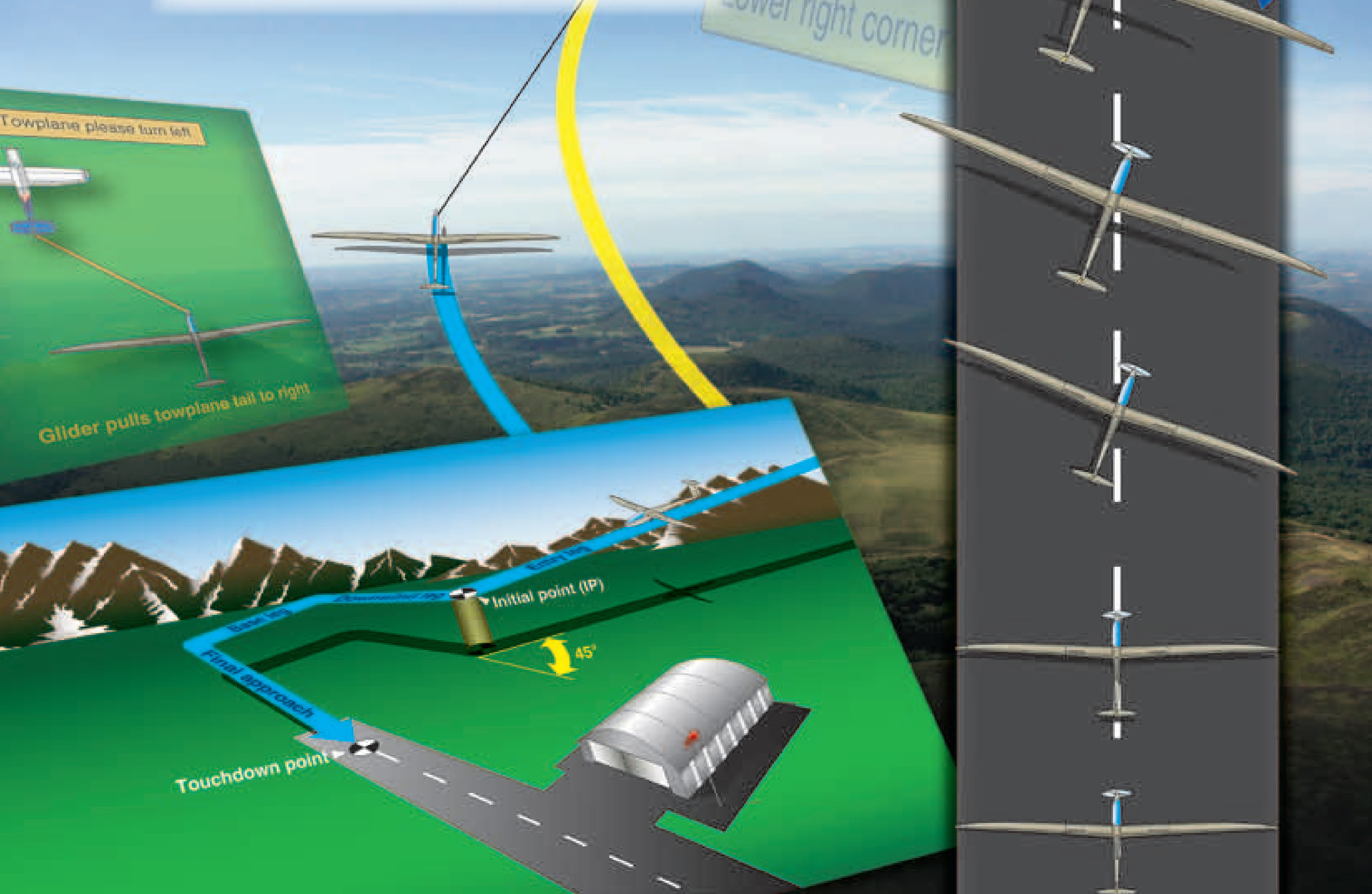
Chapter 7

Launch and Recovery Procedures and Flight Maneuvers

Introduction

In the early days of soaring, gliders were launched from the top of a hill into the wind by means of bungee cord, a stretchable cord made of rubber bands. The tail of the glider was held back or tied down, and the bungee was attached at its midpoint to a hook on the nose of the glider. Then, a group of people took each end and, when the signals were given, they walked, then ran with the bungee as hard as they could. When the tension became quite high, the tail tie-down was severed, or released, and the glider shot ahead as though it had been launched from a slingshot.



As gliders got heavier and better, pilots began to look for improved ways to launch. It was not long before enthusiasts began to use cars to pull shock cords and then to pull the gliders by the long wire or rope. Once again, improvements in technology and equipment were introduced and powered winches and airplane towing became the preferred method of launching gliders.

This chapter discusses several glider launch techniques and procedures along with takeoff procedures, traffic patterns, flight maneuvers, and landing and recovery procedures. Additional information may be found at the Soaring Society of America (SSA) website at www.ssa.org and the Soaring Safety Foundation website at www.soaringsafety.org.

Aerotow Takeoff Procedures

Signals

Launching a nonpowered glider requires the use of visual signals for communication and coordination between the glider, towing aircraft, and the ground crew. Ground launching signals consist of prelaunch signals and in-flight signals.

Prelaunch Signals

Aerotow prelaunch signals facilitate communication between pilots and launch crewmembers/wing runners preparing for the launch. These signals are shown in *Figure 7-1*.

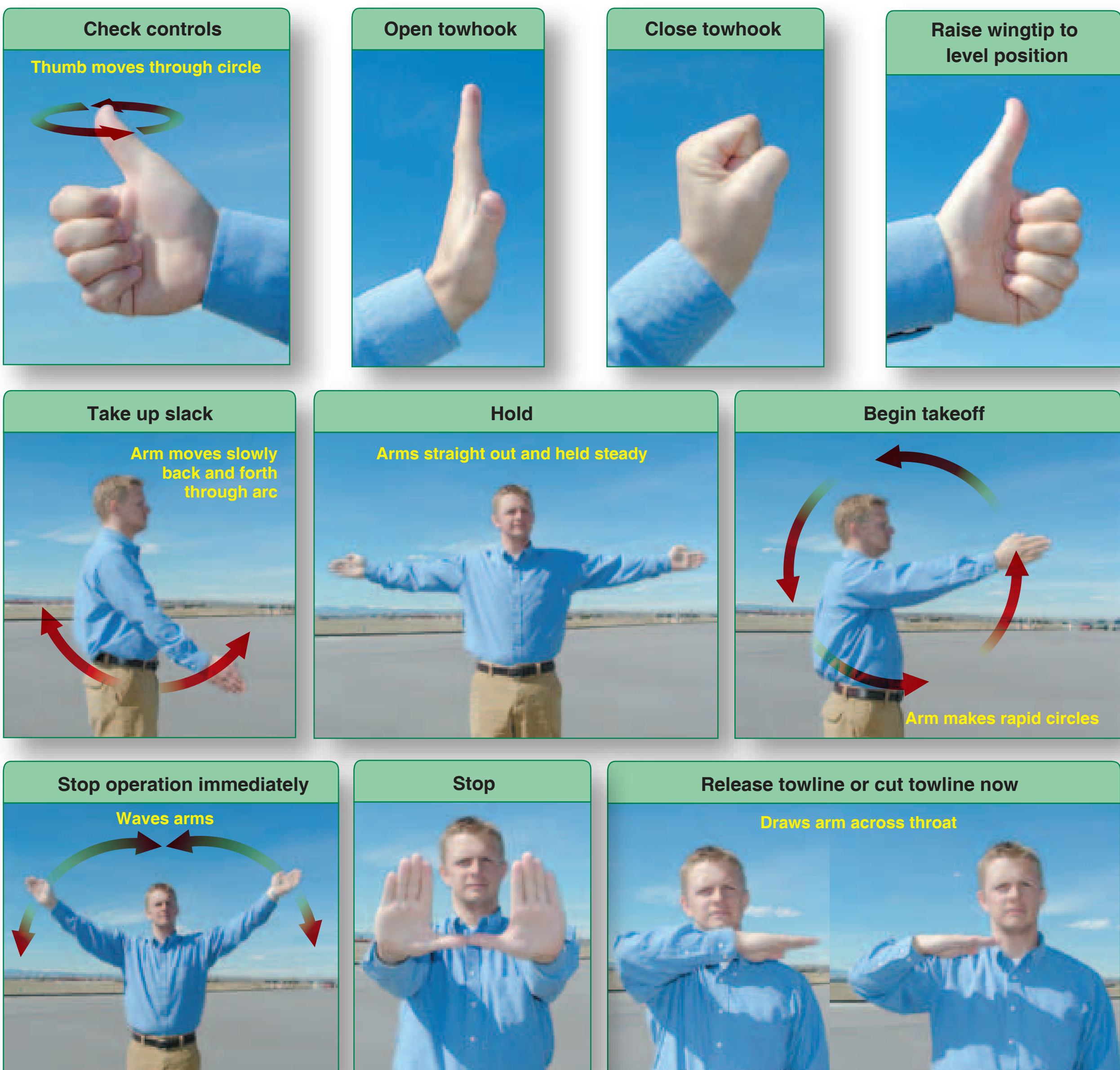


Figure 7-1. *Aerotow prelaunch signals.*

Inflight Signals

Visual signals allow the tow pilot and the glider pilot to communicate with each other. The signals are divided into two types: those from the tow pilot to the glider pilot and signals from the glider pilot to the tow pilot. These signals are shown in *Figure 7-2*.

Takeoff Procedures and Techniques

Takeoff procedures for gliders require close coordination between launch crewmembers, wing runners, and pilots. Both the glider pilot and tow pilot must be familiar with the appropriate tow procedures. The assisted takeoff includes a wing runner that holds the wing in a level position. An unassisted takeoff does not include a wing runner or other ground crew. The unassisted launch requires good procedures and should only be attempted by highly experienced glider and tow pilots. It is recommended that all takeoffs include a ground crewmember for traffic scanning and general assistance during the takeoff.

It is very important to never connect a glider to a towplane or towline unless the pilot is aboard and ready for flight. If the pilot exits the glider for any reason, the towline should be released and disconnected because some hitches like a Tost hitch require slight pressure for the tow ring to actually move from the jaws. If no tension is applied, the ring stays in place and connected when the jaws close.

Normal takeoffs are made into the wind. Prior to takeoff, the tow pilot and glider pilot must reach an agreement on the plan for the aerotow. The glider pilot should ensure that the launch crewmember is aware of safety procedures concerning the tow. Some of these items would be proper runway and pattern clearing procedures and glider configuration checks (spoilers closed, tailwheel dolly removed, canopy secured).

