Cross Country Soaring's
Winch Launch Training Guidelines

http://www.crosscountrysoaring.com
March 1st, 2009 Revision

Introduction

Training manuals for winch launch are difficult to write for universal use since there are many differences between launch sites, winches and the 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 their operation.

Any group setting out to provide winch launch 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 and 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 the instructors good technique and, hopefully, adopt the instructor's technique.

The training syllabus should plan six consecutive flights with each student in each session. Most students will be “saturated” after six launches and little can be gained from more while 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.

In order to maintain focus on the launch, this document will address the subject from the point of view of the pilot and instructor. For a treatise on winch field operations, see “Winch Operations Guidelines”. This document assumes the reader has read that document.

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 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 it's characteristics. In the authors experience, no two of them are alike.

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. It it's new home, the power train still tries to maintain drum RPM even though 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 CVT (Continuously Variable Transmissions) drives and tensiometers which control rope tension using a microcontroller or Process Logic Controller (PLC) providing far more precise control of the launch allowing standardized training.

In the case of SC winches, the winch operator controls the glider airspeed with the winch throttle. If the pilot wishes to change airspeed, he/she must signal the winch operator to increase or decrease speed. Although the winch operator charged with controlling the glider airspeed, he/she has no direct knowledge of it and must proceed on “feel” or signals from the pilot. The pilot can only control the steepness of the climb by controlling 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 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 inputs just as in free flight; i.e. nose up reduces airspeed and nose down increases airspeed. Both the winch operator and 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 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.

For more information on glider winch design please read *Winch Design Guidelines*.

Equipment – Gliders

Various glider designs introduce further complications. Modern glider designs tend to behave very well during winch 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, high wings and limited down elevator authority present special problems as well. These 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 gentile, low power launches until its behavior is learned.

Equipment – Winch Rope

Traditionally, winches have used stranded steel cable or solid wire but UHMWPE rope is rapidly replacing it. Spectra/Dyneema 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 make sure both he/she and the glider are ready for launch. Extra care must be taken to ensure that there are no loose objects in the cockpit and that any seat cushions are firm enough that the pilot will not sink into them under the force of acceleration. If the pilot sinks into the seat back cushions he/she may pull the stick further back than intended or may be unable to reach certain controls.

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 groundloop.

The pre-launch checklist should be done carefully to ensure air brakes and canopy are locked. The pilot must ensure the correct weak link as specified in the POH is used and ring set is attached to the CG release.

