematurely. The transition from takeoff attitude to climb attitude (About 35 degrees) should last about 5 seconds.

Airspeed Excursions

In an otherwise normal launch there may be airspeed errors due to a variety of causes including pilot error, winch behavior, operator error, and turbulence or wind layers. Whatever the cause, these airspeed errors in themselves represent less of a threat than possible precipitated actions by the pilot.

The pilot should take every action necessary to keep the airspeed below the maximum ground launch airspeed. Managing the problem while still on the rope is far preferable to an ill-considered early release. Do not be overly concerned about exceeding the placarded maximum winch launch speed during the early part of the launch. The relatively low placarded maximum winch launch speed of many gliders is to protect the glider from undue stress during the top of the launch, where the lift opposes a large tension in the cable. At high angles to the winch (top of the launch), there is no bending relief as there would be in high g maneuver in free flight. The stress from a gust is also greater than in free flight. During the first third of the launch the stresses on the structure are moderate and the placarded maximum launch speed may be temporarily exceeded, with care.

The correct action in response to excessive airspeed is to raise the nose to load the winch, while calling the winch operator, requesting a reduction in power. If this fails, delay the release until at a safe altitude, release and fly a normal landing pattern. No airworthy glider has ever been damaged by excessive airspeed on a winch launch.

If the airspeed is low, the pilot need only lower the nose slightly to reduce the load on the wing allowing the airspeed to increase. This should signal to the winch operator to increase power. Use the radio to request more power if necessary. However, be aware that the first sign of winch failure is a decrease in glider airspeed.

Glider to Winch Speed Signals

The following does not address launch crew signals such as to take up slack or initiate the launch. Those signals are covered in ground operations training. The following deals with airborne pilot to winch signals.

As noted in the section on equipment, no signals are necessary with ATC winches. It is only with SC winches that the pilot needs to use visual signals.

To request an increase in power, the pilot lowers the nose. The winch operator, seeing that the glider is not climbing normally, will increase throttle to compensate. Lowering the nose itself may cause the airspeed to increase. To request a reduction in speed, the pilot yaws the glider left and right vigorously with the rudder. The winch operator will increase or decrease power roughly 5% in response to each signal.

Older winch launch manuals describe rocking the wings to signal for more airspeed. The current view is that if the airspeed is too slow, vigorous use of the ailerons to rock the wings is not wise.

If reliable radio communication is available, the pilot can read airspeed to the winch operator who will use this information to adjust the winch throttle.

Crosswind Technique

The use of a CG release makes the glider more responsive to the effect of a crosswind. No launch should be made with a crosswind component more than the maximum demonstrated crosswind component listed in the glider's POH.

Aero trained pilots will have been trained to hold the upwind wing low during the takeoff roll in order to maintain position behind the tug. For winch launch, this technique introduces the potential of dragging the upwind wing, leading to a ground loop. It is best to keep wings level, or keep a tiny bank into the wind during the ground roll. Similarly, it is best not to use large amounts of downwind rudder. All asymmetric control inputs must be removed during the ground roll phase. Fortunately, the ground roll is very short, so allowing the glider to drift a few feet downwind is of little consequence.

Once past the rotation phase and in the main climb, lowering the upwind wing will cause the glider to track upwind. You can wait until 300 feet typically to induce crosswind correction. The winch operator will appreciate this since it makes the post release rope recovery easier.

Managing a Launch Failure

The term "launch failure" includes a variety of failure modes. Most commonly it is a rope break, but may also include mechanical failure of the winch. A break with UHMWPE rope is unmistakable. There will be a loud thump and the glider will surge upward. Whatever the reason, the pilot response is always the same - ***FLY THE GLIDER!*** One of the most common causes of accidents during winch operations is the pilot failing to properly fly the glider after a launch failure. Sharp focus on precise flying is paramount!

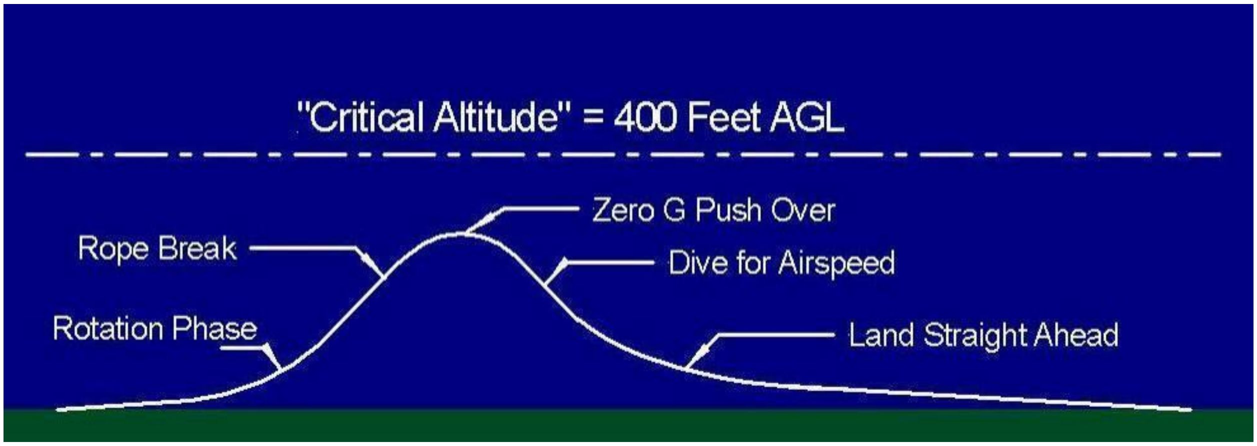
> **Instructor Note: Steel wire breaks**
> If a steel cable breaks near the winch, the weight of the cable remaining on the glider release will pull the glider forward, which feels more like a reduction in winch power than an actual cable break. The effect is subtle and may confuse a student pilot.