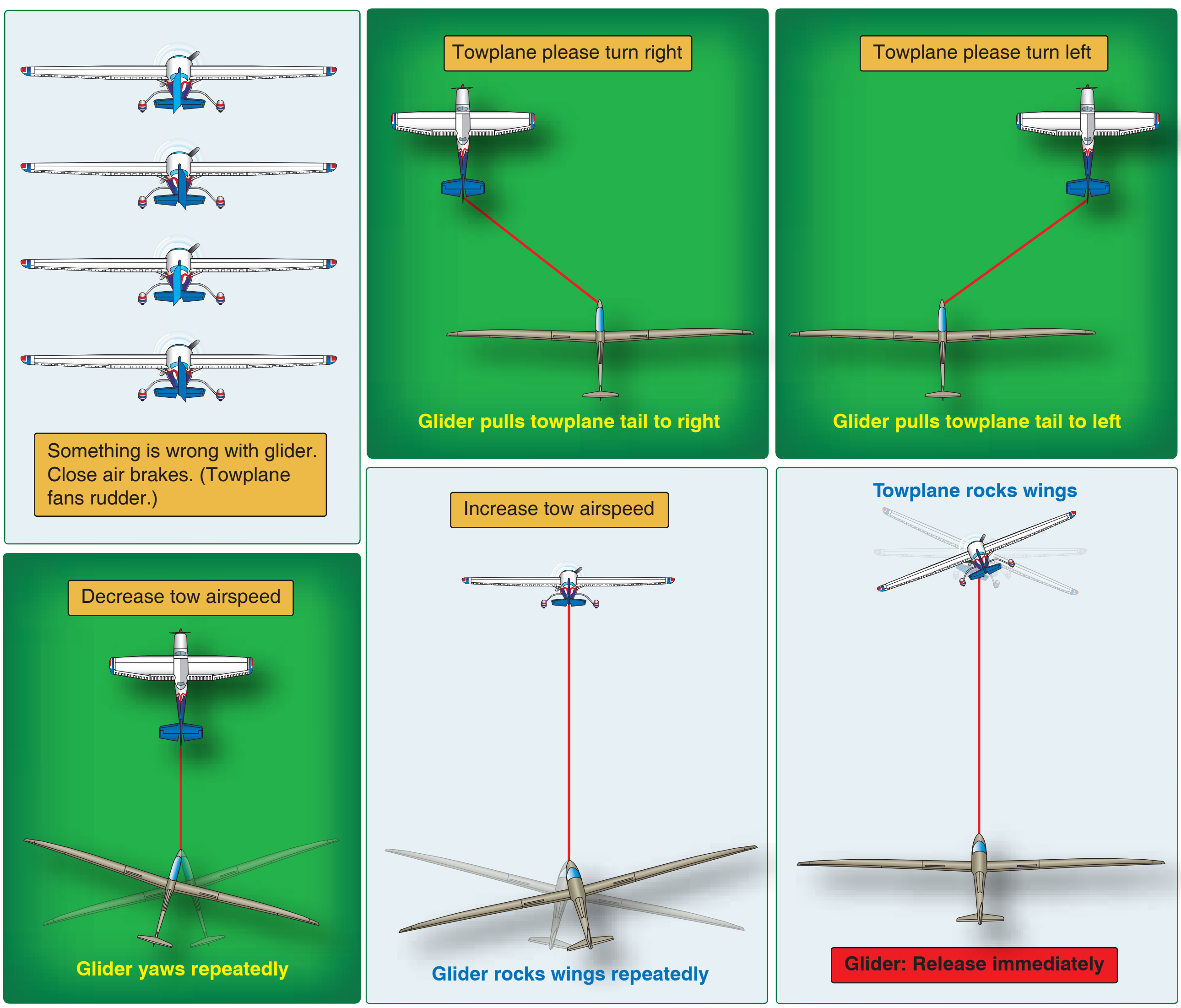


Figure 7-2. *Inflight aerotow visual signals.*

When the required checklists have been completed and both the glider and towplane are ready for takeoff, the glider pilot signals the launch crewmember/wing runner to hook the towline to the glider.

Normal Assisted Takeoff

The towrope hookup should be done deliberately and correctly, and the release mechanism should be checked for proper operation. The launch crewmember/wing runner applies tension to the towline and signals the glider pilot to activate the release. The launch crewmember should verify that the release works properly and signal the glider pilot. When the towline is hooked up to the glider again, the launch crewmember repositions to the wing that is down. When the glider pilot signals "ready for takeoff," the launch crewmember/wing runner clears both the takeoff and landing area, and then signals the tow pilot to "take up slack" in the towline. Once the slack is out of the towline, the launch crewmember verifies that the glider pilot is ready for takeoff; this may include a "thumbs up" by the glider pilot. The crewmember/wing runner does a final traffic pattern check, and then raises the wings to a level position. With the wings raised, the crewmember/wing runner then signals the tow pilot for takeoff. At the same time, the glider pilot signals the tow pilot by wagging the rudder back and forth, concurring with the launch crewmember's/wing runner's takeoff signal. If a radio is used, the glider pilot advises the tow pilot that he or she is ready for takeoff, stating "Canopy and dive/air brakes closed and locked."

As the launch begins and the glider accelerates, the launch crewmember/wing runner runs alongside the glider, holding the wing level. When the glider achieves lift-off speed, the glider pilot should allow the glider to become just barely airborne and level behind the towplane's tail, as it accelerates to climb speed. The glider pilot must be precise in controlling the glider at this very low altitude of 2 to 4 feet, more or less depending on the aircraft involved. Any large excursions from the position of level directly behind the towplane's tail can lead to disaster for the tow pilot and the glider pilot(s). The glider pilot must not climb above the towplane's tail, as this can force the towplane's propeller into the runway surface. Lateral glider deviations side to side can drive the towplane off the runway. The glider pilot should maintain this altitude by applying forward stick pressure, as necessary, while the glider is accelerating. Once the towplane lifts off, it accelerates in ground effect to the desired climb airspeed, and then the climb begins for both the glider and towplane.

During takeoff while at very low altitudes, it may be necessary to steer the glider solely with the rudder due to the very long wings of most gliders. The long wings, combined with very short landing gear stances, make gliders prone to hitting runway lights and signage. Keeping the glider's wings level helps prevent collisions with obstructions but restricts aileron usage close to the surface. Control the bank angle of the wings with the ailerons. Full deflection of the flight controls may be necessary at low airspeeds, but the flight controls become more effective as airspeed increases. *[Figure 7-3]*

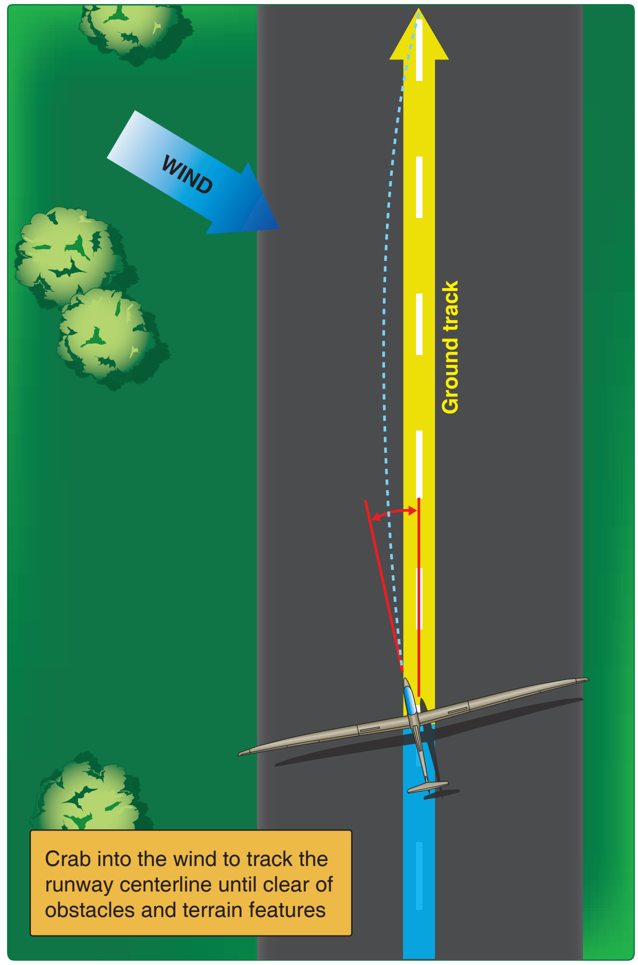


Figure 7-3. *Tracking the runway centerline.*

In most takeoffs, the glider achieves flying airspeed before the towplane. However, if the glider is a heavily ballasted glider, the towplane may be able to achieve liftoff airspeed before the glider. In such a situation, the towplane should remain in ground effect until the glider is off the ground. Climb-out must not begin until the previously determined climb airspeed has been achieved.

One of the most dangerous occurrences during aerotow is allowing the glider to fly high above and losing sight of the towplane. The tension on the towline caused by the glider pulls the towplane tail up, lowering its nose. If the glider continues to rise, pulling the towplane tail higher, the tow pilot may not be able to raise the nose. Ultimately, the tow pilot may run out of up elevator authority.

In some towhook systems, the high pressure loading on the towhook causes towhook seizure, and the tow pilot may not be able to release the towline from the towplane. This situation can be critical if it occurs at altitudes below 500 feet above ground level (AGL). Upon losing sight of the towplane, the glider pilot must release immediately.

Unassisted Takeoff

The unassisted takeoff is basically conducted in the same manner as a normal takeoff, but the glider is positioned slightly off the runway heading (runway centerline) by approximately 10–20° with one wing on the ground. If the glider is canted to the right, then the right wing would be resting on the ground. To the left, the left wing would be resting on the ground. When the glider pilot is ready for takeoff, he or she advises the tow pilot either by radio, which is the preferred method, or by signaling the tow pilot with the "ready for takeoff" rudder waggle signal, as in the assisted takeoff. As the towplane accelerates, the wing on the ground (trailing wing) accelerates at a slightly faster rate as it is pulled in a slight arc, allowing that wing to rise quickly with little dragging.

If the glider is aligned with the towplane during the takeoff, the wing that is on the ground has a tendency to be dragged and a ground loop may occur (or severe swerving). After the wings are level, proceed as in the normal takeoff configuration.

Crosswind Takeoff

Crosswind takeoff procedures are a modification of the normal takeoff procedure. The following are the main differences in crosswind takeoffs:

- The glider tends to weathervane into the wind any time the main wheel is touching the ground. The stronger the crosswind is, the greater the tendency of the glider is to turn into the wind.
- After lift-off, the glider tends to drift downwind off the runway centerline. The stronger the crosswind is, the greater the tendency of the glider is to drift downwind.

Assisted

Prior to takeoff, the glider pilot should coordinate with the launch crewmember to hold the upwind wing slightly low during the initial takeoff roll. If a crosswind is indicated, full aileron should be held into the wind as the takeoff roll is started. This control position should be maintained while the glider is accelerating and until the ailerons become effective for maneuvering the glider about its longitudinal (roll) axis. With the aileron held into the wind, the takeoff path must be held straight with the rudder. This requires application of downwind rudder pressure, since the glider tends to weathervane into the wind while on the ground. *[Figure 7-4]* As the glider's forward speed increases, the crosswind becomes more of a relative headwind; the mechanical application of full aileron into the wind should be reduced. It is when increasing pressure is being felt on the aileron control that the ailerons are becoming more effective. Because the crosswind component effect does not completely dissipate, some aileron pressure must be maintained throughout the takeoff roll to prevent the crosswind from raising the upwind wing. If the upwind wing rises, exposing more wing surface to the crosswind, a skipping action may result, as indicated by a series of small bounces occurring when the glider attempts to fly and then settles back onto the runway. This side skipping imposes side loads on the landing gear. Keeping the upwind wingtip slightly lower than the downwind wingtip prevents the crosswind from getting underneath the upwind wing and lifting it. If the downwind wingtip touches the ground, the resulting friction may cause the glider to yaw in the direction of the dragging wingtip. This yaw could lead to a loss of directional control and runway departure.

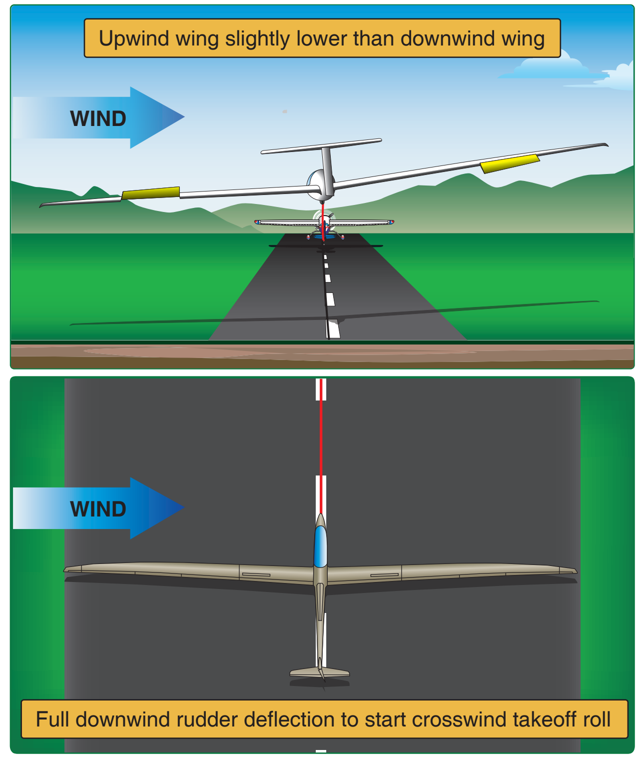


Figure 7-4. *Crosswind correction for takeoff.*

While on the runway throughout the takeoff, the glider pilot uses the rudder to maintain directional control and alignment behind the towing aircraft. Yawing back and forth behind the towplane should be avoided, as this affects the ability of the towplane pilot to maintain control. If glider controllability becomes a problem, the glider pilot must release and stop the glider on the remaining runway. Remember, as the glider slows, the crosswind may cause it to weathervane into the wind.

Prior to the towplane becoming airborne, and after the glider lifts off, the glider pilot should turn into the wind and establish a wind correction angle to remain behind the towplane. This is accomplished by using coordinated control inputs to turn the glider. Once the towplane becomes airborne and establishes a wind correction angle, the glider pilot repositions to align behind the towplane.

Unassisted

Just as in the unassisted takeoff with no wind, the unassisted crosswind takeoff is conducted slightly differently with regard to wing positioning and glider alignment. The glider should be placed on the upwind side of the runway or take area; if unable, the towplane should try to angle into the wind as best as possible to reduce the crosswind component for the glider. Most gliders have a crosswind limit up to approximately 10–12 knots. See the Glider Flight Manual/ Pilot's Operating Handbook (GFM/POH) for information specific to your glider. Again, the unassisted launch should be attempted only by highly experienced pilots.