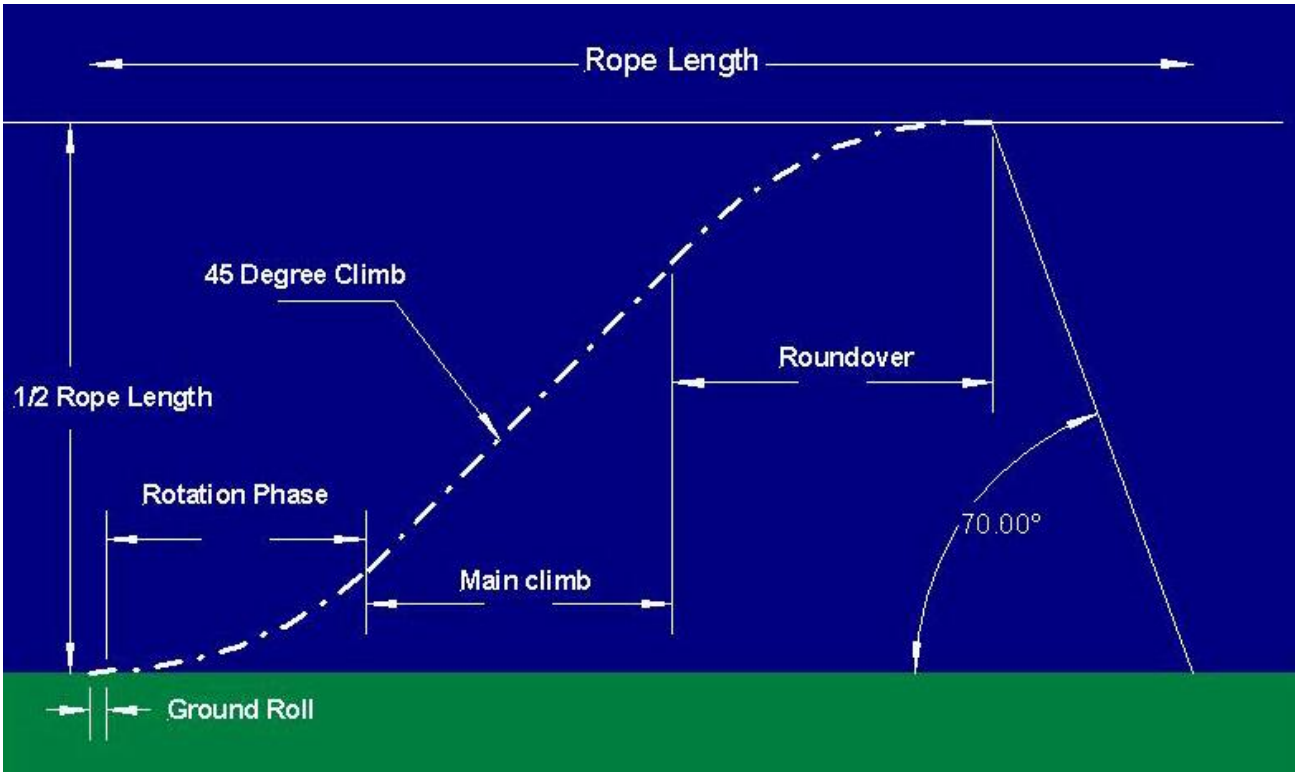
The pilot should have a “target airspeed” in mind and know the maximum winch launch airspeed. The pilot should have selected a “critical altitude” below which there is sufficient runway to land straight ahead and above which there is enough altitude to circle back to the departure runway.

The launch must not proceed if the crosswind component exceeds that allowed by the POH.

Finally, just before the launch begins, the pilot should place the left hand on the release but not gripping it so that it can be pulled without delay.