For convenience, this document will divide launch failures into: "high" and "low". Low failures end with a straight ahead landing on the runway and high failures require a circle to land. Each runway-winch-glider combination will have a critical altitude below which a straight ahead landing can be safely made using a slip and spoilers. Above the critical altitude the pilot can safely circle back to land on the departure runway.

On most runways and with most gliders, the option to land straight ahead and the option to circle overlap by several hundred feet of altitude. This makes the landing option obvious and fairly benign. When the option exists, the pilot is expected to land straight ahead.

If the nose is up 45 degrees at the failure, the glider will be losing airspeed at about 12 knots per second, so the pilot must react swiftly. The correct response is to push over vigorously in a zero G ballistic trajectory. **Do not delay the recovery.**

At zero G the wing is producing no lift thus has no induced drag. This will minimize airspeed loss. This ballistic trajectory should continue until the nose is as far below the horizon as is was above it when the rope break occurred. Release the cable when time permits.



The words *"as far below the horizon as above it"* have been carefully chosen to work, so the maneuver will work in all cases. They mean exactly what they say. If a rope break occurs at 20 feet with the nose up 10 degrees, the glider will strike the runway if the pilot attempts a 45 degree nose down recovery. At 500 feet, with the nose up 45 degrees above the horizon, lowering the nose only 10 degrees will not result in a safe recovery.

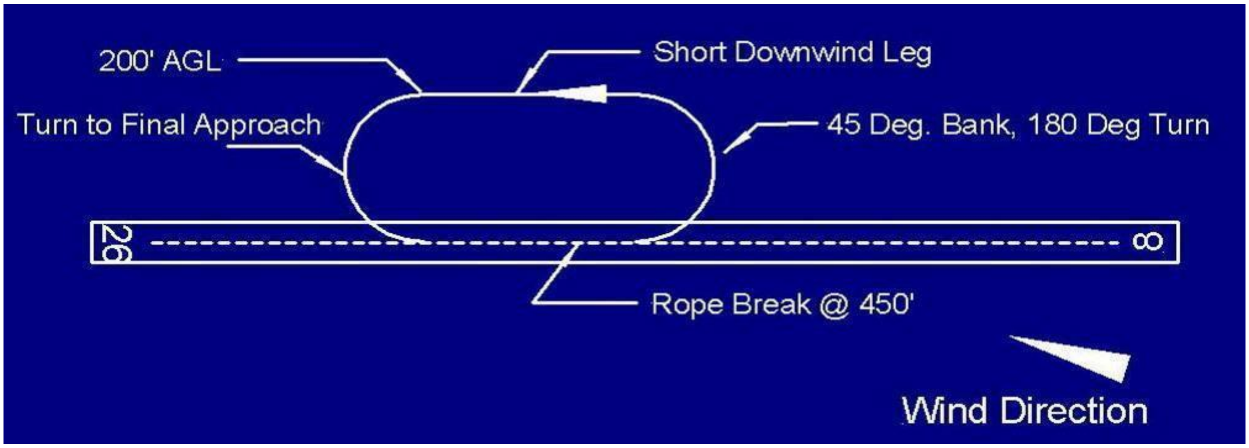
Instructor Note: Low G Sensitivity Training

It has been determined that some pilots are unduly sensitive to low G pushovers, apparently associating the floating sensation with a stall. This causes them to keep pushing the nose lower in an attempt to affect stall recovery and may lead to a nose low impact with the runway.

To test for this and teach proper pushover technique, have the student fly a series of dive, zoom and zero G pushover maneuvers at several thousand feet AGL.

With the nose held in the recovery attitude, the pilot **must wait** (This can take up to 5 seconds when initiated from a 45 degree climb) for a safe airspeed, with an increasing trend, before taking further action. A good technique is to call out the actual altitude while lowering the nose to achieve flying speed. This will help identify whether the launch failure was above or below the critical altitude. It is crucial that no turn be initiated or the spoilers opened until a safe airspeed is achieved. This runs contrary to our aerotow training where an immediate turn back to the runway (At 200 feet) is taught.

Once safe airspeed is in hand, the pilot must decide whether to land straight ahead on the remaining runway or circle. If the break occurred below the critical altitude the landing is made straight ahead, perhaps with full spoiler extension and maybe a slip. If the break occurred above the critical altitude there will not be enough runway left to land ahead so the pilot must circle to a landing. The decision to land straight ahead or circle must be made as airspeed is accelerating, further emphasizing the need to determine the launch failure altitude early in the recovery process.