The glider should be placed with the upwind wing on the ground and the glider angled approximately 20–30° into the wind. *[Figure 7-5]* If the upwind wing is permitted to be up during the takeoff run, the glider pilot finds it very difficult to level the wings. A ground loop usually results since the downwind wing is being dragged along the ground. With the upwind wing on the ground during the early stages of the takeoff, the glider pilot finds it easier to level the wings early in the takeoff. As in the unassisted takeoff, the upwind wing is swung forward at a faster rate than the downwind wing, aiding the pilot in leveling the wings. The crosswind strikes the fuselage of the glider, tending to push it downwind, making it necessary to place the glider on the upwind side of the runway. Execute a crosswind takeoff from this point after both wings are level.

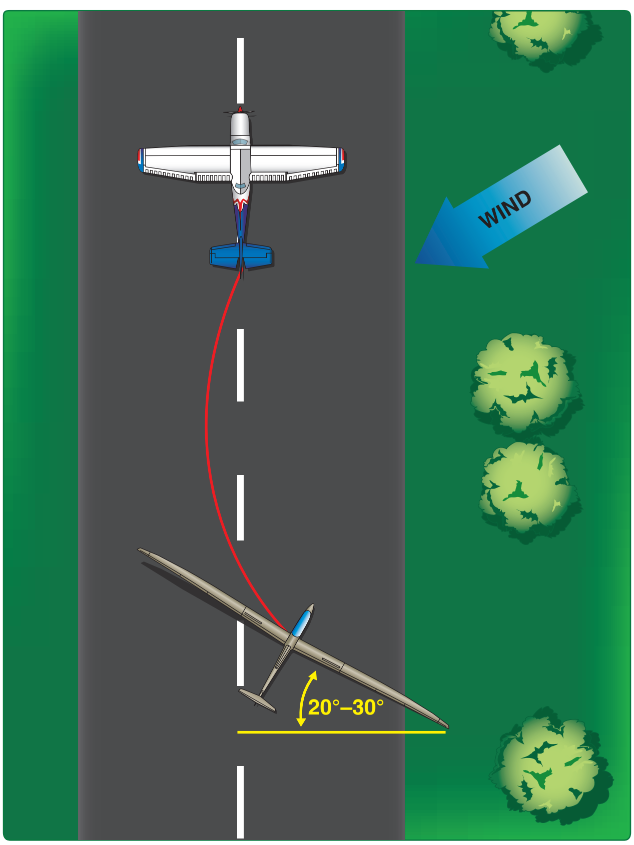


Figure 7-5. *When setting up for a crosswind takeoff, the glider should be placed on the upwind side of the runway.*

Common errors in aerotow takeoffs include:

- Improper glider configuration for takeoff,
- Improper initial positioning of flight controls,
- Improper alignment of the glider (unassisted takeoff),
- Improper use of visual launch signals,
- Failure to maintain alignment behind towplane before towplane becomes airborne,
- Improper alignment with the towplane after becoming airborne, and
- Climbing too high after lift-off and causing a towplane upset.

Aerotow Climb-Out

Once airborne and climbing, the glider can fly one of two tow positions. High tow is aerotow flight with the glider positioned slightly above the wake of the towplane. Low tow is aerotow flight with the glider positioned just below the wake of the towplane. *[Figure 7-6]* Climbing turns are made with shallow bank angles and the glider in the high tow position. Pilots are trained using these positions to learn coordinated towing procedures and understanding the dynamics of the aerotow. In training, glider pilots are advised to control vertical position relative to the towplane using the horizon.

The glider pilot's sight picture depends on the type of towplane being used for the launch. The instructor, through flight experience, can determine the particular towplane's vertical wake boundaries and describe the positions. Sometimes, the glider may use the picture of the towplane's wings on the horizon. On another type of towplane, maintaining the towplane's rudder centered over the fuselage of the towplane ensures the glide is directly behind the towplane in straight flight. Any excessive deviation from the low or high tow position by the glider requires abnormal control inputs by the tow pilot, which always generates more drag and degrades climb performance during the tow.

The towplane's wake drifts down behind the towing aircraft. Straight ahead climbs are made with the glider in the level or

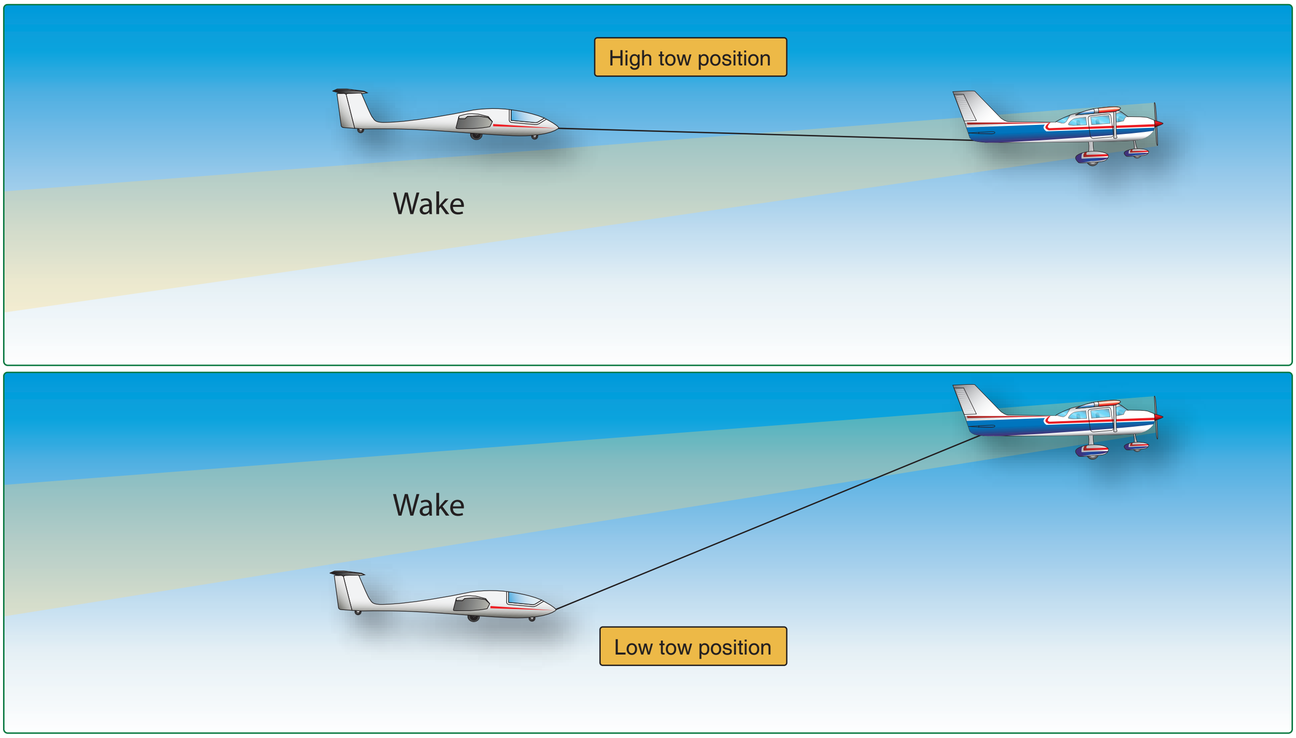


Figure 7-6. *Aerotow climb-out.*

high tow position. The tow pilot strives to maintain a steady pitch attitude and a constant power setting for the desired climb airspeed. The glider pilot uses visual references on the towplane to maintain a proper lateral and vertical position.

In a level flight tow, the pilot should position the glider above the wake of the towplane. Low tow offers the glider pilot a better view of the towplane and provides for a more aerodynamically efficient tow, especially during climb, as the towplane requires less upward elevator deflection due to the downward pull of the glider. However, because of the risk of towline fouling if the towline breaks or is released by the towplane, low tow should be mainly used for level flight aero-tows such as for a cross-country flight.

Climbing turns are made with shallow bank angles in the high tow position. During turns, the glider pilot observes and matches the bank angle of the towplane. In order to stay in the same flightpath of the towplane, the glider pilot must aim the nose of the glider at the outside wingtip of the towplane. This allows the glider's flightpath to coincide with the flightpath of the towplane. *[Figure 7-7]*

If the glider's bank is steeper than the towplanes bank, the glider's turn radius is smaller than the towplane turn radius. *[Figure 7-8]* If this occurs, the reduced tension on the towline causes it to bow and slack, allowing the glider's airspeed to slow. As a result, the glider begins to sink relative to the towplane. The correct course of action is to reduce the

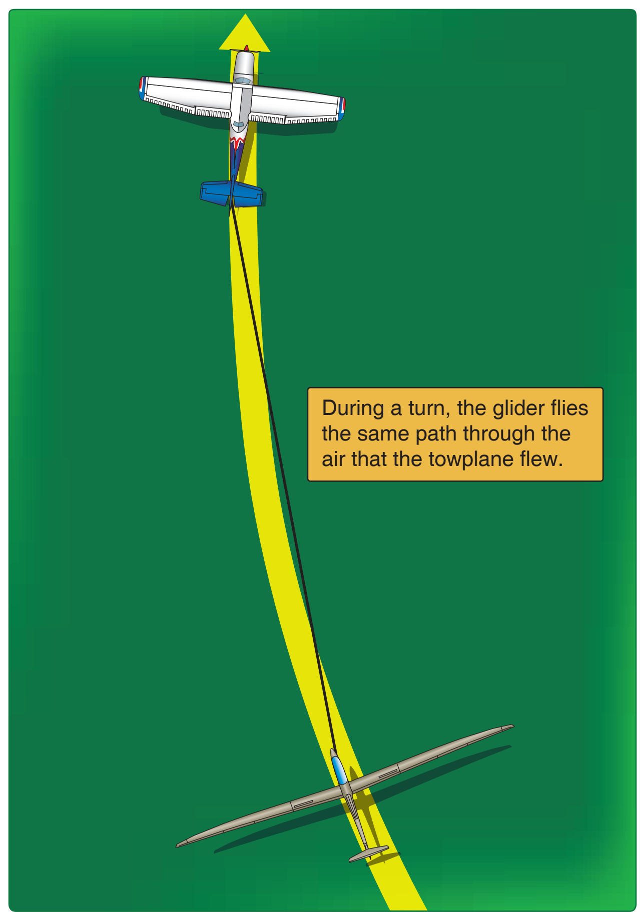


Figure 7-7. *Aerotow climbing turns.*

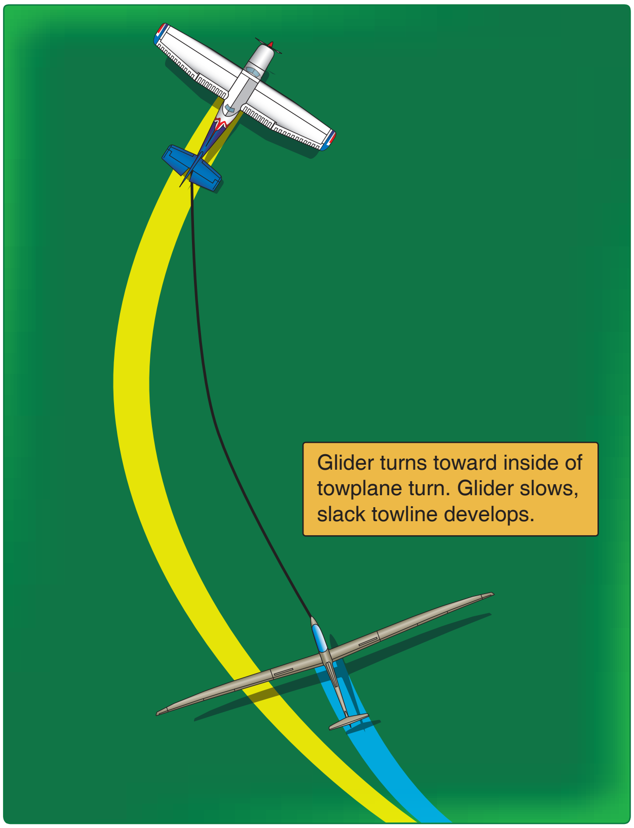


Figure 7-8. *Glider bank is steeper than that of towplane, causing slack in towline.*

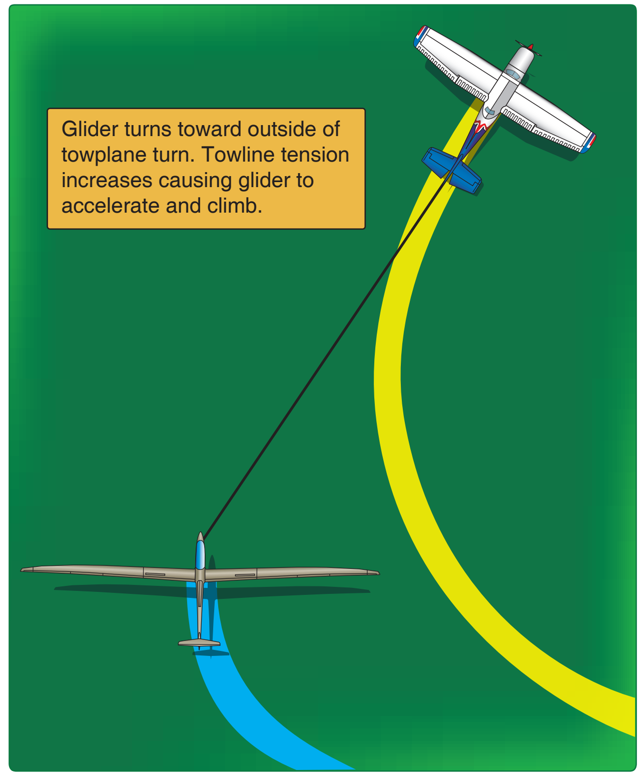


Figure 7-9. *Glider bank too shallow, causing turn outside towplane turn.*

glider's bank angle so the glider flies the same radius of turn as the towplane. If timely corrective action is not taken and the glider slows and sinks below the towplane, the towplane may rapidly pull the towline taut and possibly cause it to fail and/or cause structural damage to both aircraft.