The Normal Launch

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

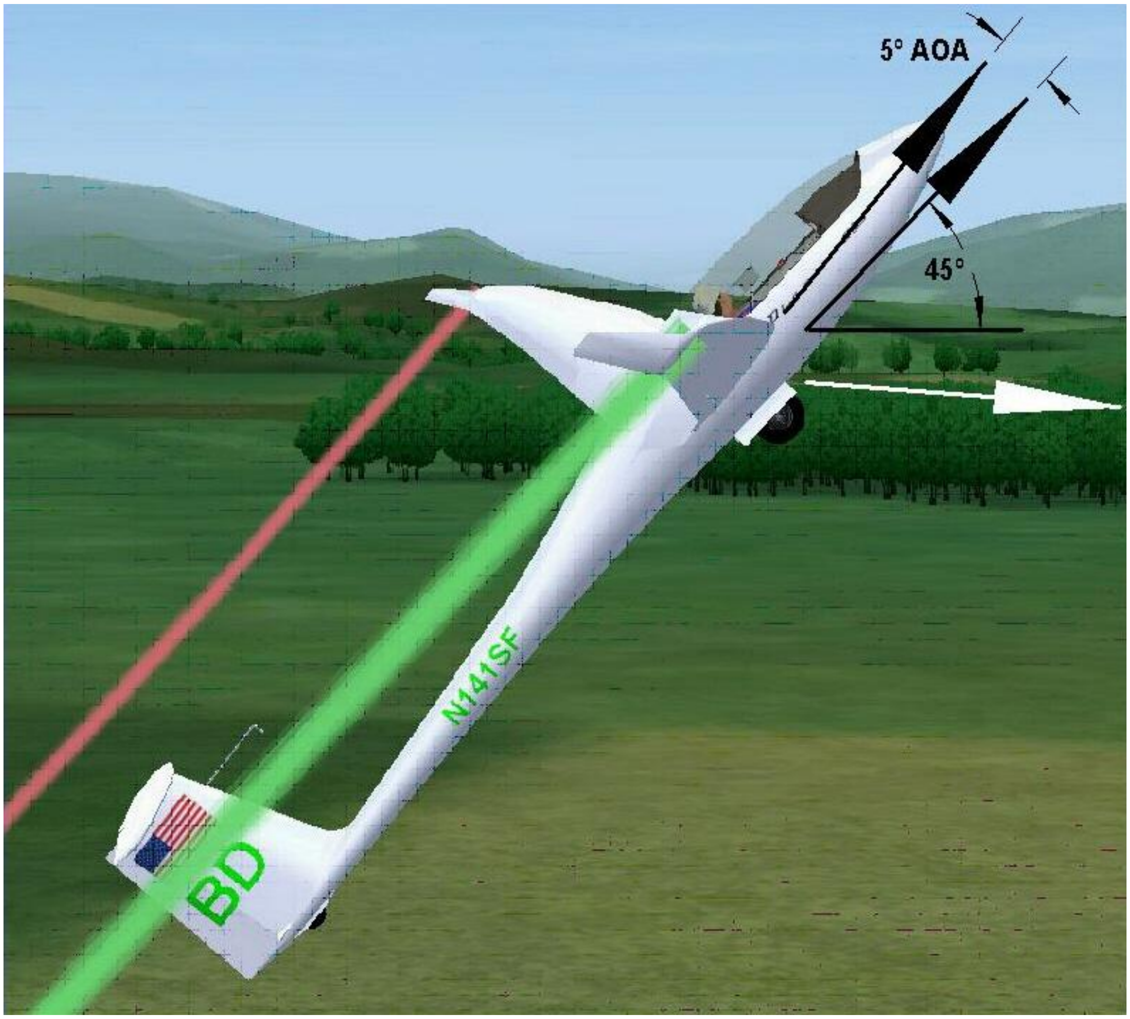


With an ATC rope winch and a modern trainer like an ASK-21, the launch will begin with an acceleration of one G or 32 feet per second per second. After one second, the glider will have traveled 16 feet and have reached a velocity of 32FPS or 19 knots. At this speed the pilot will have firm control authority. After 2 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 1G acceleration startling but it is exactly the same as is felt when lying on ones back. Most automobiles are capable of 1G 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 an height of about 150 feet AGL. This technique is the same as that used in high performance airplanes.

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 could not 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.

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 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 angle 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 runway equal to about half the length of the rope used. If launched into a headwind, the height will be greater.