With most runways, there is an overlap where either a straight ahead landing or a circle is possible. A straight ahead landing is always preferred for safety reasons. When landing straight ahead, the pilot should make an attempt not to land on the rope.

A circle is done in phases. The first is a 45 degree bank, 180 degree turn to the downwind side of the runway if a crosswind component is present. The downwind turn direction is chosen to place the airfield upwind of the glider so the bank angle will be decreasing as the pilot performs the final 180 turn to align with the runway.

As the glider approaches the 180 degree point, the pilot must assess the situation and decide if a short downwind leg is needed. If the height is about 200 AGL, the turn should be continued through 360 degrees so the glider is lined up with the runway.

If the height is greater than 200 feet AGL, at the end of the first 180 degree turn a short downwind leg is flown until the height reaches 200 feet, where another 180 degree turn is made to align with the runway. The final 180 degree turn is begun at 200 feet AGL which is the same height students are taught to turn back when dealing with an aero tow rope break. In no case should the downwind leg continue beyond the point where a normal base leg would be.

Teaching a return to the departure runway has many advantages. It will work at all airfields, no off field landing need be considered and the landing will be into the wind. However, if other runways are available, their use should be considered an option.

Some pilots will insist on gliding to the departure end of the runway before making a “button hook” turn and a downwind landing, stopping at the start line. This might be permissible with no wind and no other traffic, but is not to be taught as a generally acceptable technique.

The purpose of the circle to land maneuver is not to fly the glider back to the start line, but to allow a safe landing on any part of the runway. Stretching the maneuver to stop at the start line should be strongly discouraged. A safe landing is always preferred over a convenient one.

An astute reader will notice that no mention is made of pulling the release to drop any remaining rope that might be dangling from the CG hook. In fact, it is very likely that the remaining rope will automatically release during the return for landing. If the pilot chooses to pull the release, it should be done where there is no danger to persons or property on the ground and when time permits and under tension if possible to avoid fouling with the glider.

Glider Release Failure

True release failures are extremely rare. What is slightly more common is the rope fouling the landing gear which results in an attachment point other than the CG hook. For this reason, if the glider is jerked forward over the rope, the launch should be stopped, the glider pushed back and the ring set attachment to the CG hook re-checked.

To prevent fouling, the 30 foot lead rope between the apex of the parachute and the ring set should be made very stiff so it can't bend around the wheel. If despite this, the launch has begun with the rope fouled with the wheel the pilot will have no way to release. The pilot should overfly the winch on the runway heading so the winch operator will see that the glider has not released. This will tell the winch operator to trigger the guillotine, cutting the rope at the winch.

Unlike steel cable, UHMPE rope will trail nearly horizontally behind the glider like a spider web. This allows a high pattern and a steep approach to the runway with a touchdown planned as near the departure end as safe. This should prevent the trailing rope from fouling anything on the ground.

Winch Failure

Old automotive derived winches can have many failure modes. Unlike automobiles, a winch can't be driven to diagnose problems so many issues go unnoticed. For this reason, any odd behavior should be cause to discontinue launches until it can be eliminated.

Unlike rope breaks, a winch failure can be insidious. Instead of a sharp "thump", the rope tension may slowly fade away. If the pilot is controlling airspeed, this will cause him to lower the nose, which is the right response. If the pilot is maintaining attitude and ignoring airspeed, the airspeed will rapidly decay until the glider stalls.

The pilot should always be monitoring instruments. If the rate of climb diminishes, the pilot should assume a winch failure. In this case the rope should be released and the launch treated as a rope break.

Remember, the time after a launch failure is a very poor time to develop a recovery plan. Know in advance what you will do when the launch fails.

***The chart on the following page is taken directly from the 2009 Safe Winch Launch Brochure of the British Gliding Association.**

STAGE	HAZARD	AVOIDANCE	PRACTICALITIES
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. Release if the glider swings too close to it during the ground run. • Anticipate yaw. • Hold correct wing. • Run with tip. • Monitor wings level. • If wing drop release before the wing touches the ground. • First flight on type in benign conditions.
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 35º) 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; reduce rate of rotation if appropriate.
	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.**	• No cross wind correction below 300ft. • If speed is excessive do not release; maintain shallow climb to a few hundred ft and then release or signal. • Beware habitual opening of airbrake; use airbrakes with care or not at all after launch failure. • Do not release the cable; allow it to back release.
Climb	Stall, spin, or heavy landing, after launch failure.	• Adopt the recovery attitude; do not turn or use the brakes until the approach speed is attained. • Land ahead if it is safe to do so.	• If airspeed reduces, unload the wing; consider releasing if airspeed approaches 1.5 times stalling speed. • It typically takes 5 seconds in the recovery dive to accelerate to the approach speed.
	Controlled flight achieved after launch failure but subsequent stall, undershoot, overshoot, heavy landing, or collision.	• Plan provisional circuit options before taking off.	• If instructing, and P2 makes a mistake, take over early.