If the glider's bank is shallower than the towplane, the glider's turn radius is larger than the towplane's turn radius. *[Figure 7-9]* If this occurs, the increased tension on the towline causes the glider to accelerate and climb. The correct course of pilot action when the glider is turning outside the towplane radius of turn is to increase glider bank angle. As the glider moves back into position behind the towplane, the glider corrects to the same radius of turn as the towplane. If timely corrective action is not taken and the glider accelerates and climbs above the towplane, the towplane may lose rudder and elevator control. In this situation, the glider pilot should release the towline and turn to avoid the towplane.

Common errors in aerotow climb-out include:

- Faulty procedures by not maintaining proper vertical and lateral position during high or low tow.
- Inadvertent entry into towplane wake.
- Failure to maintain glider alignment during turns on aerotow causing towplane upset.

Aerotow Release

Standard aerotow release procedures provide safety benefits for both the glider and the towing aircraft. When the aerotow reaches release position, the glider pilot should clear the area for other aircraft in all directions, especially to the right. Prior to release, the towline should be under normal tension for a normal release. Depending on the hook, some tension is required to extract the ring from the hook. The hook-type towing attachments may need pressure to make the hook swing open to release the hook. When ready to release, the glider pilot pulls the release handle completely out to ensure the towline hook is fully open to allow the release of the towline and hold the hook release open until it is verified that the towline is free of the glider. Generally, the release of the towline is felt as the forward motion begins to decelerate, but the glider pilot should always visually confirm the towline release prior to the 90° right clearing turn. *[Figure 7-10A]* Next, the glider pilot banks to the right, accomplishing 90° of heading change, then in level flight flies away from the release point while observing the towplane actions.

Shown in *Figure 7-10B*, this 90° change of heading achieves maximum separation between towplane and glider in minimum time. After confirming glider release and 90° turn away from the towplane, the tow pilot turns left away from the release point, achieving safe maximum separation.

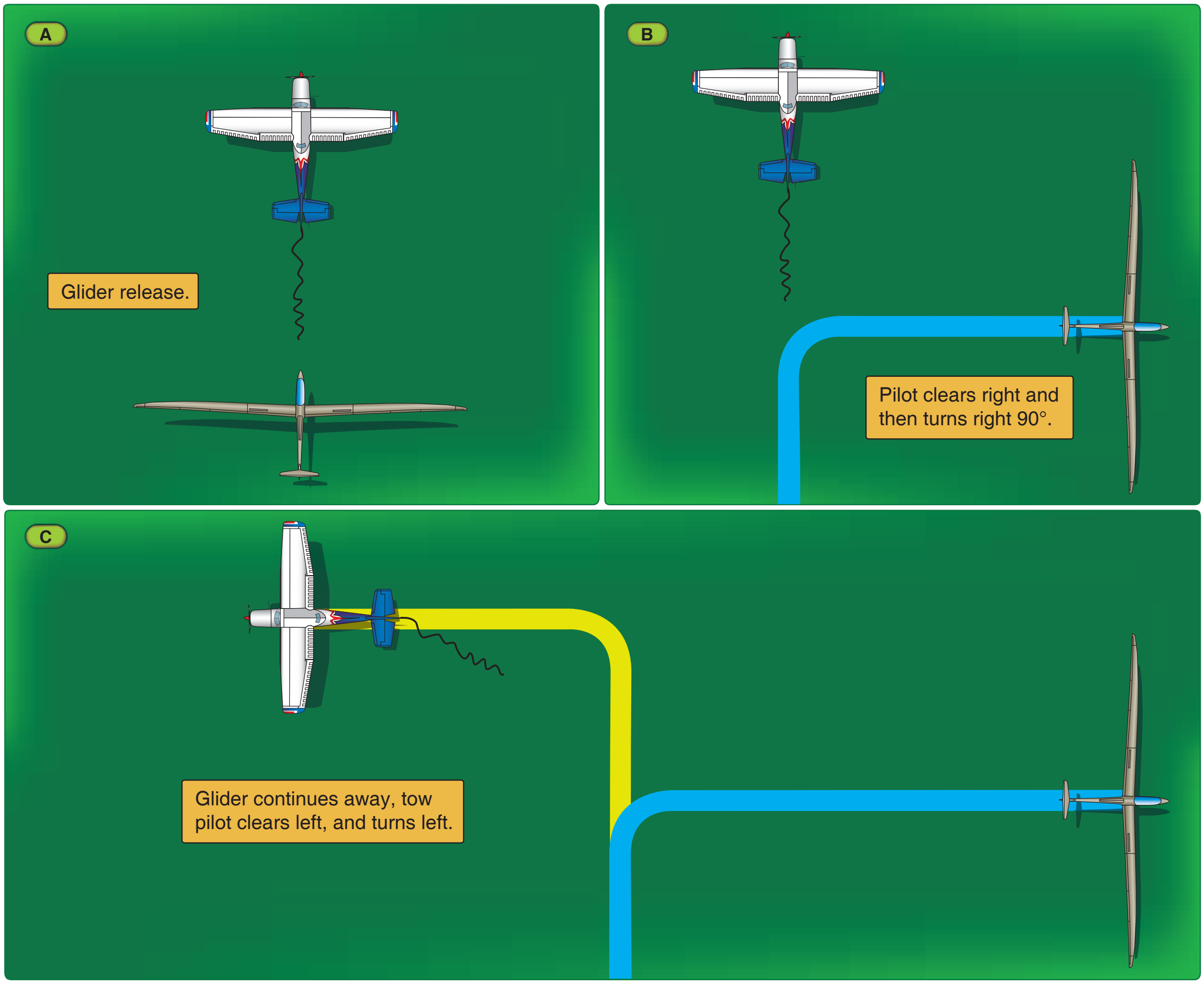


Figure 7-10. *Aerotow release.*

Shown in *Figure 7-10C*, once clear of the glider and other aircraft, the tow pilot then begins a descent. The tow pilot should continue to observe the glider's actions as the glider pilot may have started his/hers thermalling procedure with the possibility of the glider pilot losing sight of the towing aircraft. Common errors in aerotow release include:

- Lack of normal tension on towline or slack in towline.
- Failure to clear the area prior to release.
- Failure to make a 90° right turn after release.
- Release in close proximity of other aircraft.
- Glider pilot and tow pilot losing sight of each other's aircraft.

Maintaining proper release procedures is important to ensure proper aircraft separation in case pilots lose sight of each other's aircraft. It is imperative for the tow pilot to exit the immediate area of the glider release. If the glider releases in a thermal or other lift, the glider must stay in that lift to gain altitude, whereas the tow pilot has the ability to completely clear the glider's area before returning to the airport. Both the tow pilot and glider pilot should be aware of other gliders near areas of lift.

Slack Line

Slack line is a reduction of tension in the towline. If the slack is severe enough, it might entangle the glider or cause damage to the glider or towplane. The following situations may result in a slack line:

- Abrupt power reduction by the towplane
- Aerotow descents
- Glider turns inside the towplane turn radius *[Figure 7-8]*
- Updrafts and downdrafts
- Abrupt recovery from a wake box corner position *[Figure 7-11]*

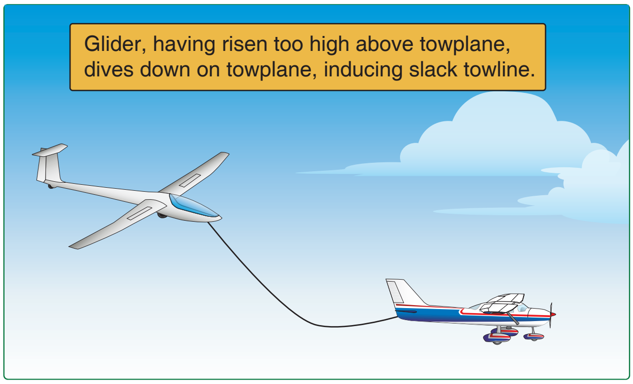


Figure 7-11. *Diving on towplane.*

When the towplane precedes the glider into an updraft, the glider pilot first perceives that the towplane is climbing much faster and higher than it actually is. Then, as the glider enters the updraft, it is lighter and more efficient than the towplane. It climbs higher and faster than the towplane did in the same updraft. As a result, the glider pilot pitches the glider over to regain the proper tow altitude but gains airspeed more quickly than the towplane, hence the slack towline. The glider pilot must be ready to control the descent and closure rate to the towplane.

Slack line recovery procedures should be initiated as soon as the glider pilot becomes aware of the situation. The glider pilot should try slipping back into alignment with the towplane. In the event that slipping fails to reduce the slack sufficiently, careful use of spoilers/dive brakes can decelerate the glider and take up the slack. When the towline tightens, stabilize the tow and gradually resume the desired aerotow position. When slack in the towline is excessive, or beyond the pilot's capability to safely recover, the glider pilot should immediately release from the aerotow.

Common errors regarding a slack line include:

- Failure to take corrective action at the first indication of a slack line.
- Use of improper procedure to correct slack line causing excessive stress on the towline, towplane, and the glider.

Boxing the Wake

Boxing the wake is a training and performance maneuver designed to demonstrate a pilot's ability to accurately maneuver the glider around the towplanes wake during aerotow. This maneuver is used by flight instructors to teach students how to find the towing aircraft wake; then, safely maneuver around the wake during the aerotow. *[Figure 7-12]*

Boxing the wake requires flying a rectangular pattern around the towplane's wake and not the towplane. Prior to takeoff, the glider pilot should advise the tow pilot that he or she is planning to box the wake. Boxing the wake should commence outside of the traffic pattern area and at no lower than 1,000 feet AGL.

Before starting the maneuver, the glider should descend through the wake to the center low tow position as a signal to the tow pilot that the maneuver is about to begin. The pilot uses coordinated control inputs to move the glider level to one side of the wake and holds that lower corner of the rectangle momentarily with rudder pressure.

Applying back pressure to the control stick starts a vertical ascent using rudder pressure to maintain equal distance from the wake. The pilot holds the wings almost level with the ailerons to parallel the towplane. When the glider has attained high corner position, the pilot momentarily maintains this position.