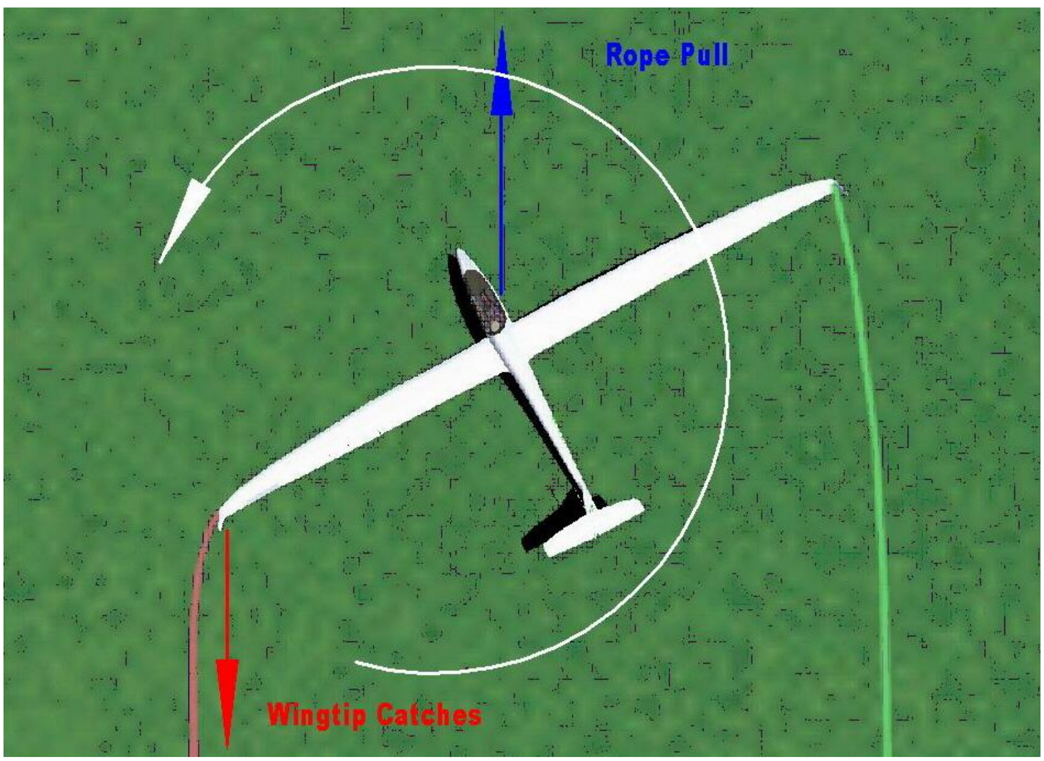
Ground Roll Technique & Hazards

The first seconds of a winch launch are critical and the pilot must be completely “switched 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 cockpit pre-flight check, the pilot should consciously center the ailerons and rudder. The only exceptions are rudder input when the CG release is located on the fuselage side as with the K-13 or when a crosswind component is present and even this should be removed before the ground roll ends.

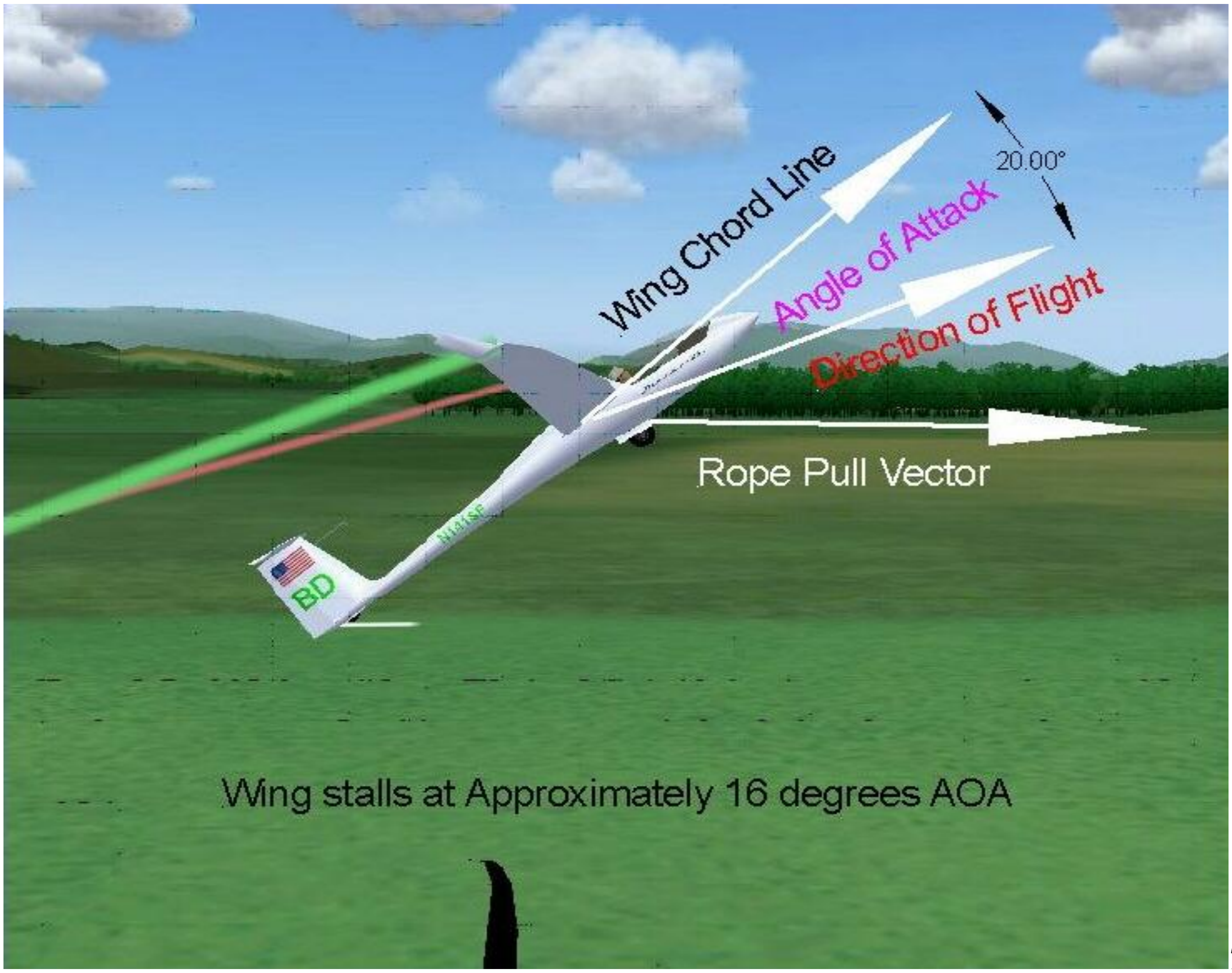
If it is seen that a wing tip will touch the runway despite corrective aileron input, the pilot should release and not try to “save” the launch. Failure to do so may result in a particularly ugly ground loop which may end with the glider crashing inverted. The CG release does not help keep the glider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