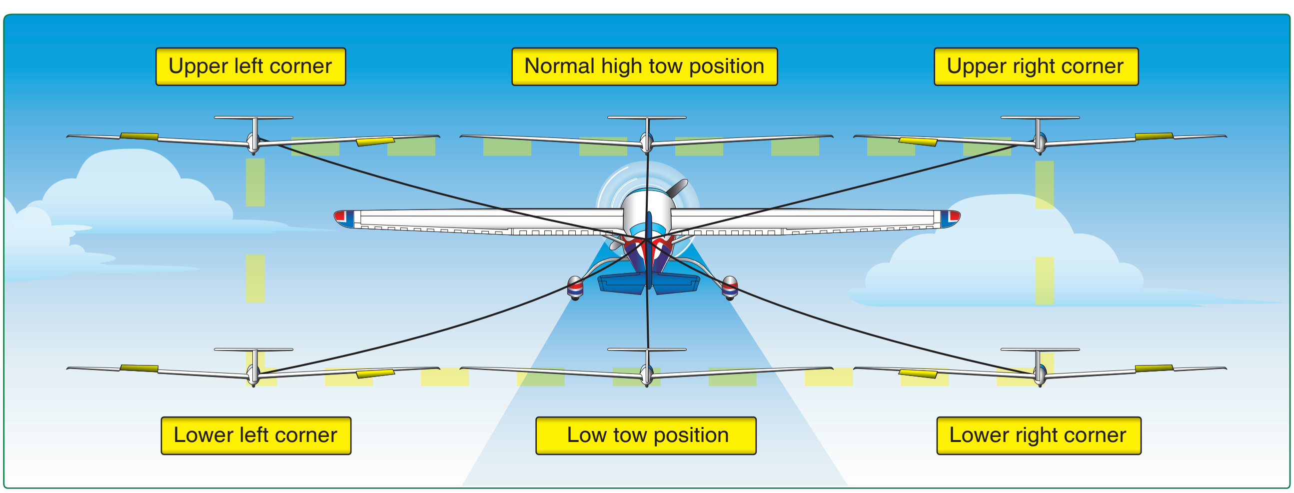


Figure 7-12. *Boxing the wake.*

As the maneuver continues, the pilot reduces the rudder pressure and uses coordinated flight controls to slightly bank the glider to fly along the top side of the box. The glider proceeds to the opposite corner using aileron and rudder pressure, as appropriate. The pilot maintains this position momentarily with rudder pressure, then begins a vertical descent by applying forward pressure to the control stick. Rudder pressure is used to maintain glider position at an equal distance from the wake.

The pilot holds the wings level with the ailerons to parallel the towplane. When the glider has attained low corner position, the pilot momentarily maintains this position. The pilot releases the rudder pressure and, using coordinated flight controls, slightly banks the glider to fly along the bottom side of the box until reaching the original center low tow position.

From center low tow position, the pilot maneuvers the glider through the wake to the center high tow position, completing the maneuver.

Common errors when boxing the wake include:

- Performing an excessively large rectangle around the wake. *Figure 7-12* has exaggerated positions and is not to scale.
- Improper control coordination and procedure.
- Abrupt or rapid changes of position.
- Allowing or developing unnecessary slack during position changes.

Ground Launch Takeoff Procedures

When ground launching, it is essential to use a center of gravity (CG) towhook that has an automatic back release feature. This protects the glider if the pilot is unable to release the towline during the launch. The failure of the tow release could cause the glider to be pulled to the ground as it flies over the launching vehicle or winch. Since the back release feature of the towhook is so important, it should be tested prior to every flight. *[Figure 7-13]*

CG Hooks

Some training and high-performance gliders have only a CG towhook. CG towhooks are necessary for ground launch operations so the glider is not pulled into the ground. Attachment at the center of gravity allows the glider pilot to have full control of the glider without undue influence from the ground pull. Attachment of a ground launch towline to the nose hook would tend to pull the glider into the ground and would overload the horizontal stabilizer and elevator. Conversely, depending on design, the CG hook may not have sufficient movement to fully release an aerotow line under pressure. If the hook only swings about 90° down, the towline may stay hung on the gliders hook until the pressure is released and slack allows the towline to simply fall off. It may be located either ahead of the landing gear, in the landing gear well, or the glider may utilize a bracket that attaches outside on the fuselage near the cockpit.

If the CG hook is in the landing gear well, retracting the gear on tow interferes with the towline. Even if the glider has a nose hook, retracting the gear on tow is not recommended until the aircraft is safely airborne and an immediate or emergency return is not necessary. Leaving the gear down allows the glider pilot more time to assess the best landing options.

A CG hook, as compared to a nose hook, makes a crosswind takeoff more difficult since the glider can weathervane into the wind more easily. In addition, a CG hook makes the glider more susceptible to kiting on takeoff, especially if the CG is near the aft limit. This can present a serious danger to the towplane during the aerotow.

Signals

Prelaunch Signals (Winch/Automobile)

Prelaunch visual signals for a ground launch operation allow the glider pilot, the wing runner, the safety officer, and the

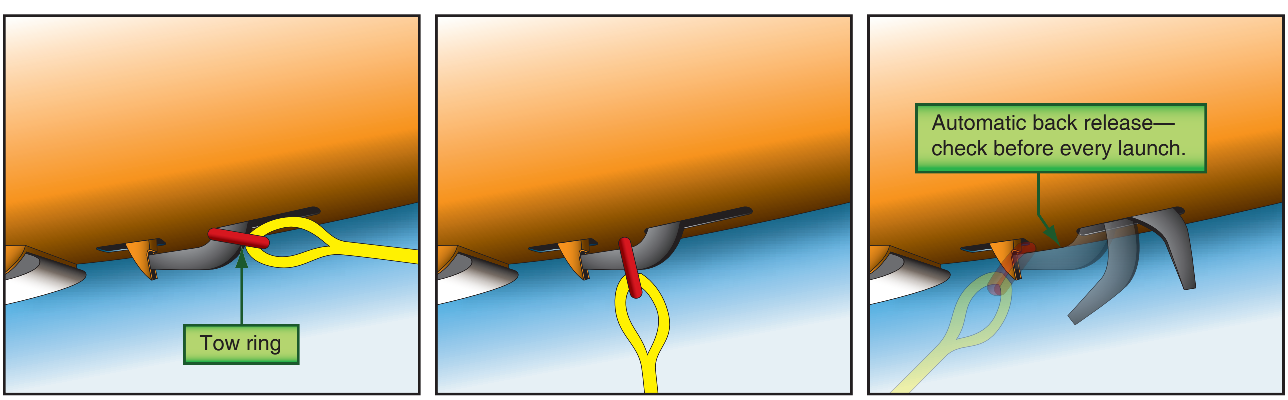


Figure 7-13. *Testing the towhook.*

launch crew to communicate over considerable distances. When launching with an automobile, the glider and launch automobile may be 1,000 feet or more apart. When launching with a winch, the glider may start the launch 4,000 feet or more from the winch. Because of the great distances involved, members of the ground launch crew use colored flags or large paddles to enhance visibility, as shown in *Figure 7-14*. When complex information must be relayed over great distances, visual prelaunch signals can be augmented with direct voice communications between crewmember stations. Hard-wired ground telephones, two-way radios, or wireless telephones can be used to communicate between stations, adding protection against premature launch and facilitating an aborted launch if an unsafe condition arises. The towline should never be attached to the glider until the crew is onboard and ready to launch.

Inflight Signals

Since ground launches are of short duration, inflight signals for ground launches are limited to signals to the winch operator or ground vehicle driver to increase or decrease speed. *[Figure 7-15]*

Tow Speeds

Proper ground launch tow speed is critical for a safe launch. *Figure 7-16* compares various takeoff profiles that result when tow speeds vary above or below the correct speed.