Dragging Wing Tip Leads to Ground Loop



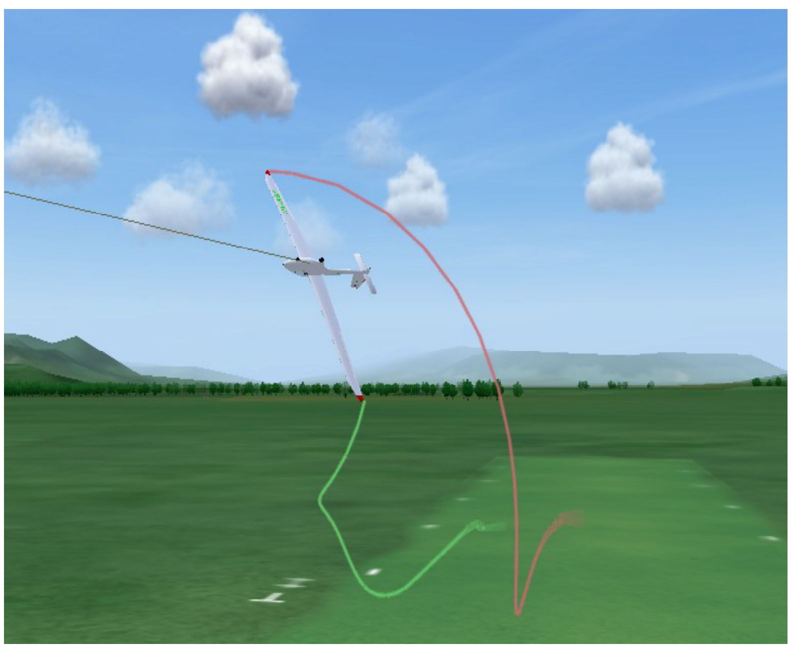
Before the ground roll begins, the pilot should place the left hand on the release control but not gripping it so the release can be used without delay. If the pilot grips the release the acceleration may cause him to inadvertently pull it. The pilot must have a plan in mind for dealing with any eventualities

Liftoff and Rotation Technique & Hazards



T

oo Rapid Rotation Leads to Stall

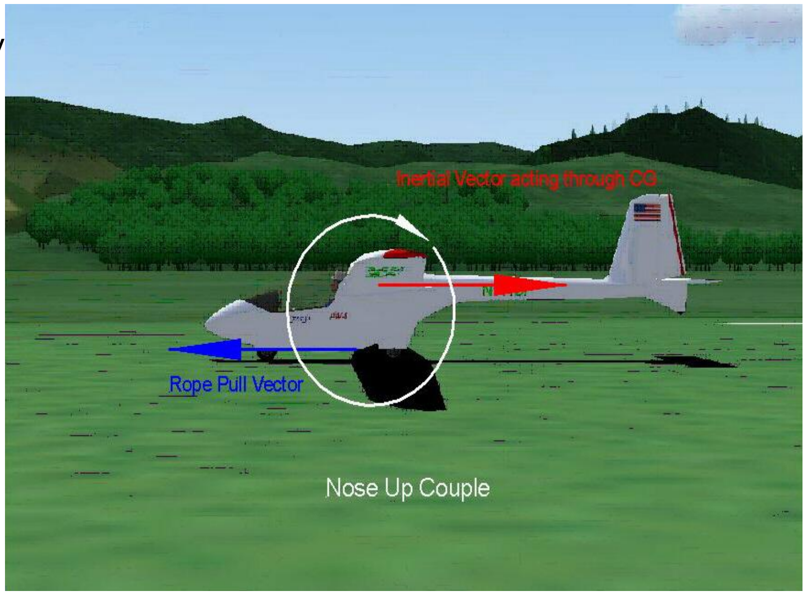


The stall margin is at a minimum during the rotation phase. The wing is loaded by the need to accelerate the glider to a vertical speed of over 4500 feet per minute in only a few seconds even as it is beginning to take on the load of the rope pull.

As a result the “loaded stall speed” increases significantly during the rotation phase.

If a stall does occur while there is left-right asymmetry in the control inputs, a snap roll (Br, “flick roll”) may ensue with fatal results.

The pilot should be trying to achieve a smooth rotation with airspeed increasing to a stable climb speed as one would do with a high performance airplane.



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 and early rotation to prevent too-rapid rotation.

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

Stall hazards may be avoided by carefully monitoring airspeed during the takeoff roll and rotation into the full climb while resisting any tendency to rotate into the climb prematurely.

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, turbulence or wind layers. Whatever the cause, these airspeed errors in themselves represent less of a threat than possible precipitative actions by the pilot.

Although the pilot should take every action to keep the airspeed below the winch redline, ($\mathbf{V_W}$) managing the problem while still on the rope is far preferable to an ill considered early release.

If the airspeed is low, the pilot need only lower the nose slightly to reduce the load on the winch allowing the airspeed to increase.

On the other hand, airspeed can exceed Vw during the first half of the launch with no danger. It is only in the last half of the launch where the pull of the rope is more nearly at right angles to the longitudinal axis that one needs be concerned and even then the glider is protected by the weak link.

The correct action in response to excessive airspeed is to raise the nose to load the winch while signaling 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. The BGA states categorically that, “No airworthy glider has ever been damaged by excessive airspeed on a winch launch.”

Glider to Winch Speed Signals

The following does not address launch crew signals such as to take up slack or initiate 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 pilots need to use visual signals.

To request an increase in power, the pilot lowers the nose and 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 described 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 effects of a crosswind. For this reason, no launch should be made with a crosswind component greater than the demonstrated crosswind component listed in the glider's POH.

Aero tow 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 tip leading to a groundloop. It is best to keep wings level or use only 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 rotation phase. Fortunately, the ground roll is very short so allowing the glider to drift a few feet downwind is usually of little consequence.

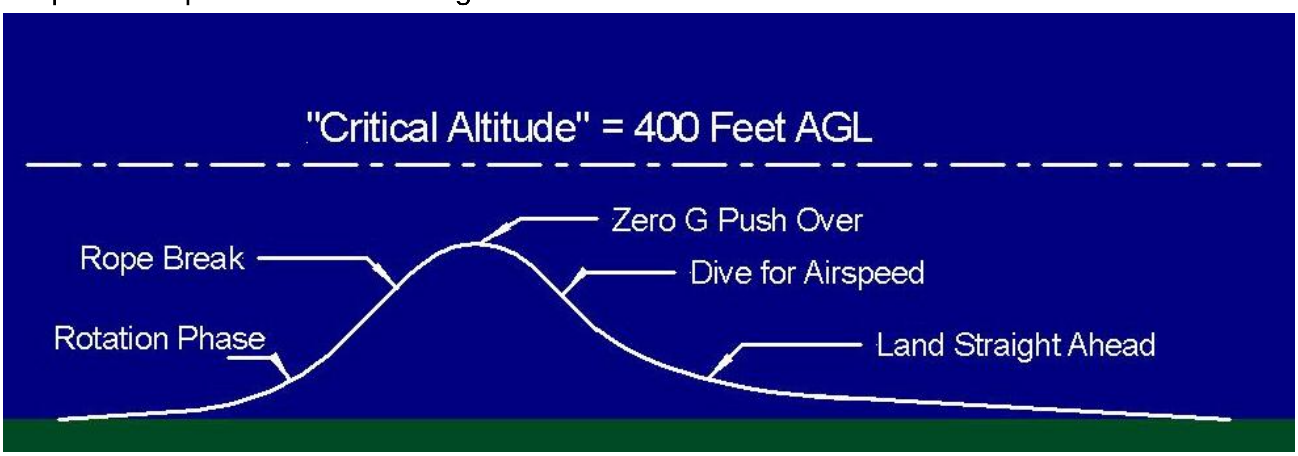
Once past the rotation phase and in the main climb, lowering the upwind wing will cause the glider to track upwind. The winch operator will appreciate this since it makes the post-release rope recovery easier.