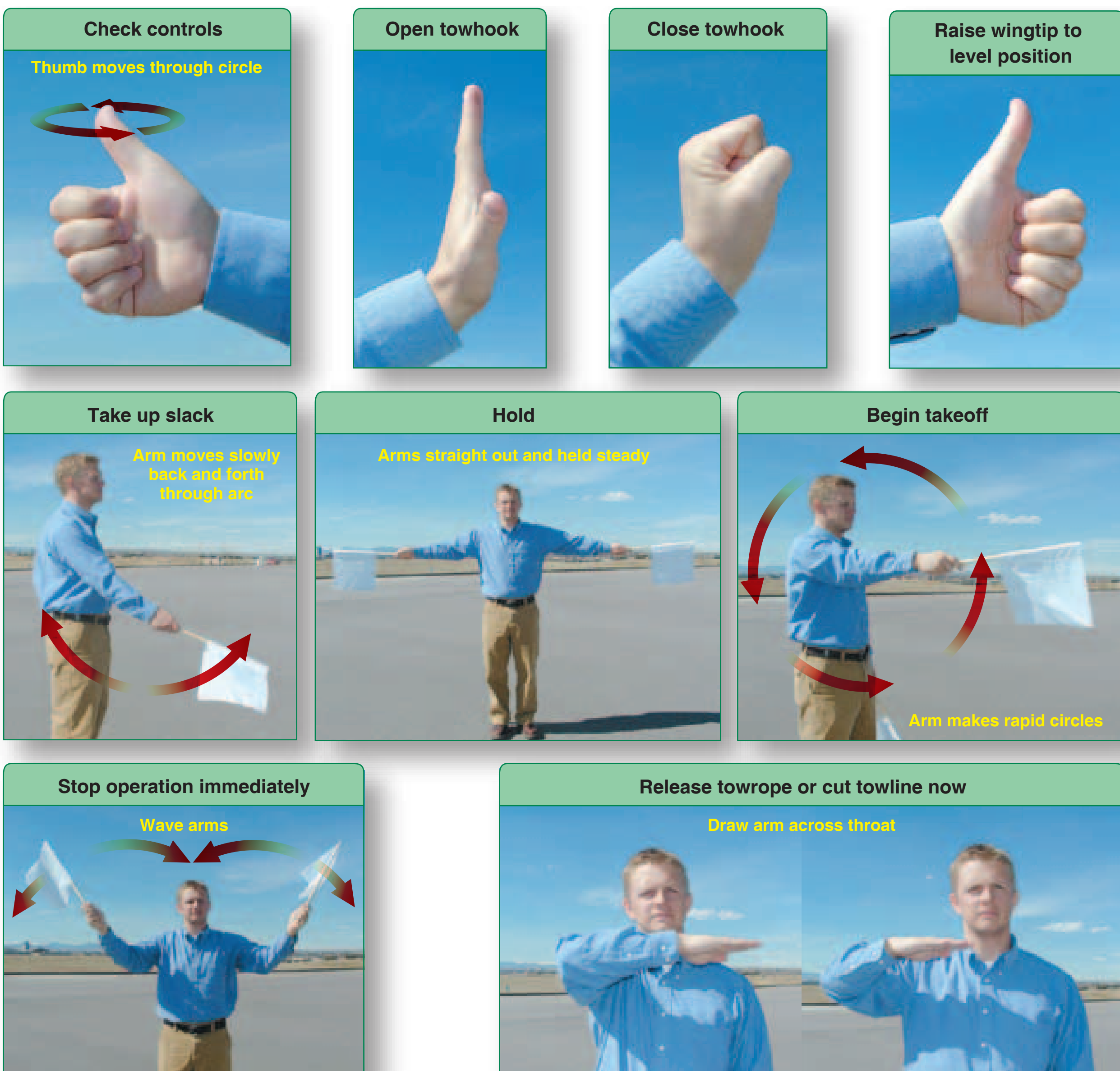


Figure 7-14. *Winch and aerotow prelaunch signals.*

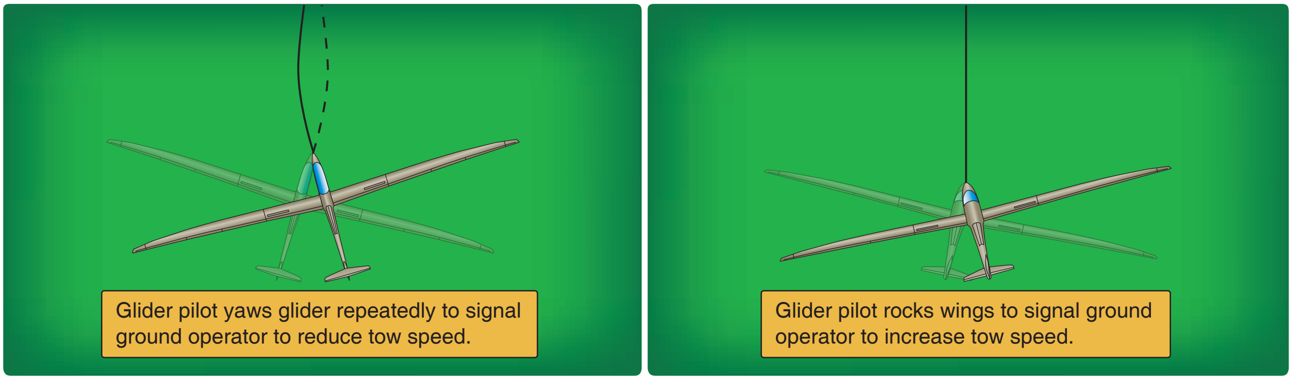


Figure 7-15. *Inflight signals for ground launch.*

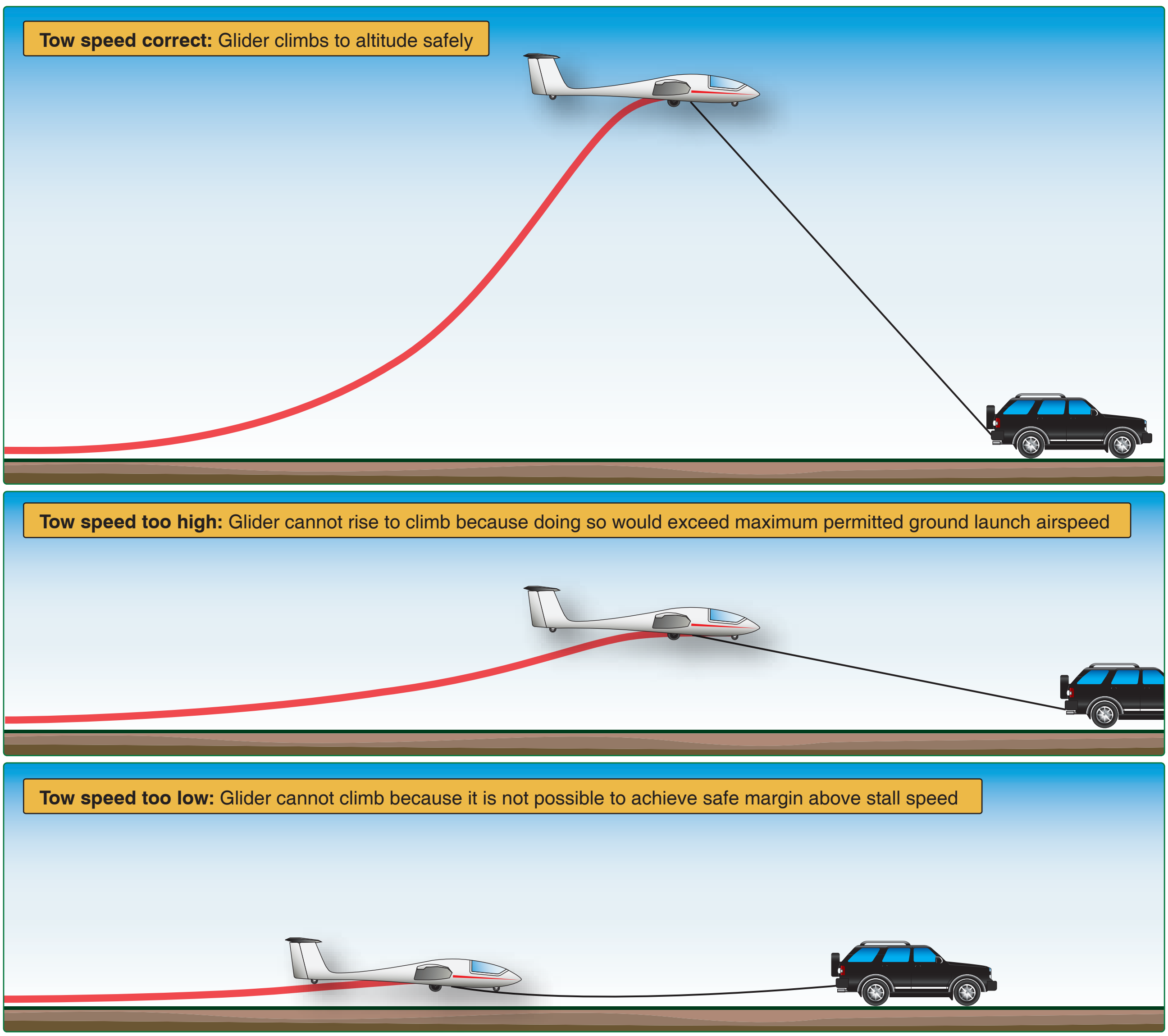


Figure 7-16. *Ground launch tow speed.*

Each glider certificated for ground launch operations has a placarded maximum ground launch tow speed. This speed is normally the same for automobile or winch launches. The glider pilot should fly the launch staying at or below this speed to prevent structural damage to the glider during the ground tow.

Automobile Launch

Automobile launches today are very rare. During automobile ground launches, the glider pilot and driver should have a thorough understanding of the groundspeeds to be used prior to any launch. Before the first launch, the pilot and vehicle driver should determine the appropriate vehicle ground tow speeds, considering the surface wind velocity, the glider speed increase during launch, and the wind gradient encountered during the climb. They should include a safety factor to avoid exceeding this maximum vehicle ground tow speed.

If a crosswind condition is present, the glider should be positioned slightly downwind of the takeoff heading and angled into the wind to help eliminate control problems until sufficient airspeed is obtained. Due to the slow acceleration of the glider during an automobile ground launch, the towline should be laid out to allow the glider to obtain sufficient speed for control while still in a headwind. *[Figure 7-17]*

The tow speed can be determined by using the following calculations:

1. Subtract the surface winds from the maximum placarded ground launch tow speed for the particular glider.
2. Subtract an additional five miles per hour (mph) for the airspeed increase during the climb.
3. Subtract the estimated wind gradient increase encountered during the climb.
4. Subtract a 5 mph safety factor.

Maximum ground launch tow speed	75 mph
1. Surface winds 10 mph	–10 mph
2. Airspeed increase during climb 5 mph	–5 mph
3. Estimated climb wind gradient 5 mph	–5 mph
4. Safety factor of 5 mph	–5 mph
Automobile tow speed	50 mph

During winch launches, the winch operator applies full power smoothly and rapidly until the glider reaches an angle of 30° above the horizon. At this point, the operator should start to reduce the power until the glider is about 60° above the horizon where approximately 20 percent power is needed. As the glider reaches the 70° point above the horizon, power is reduced to idle. The winch operator monitors the glider continuously during the climb for any signals to increase or decrease speed from the glider pilot. *[Figure 7-18]*

Crosswind Takeoff and Climb

The following are the main differences between crosswind takeoffs and climb procedures and normal takeoff and climb procedures:

- During the takeoff roll, the glider tends to weathervane into the wind.
- After liftoff, the glider drifts toward the downwind side of the runway.
- In strong crosswinds there is a greater tendency for the glider to drift downwind.
- If space is available in the takeoff area, the towline or cable should be laid out in a manner that the initial takeoff roll is slightly into the wind to reduce the crosswind component of the glider. *[Figure 7-19]*

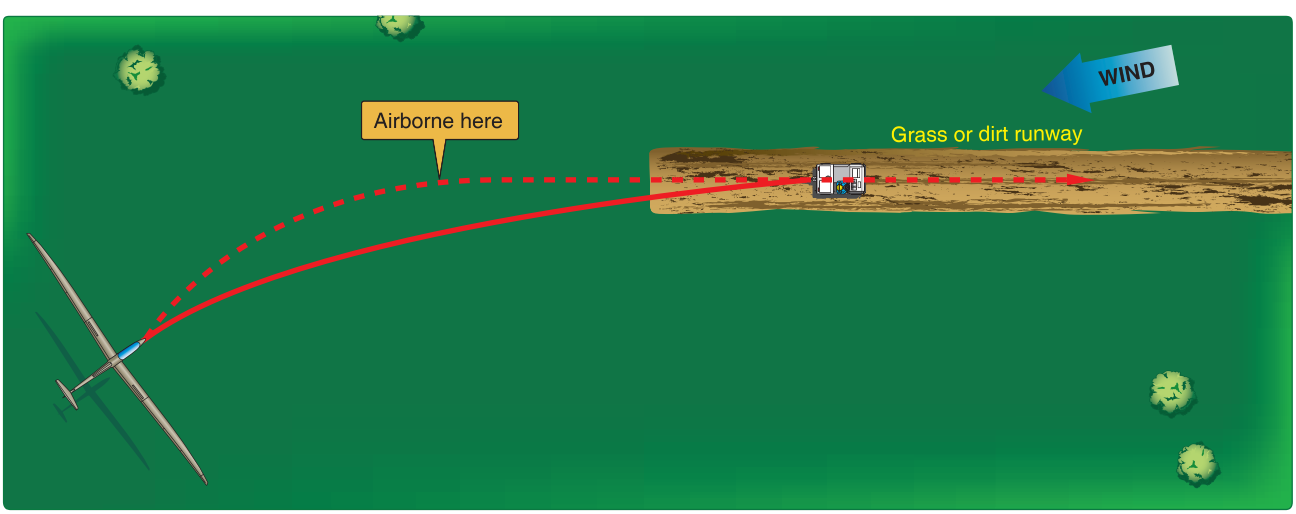


Figure 7-17. *Ground launch procedures.*

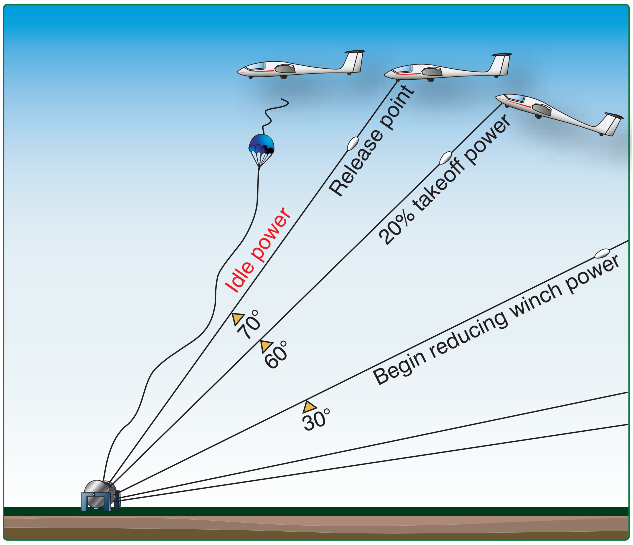


Figure 7-18. *Winch procedures.*

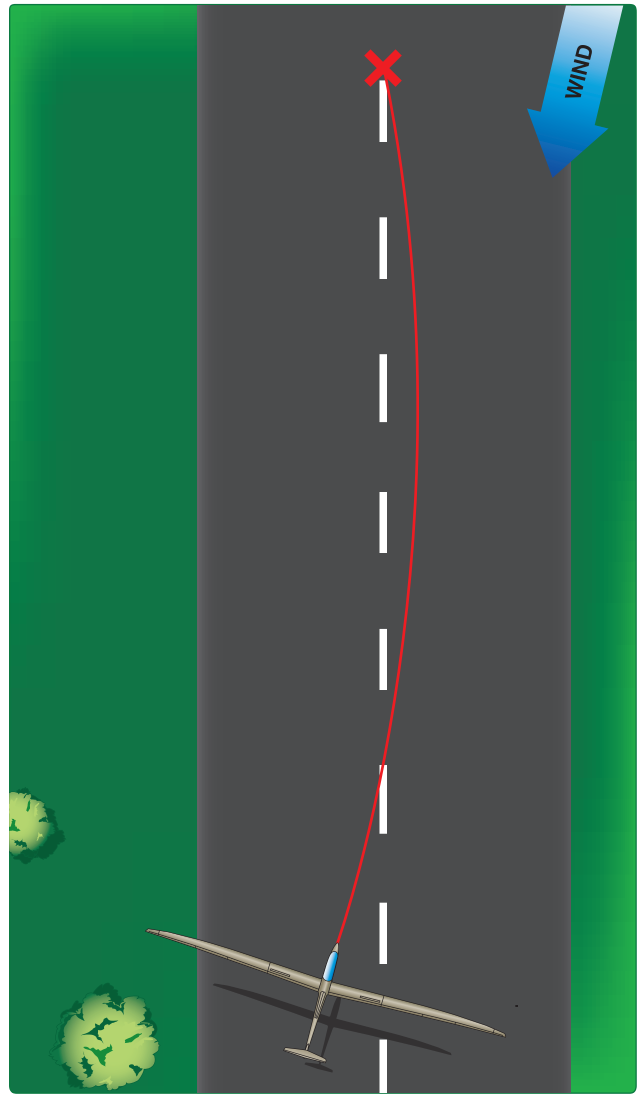


Figure 7-19. *Wind correction angle for winch procedures.*

After lift-off, the glider pilot should establish a wind correction angle toward the upwind side of the runway to prevent drifting downwind. This prevents downwind drift and allows the glider to work upwind of the runway during the climb-out. When the towline is released at the top of the climb, it tends to drift back toward the centerline of the launch runway, as shown in *Figure 7-20*. This helps keep the towline from fouling nearby wires, poles, fences, aircraft, and other obstacles on the side of the launching runway. Should the glider drift to the downwind side of the runway, the towline could damage other aircraft, runway lights, nearby fences, structures, obstacles, etc.