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 the same - *"Fly the Glider!"*. Virtually all incidents related to poorly managed launch failures result from the pilot failing to fly the glider.

> **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 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 made safely using spoiler and slip. Above the "Critical Altitude" the pilot can safely circle back to land on the departure runway. On most runways and with most gliders, the land ahead and circle back options overlap by several hundred feet of altitude making the choice obvious and relatively 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.

At zero G the wing is producing no lift thus has no induced drag which minimizes airspeed loss. This ballistic trajectory should continue until the nose is as far below the horizontal as it was above it when the rope break occurred.

The words *"as far below the horizon as it was above"* have been carefully chosen to work in all cases and mean exactly what they say. If a

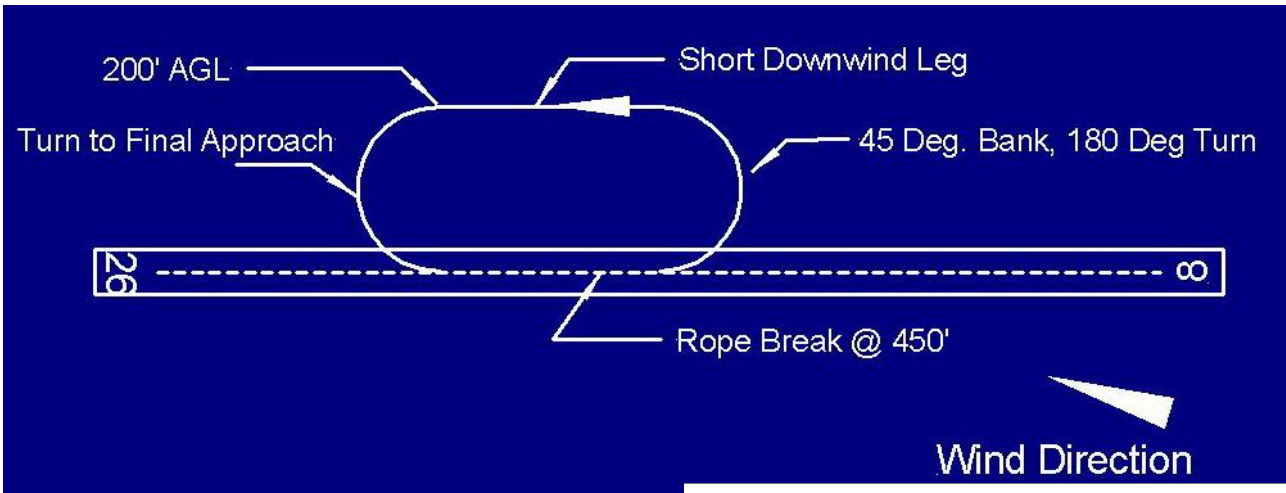
> **Instructors Note:** **180 Turns**
>
> Aero tow trained pilots will have an instinct to make a 180 turn to land downwind after a low launch failure. Since the glider will still be near the approach end, a 180 turn will leave the glider with nowhere to land. In fact, most of the runway is available for a straight ahead landing.
>
> runway.
>
> To test for this and teach proper pushover technique, have the student fly a series of dive, zoom and 0 G pushover maneuvers at several thousand feet AGL.

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 dive but at 500 feet with the nose 45 degrees above the horizon, lowering the nose only 10 degrees below the horizon will not result in safe airspeed recovery.

With the nose held well below the horizontal the pilot **must wait** for a safe airspeed with an increasing trend before taking further action. It is critical that no turn be initiated or the spoilers opened until a safe airspeed is achieved.

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 always made straight ahead with full spoiler 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.



<u>"Bridle"- type CG hooks</u> (Blanik)

The European Union has decreed that bridle-type be replaced with belly mounted Tost CG releases. Their experience has shown that the bridle-hooks have more failure modes than the standard Tost releases. It is also easier for the bridle to foul the landing gear.

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

A circle to land 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 and so the bank angle will be decreasing as the glider performs the final 180 degree 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 AGL is about 200 feet the turn should be continued through 360 degrees so the glider is again lined up 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 a aero tow rope break.

If the height is greater than 200 feet AGL at the end of the first 180 turn, a short downwind leg is flown until the height reaches 200 feet AGL where another 180 degree turn is made to align with the runway. 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 before making a “button hook” turn and a downwind landing stopping at the start line. This might be acceptable 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 than 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 back-release as the drag of the parachute assembly pulls backward on the CG release. In the worst case if the rope remains on the hook, there is little danger since it will back release during 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.

Glider Release Failure

True release failures are thankfully 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 is 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, UHMWPE rope will trail nearly horizontally behind the glider like a spider web. This allows a high pattern and steep approach to the runway with touchdown planned as near the departure end as is safe. This should prevent the trailing rope from fouling anything on the ground.

Winch Failures

Old automotive derived winches can have many failure modes. Unlike automobiles, a winch can't be driven to diagnose problems so many issues can 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, and deal with it as if it were a rope break.

Winch Launch Transition Syllabus: (20 – 36 launches)   (Assumes Aero Tow Exp.)

Session one: Winch launch familiarization (Six launches)

Instructor flies three normal launches and the transition candidate observes. Then the candidate flies three launches under close observation by the instructor. If a launch failure occurs, the instructor will take the controls and fly the recovery. The instructor then debriefs the candidate on the ground offering critique with suggestions for the next session.

Session two: Further launch practice and zero G training. (One to six launches)

The candidate flies up to six launches under instructor observation and tries to contact thermal lift. If lift is found, the student will gain sufficient altitude for zero G pushover practice. Pushover practice is diving the glider to approximately 90 knots and then zooming upward at 45 degrees. When the airspeed drops to 65 knots, the instructor will yell "Rope Break!" and the candidate will push over at zero G until the nose is 45 degrees below the horizon.   This allows the candidate to experience zero G and learn the control inputs needed to achieve it. If no lift is available, it may be necessary to take an aero tow to gain enough height. The instructor will debrief the candidate and offer critique.

Session three: High launch failure training. (Six launches)

The instructor will fly a launch to pattern altitude where he/she will pull the release simulating a rope break. He will demonstrate a recovery with zero G pushover and airspeed recovery. The candidate with then fly the next 5 launches with the instructor pulling the release without warning simulating a rope break at successively lower altitudes but always above the "Critical Altitude" ending with a tight, low altitude 360 pattern to an into-the-wind landing. The instructor will debrief the candidate and offer critique.

Session four: Low launch failure training. (Six launches)

The instructor will fly a launch to a height just below the "Critical Altitude" and pull the release simulating a rope break. The instructor will then land straight ahead. The candidate will fly the next 5 launches with the instructor pulling the release without warning at progressively lower altitudes ending with a simulated break at about 100 feet AGL. The instructor will debrief the candidate and offer critique.

Session Five: Winch failure training. (Six launches)

The student will fly six launches with the winch operator simulating various winch failure modes. These should include overspeed, under speed, slow power loss, delayed power cut and unusual gear changes if the winch is equipped with a transmission. The instructor and winch operator will debrief the candidate and offer critique.

Session Six: Crosswind training. (Two to six launches)

This session may be skipped if the preceding sessions encountered significant crosswinds. Otherwise, it should be delayed until crosswinds are available.