Normal Into-the-Wind Launch

Normal takeoffs are made into the wind. Prior to launch, the glider pilot, ground crew, and launch equipment operator must be familiar with the launch signals and procedures. When the required checklists for the glider and ground launch equipment have been completed and the glider pilot, ground crew, and launch equipment operator are ready for takeoff, the glider pilot should signal the ground crewmember to hook the towline to the glider. The hookup must be done deliberately and correctly. The release mechanism should be checked for proper operation. To accomplish this, the ground crewmember should apply tension to the towline and signal the glider pilot to activate the release. The ground crewmember should verify that the release has worked properly and signal the glider pilot. When the towline is hooked up to the glider again, the ground crewmember takes a position at the wingtip of the down wing. When the glider pilot signals "ready for takeoff," the ground crewmember clears both takeoff and landing areas. When the ground crewmember has ensured the traffic pattern is clear, the ground crewmember then signals the launch equipment operator to "take up slack" in the towline. Once the slack is removed from the towline, the ground crewmember again verifies that the glider pilot is ready for takeoff. Then, the ground crewmember raises the wings to a level position, does a final traffic pattern check, and signals to the launch equipment operator to begin the takeoff.

CAUTION: Never connect a glider to a towplane or towline unless the pilot is aboard and ready for flight. If the pilot exits the glider for any reason, the towline should be released and disconnected. Glider pilots should be prepared for a takeoff anytime the towline is attached to the glider.

The length, elasticity, and mass of the towline used for ground launching have several effects on the glider being launched. First, it is difficult or impossible to prevent the glider from

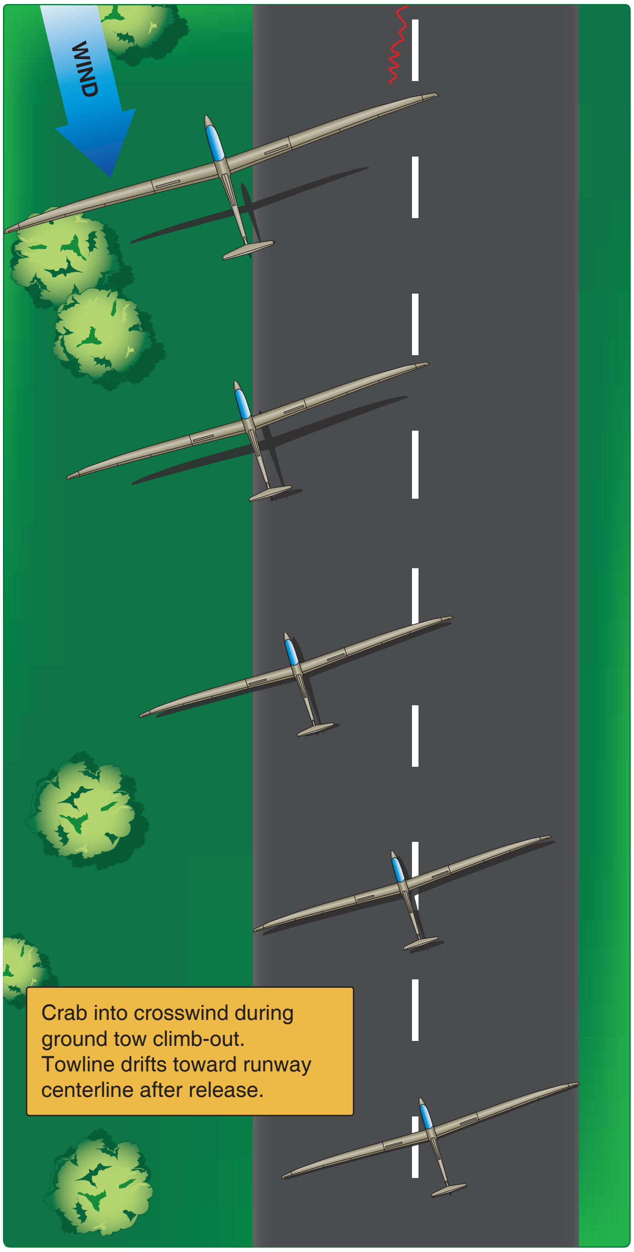


Figure 7-20. *Ground launch crosswind drift correction.*

moving forward as the long towline is tautened. Elasticity in the towline causes the glider to creep forward as the towline is tightened. For this reason, the towline is left with a small amount of slack prior to beginning the launch. It is important for the pilot to be prepared for the launch prior to giving the launch signal. If the launch is begun before the pilot gives the launch signal, the glider pilot should pull the towline release handle promptly. In the first several seconds of the launch, the glider pilot should hold the stick forward to avoid kiting. During the launch, the glider pilot should track the runway centerline and monitor the airspeed. *[Figure 7-21, position A]*

When the glider accelerates and attains lift-off speed, the glider pilot eases the glider off the ground. The time interval from standing start to lift-off may be as short as 3 to 5 seconds. After the initial lift-off, the pilot should smoothly raise the nose to the proper pitch attitude, watching for an increase in airspeed. If the nose is raised too soon or too steeply, the pitch attitude is excessive while the glider is still at low altitude. If the towline breaks or the launching mechanism loses power, recovery from such a high pitch attitude may be difficult or impossible. Conversely, if the nose is raised too slowly, the glider may gain excessive airspeed and may exceed the maximum ground launch tow speed. The shallow climb may result in the glider not attaining planned release altitude. If this situation occurs, the pilot should pull the release and land straight ahead, avoiding any obstacles and equipment.

As the launch progresses, the pilot should ease the nose up gradually *[Figure 7-21, position B]* while monitoring the airspeed to ensure that it is adequate for launch but does not exceed the maximum permitted ground launch tow airspeed. When optimum pitch attitude for climb is attained, *[Figure 7-21, position C]* the glider should be approximately 200 feet AGL. The pilot must monitor the airspeed during this phase of the climb-out to ensure the airspeed is adequate to provide a safe margin above stall speed but below the maximum ground launch airspeed. If the towline breaks, or if the launching mechanism loses power at or above this altitude, the pilot has sufficient altitude to release the towline and lower the nose from the climb attitude to the approach attitude that provides an appropriate airspeed for landing straight ahead.

As the glider nears its maximum altitude *[Figure 7-21, position D]*, it begins to level off above the launch winch or tow vehicle to reduce the rate of climb. In this final phase of the ground launch, the towline is pulling steeply down on the glider. The pilot should gently lower the nose of the glider to reduce tension on the towline and then pull the towline release two to three times to ensure the towline releases. The pilot feels the release of the towline as it departs the glider. The pilot should enter a turn to visually confirm the fall of the towline. If only a portion of the towline is seen falling to the ground, it is possible that the towline is broken and a portion of the towline is still attached to the glider.

If pulling the tow release handle fails to release the towline, the back release mechanism of the towhook should automatically release the towline as the glider overtakes and passes the launch vehicle or winch.

Climb-Out and Release Procedures

The pitch attitude/airspeed relationship during ground launch is a unique flight experience. During the launch, pulling back on the stick tends to increase airspeed, and pushing forward tends to reduce airspeed. This is opposite of the

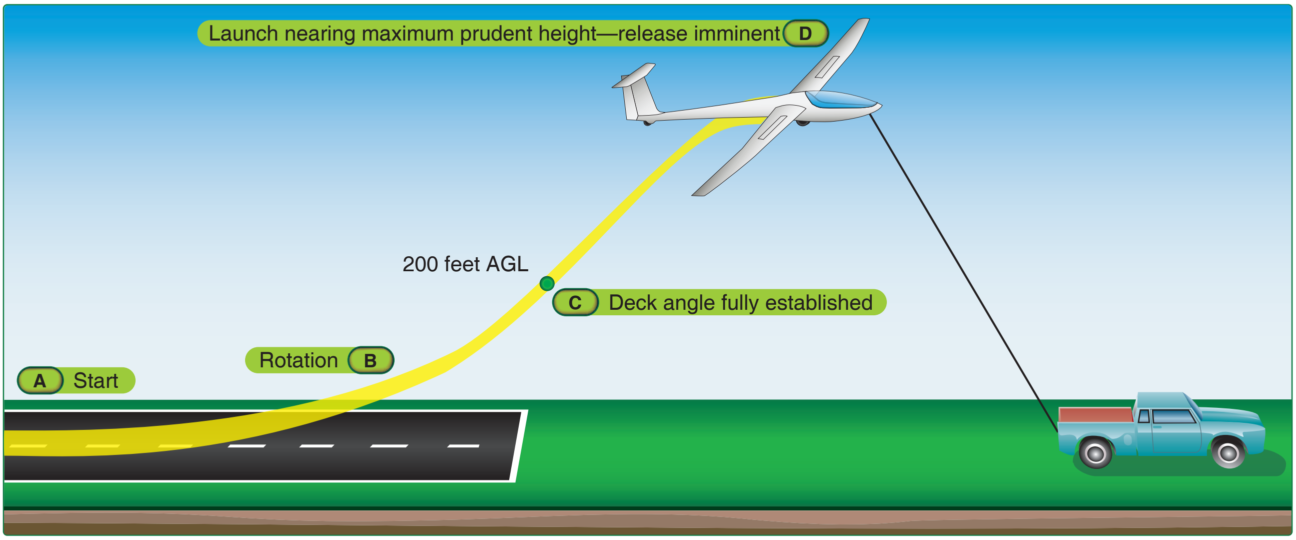


Figure 7-21. *Ground launch takeoff profile.*

normal pitch/airspeed relationship. The wings of the glider divert the towing force of the launch vehicle in an upward direction, enabling rapid climb. The greater the diversion is from horizontal pulling power to vertical lifting power, the faster the airspeed is. This is true if the tow vehicle is powerful enough to meet the energy demands the glider is making on the launch system.

Common errors in ground launching include:

- Improper glider configuration for takeoff.
- Improper initial positioning of flight controls.
- Improper use of visual launch signals.
- Improper crosswind procedure.
- Improper climb profile.
- Faulty corrective action for adjustment of airspeed and pitch.
- Exceeding maximum launch airspeed.
- Improper towline release procedure.

Self-Launch Takeoff Procedures

Preparation and Engine Start

The self-launching glider *[Figure 7-22]* has many more systems than a nonmotorized glider, so glider preflight inspection is more complex. A positive control check is just as critical as it is with any aircraft. Ailerons, elevator, rudder, elevator trim tab, flaps, and spoiler/dive brakes must all be checked. In addition, numerous other systems must be inspected and readied for flight. These include the fuel system, electrical system, engine, propeller, cooling system, and any mechanisms and controls associated with extending or retracting the engine or propulsion system. Instruments, gauges, and all engine and propulsion system controls must be inspected for proper operation.

After preflighting the self-launching glider and clearing the area, start the engine in accordance with the manufacturer's instructions. Hearing protection may be needed and is advisable when using combustion engines in self-launching or sustaining gliders. Typical items on a self-launching glider engine-start checklist include fuel mixture control, fuel tank

Figure 7-22. *Types of self-launching gliders.*

selection, fuel pump switch, engine priming, propeller pitch setting, throttle setting, magneto or ignition switch setting, and electric starter activation. After starting, the oil pressure, oil temp, alternator/generator charging, and flight instruments should be checked. If the engine and propulsion systems are operating within normal limits, taxi operations can begin. These types of gliders often feature a retractable powerplant for drag reduction. After the launch, the powerplant is retracted into the fuselage and stowed.

Common errors in preparation and engine start include:

- Failure to use or improper use of checklist.
- Improper or unsafe starting procedures.
- Excessively high revolutions per minutes (rpm) after starting.
- Failure to ensure proper clearance of propeller.

Taxiing

Self-launching gliders are designed with a variety of landing gear systems, including tricycle or tailwheel landing gear configurations. Other types of self-launching gliders rest primarily on the main landing gear wheel in the center of the fuselage and depend on outrigger wheels or skids to prevent the wingtips from contacting the ground.

Due to the long wingspan and low wingtip ground clearance of gliders, the self-launching glider pilot needs to consider airport layout and runway configuration. Some taxiways and airport ramps may not accommodate the long wingspan of the glider or limit maneuvering. Additionally, the pilot must consider the glider's crosswind capability during taxi operations. Taxiing on soft ground requires additional power. Self-launching gliders with outrigger wingtip wheels may lose directional control if a wingtip wheel bogs down. Well-briefed wing walkers should hold the wings level during low-speed taxi operations on soft ground.

Common errors in taxiing a self-launching glider include:

- Improper use of brakes.
- Failure to comply with airport markings, signals, and clearances.
- Taxiing too fast for conditions.
- Improper control positioning for wind conditions.
- Failure to consider wingspan and space required to maneuver during taxiing.

Pretakeoff Check

The manufacturer provides a takeoff checklist. As shown in *Figure 7-23*, the complexity of many self-launching gliders makes a written takeoff checklist an essential safety item. Pretakeoff items on a self-launching glider may include fuel quantity check, fuel pressure check, oil temperature check, oil pressure check, engine runup, throttle/rpm check, propeller pitch setting, cowl flap setting, and vacuum check. Other items that also must be completed include ensuring seat belts and shoulder harnesses are latched or secured, doors and windows are closed and locked, canopies are closed and locked, air brakes are closed and locked, altimeter is set, communication radio set to the proper frequency for traffic advisory, and flight instruments are adjusted for takeoff.

Common errors in the before takeoff check include:

- Improper positioning of the self-launching glider for runup.
- Failure to use or improper use of checklist.
- Improper check of flight controls.
- Failure to review takeoff emergency procedures.
- Improper radio and communications procedures.

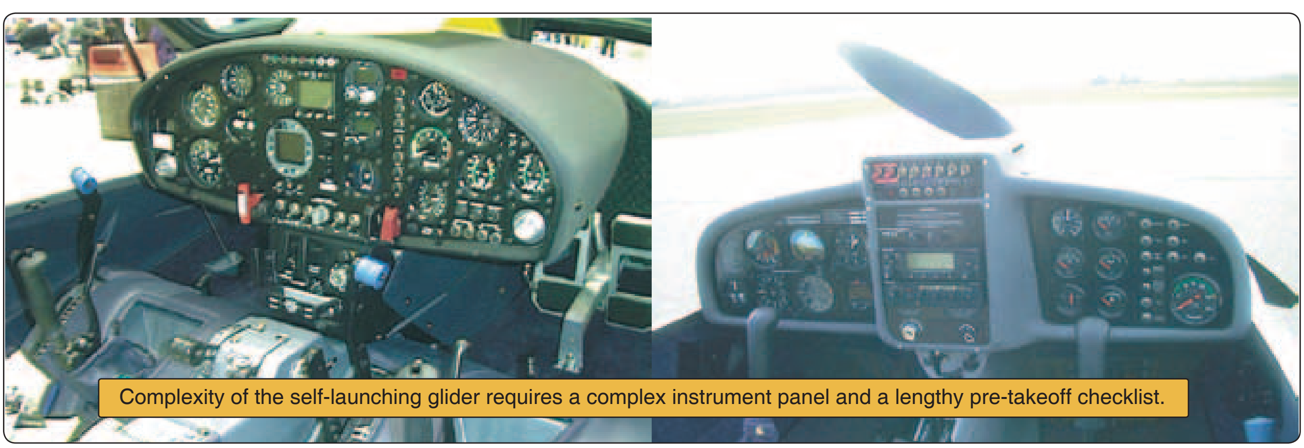


Figure 7-23. *Self-launching glider instrument panels.*

Normal Takeoff

When the pretakeoff checklist is complete, the pilot should check for traffic and prepare for takeoff. If operating from an airport with an operating control tower, request and receive an air traffic control (ATC) clearance prior to taxi. The pilot should make a final check for conflicting traffic, then taxi out onto the active runway and align the glider with the centerline.

The pilot should smoothly apply full throttle and begin the takeoff roll while tracking the centerline of the runway and then fly the self-launching glider off the runway at the recommended lift-off airspeed, allowing the glider to accelerate in ground effect (IGE) until reaching the appropriate climb airspeed. If the runway has an obstacle ahead, the preferred airspeed is best angle of climb airspeed (V_X) until the obstacle is cleared. If no obstacle is present, the preferred airspeed is either best rate of climb airspeed (V_Y) or the airspeed for best engine cooling during climb. The pilot should monitor the engine and instrument systems during climb-out. If the self-launching glider has a time limitation on full throttle operation, the throttle should be adjusted as necessary during the climb.

Crosswind Takeoff

The long wingspan and low wingtip clearance of the typical self-launching glider make it vulnerable to wingtip strikes on runway signage and airport runway and taxiway lights. The takeoff roll should be started with the upwind wing on the ground with the aileron and rudder controls coordinated for the pilots current wind situation. For example, in a right crosswind, the control stick should be held to the right and the rudder held to the left. The aileron input keeps the crosswind from lifting the upwind wing, and the downwind rudder minimizes the weathervaning tendency of the self-launching glider in a crosswind. As airspeed increases, control effectiveness improves and the pilot can gradually decrease the control setting to coordinated flight. The self-launching glider should be lifted off at the appropriate lift-off airspeed and accelerate to climb airspeed. During the climb, a wind correction angle should be established so that the self-launching glider tracks the extended centerline of the takeoff runway. *[Figure 7-24]*

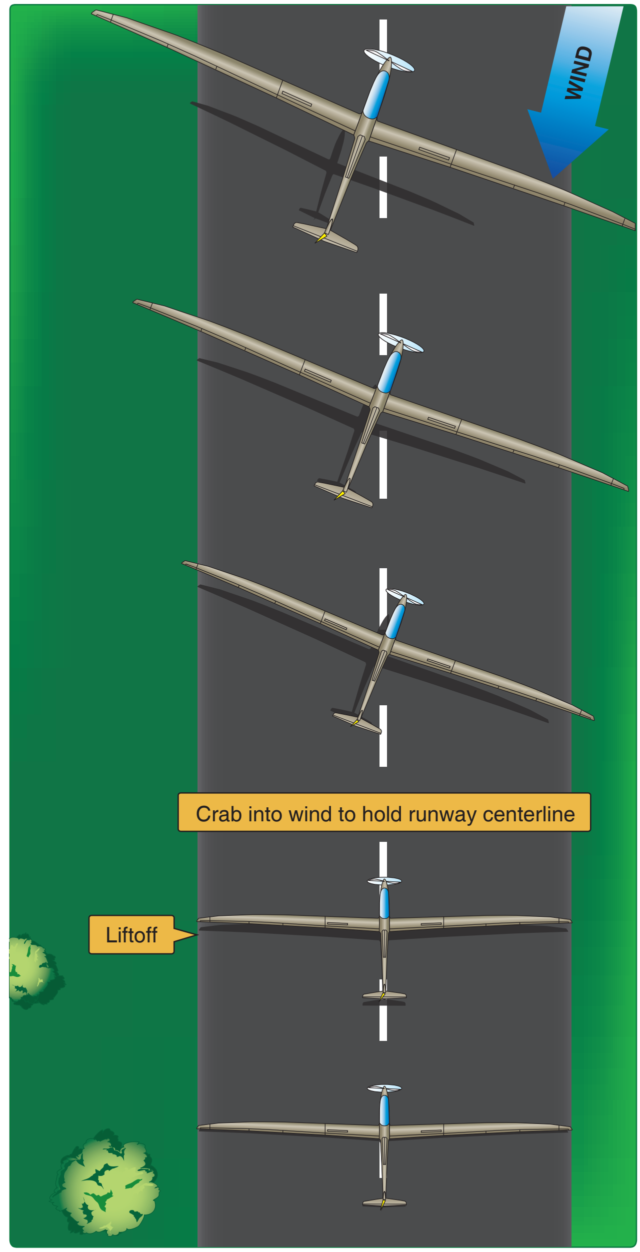


Figure 7-24. *Self-launching gliders—crosswind takeoff.*

Common errors in crosswind takeoff include:

- Improper initial positioning of flight controls.
- Improper power application.
- Inappropriate removal of hand from throttle.
- Poor directional control.
- Improper use of flight controls.
- Improper pitch attitude during takeoff.
- Failure to establish and maintain proper climb attitude and airspeed.
- Maintaining takeoff slip instead of transitioning to crab to achieve more climb efficiency.

Climb-Out and Shutdown Procedures

Self-launching gliders have powerplant limitations, as well as aircraft performance and handling limitations. Powerplant limitations include engine and oil temperatures, engine rpm limits, and other engine/aircraft limitations listed in the GFM/POH.

The GFM or POH provides useful information about recommended power settings and target airspeed for best angle of climb, best rate of climb, best cooling performance climb, and cruise performance while in powered flight. If full throttle operation is time limited to reduce engine wear, the GFM/POH describes the recommended operating procedures. Aircraft performance includes weight and balance limits, minimum and maximum front seat weight restrictions, maximum permitted airspeed with engine extended, maximum airspeed to extend or retract the engine, flap operating airspeed range, air brake operating airspeed range, maneuvering speed, rough air speed limitations, and never-exceed speed.

The engine heats up considerably during takeoff and climb, so cooling system mismanagement can lead to dangerously high temperatures in a short time. An overheated engine cannot supply full power, meaning climb performance is reduced. Extended overheating can cause an inflight fire. To minimize the chances of engine damage or fire, monitor engine temperatures carefully during high power operations, observing engine operating limitations described in the GFM/POH.

Many self-launching gliders have a time limitation on full throttle operation to prevent overheating and premature engine wear. If the self-launching glider is equipped with cowl flaps for cooling, make certain the cowl flaps are set properly for high power operations. In some self-launching gliders, operating at full power with cowl flaps closed can result in overheating and damage to the engine in as little as 2 minutes. If abnormally high engine system temperatures are encountered, follow the procedures described in the GFM/POH. Typically, these require reduced power with higher airspeed to enhance engine cooling. Cowl flap instructions may be provided as well. If these measures are ineffective in reducing high temperatures, the safest course of action may be to shut down the engine and make a precautionary landing. A safe landing, whether on or off the airport, is always preferable to an inflight fire.

Handling limitations for a given self-launching glider may be quite subtle and may include minimum controllable airspeed with power on, minimum controllable airspeed with power off, and other limitations described in the GFM/POH. Self-launching gliders come in many configurations. Those with a top-mounted retractable engine and/or propeller have a thrust line that is quite distant from the longitudinal axis of the glider. The result is that significant changes of power settings tend to cause substantial pitch attitude changes. For instance, full power setting in these self-launching gliders introduces a nose-down pitching moment because the engine thrust line is high above the longitudinal axis of the glider. To counteract this pitching moment, the pilot holds the control stick back pressure and trim. If power is quickly reduced from full power to idle power while holding an control up stick force, the glider tends to pitch up with the power reduction. This nose-pitching moment may be vigorous enough to induce aircraft stall. Smooth and coordinated management of power and flight control provides the safest procedure under these conditions.

During climb-out, the pilot should hold a pitch attitude that results in climbing out at the desired airspeed, adjusting elevator trim as necessary. As previously stated, climbs in self-launching gliders are best managed with smooth control inputs; when power changes are necessary, make smooth and gradual throttle adjustments.

When climbing under power, most self-launching gliders exhibit a left or right turning tendency (depending on whether the propeller is turning clockwise or counterclockwise) due to P-factor. P-factor is caused by the uneven distribution of thrust caused by the difference in the angle of attack (AOA) of the ascending propeller blade and the descending propeller blade. Use the rudder to counteract P-factor during climbs with power. *[Figure 7-25]*

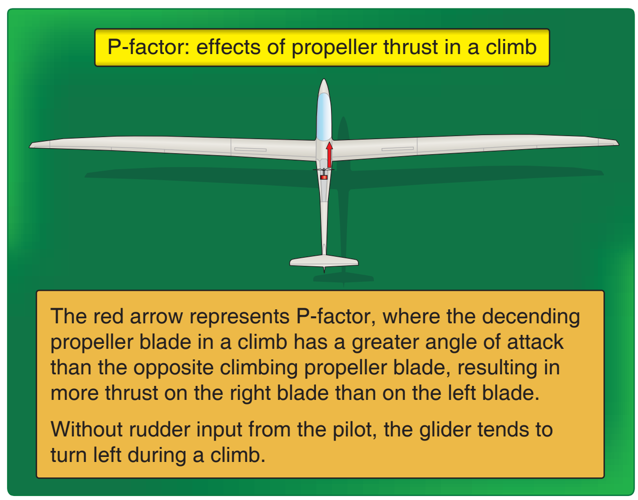


Figure 7-25. *P-factor.*

Turns are accomplished with a shallow bank angle because steep banks result in a greatly reduced rate of climb. As with all turns, properly coordinated aileron and rudder movement result in a more efficient flight and faster climb rate. The pilot should scan for other aircraft traffic before making any turn. Detailed engine shutdown procedures are described in the GFM/POH. A guide to shutdown procedures is described below, but the GFM/POH is the authoritative source for any self-launching glider.

Engines reach high operating temperatures during extended high-power operations. To reduce or eliminate shock cooling caused by a sudden reduction of engine power setting, reduce power slowly. Shock cooling is generally considered to be the outside components of an engine cooling much faster than the truly hot parts inside the engine not directly exposed to cooling airflow. This shock cooling allows the external parts to cool faster and shrink more than the interior components resulting in binding and scuffing of moving parts such as piston rings and valves.

To reduce the possibility of inflight fire, the manufacturer provides engine cool-down procedures for reducing engine system temperatures prior to shutdown. Reducing throttle setting allows the engine to begin a gradual cool down. The GFM/POH may also instruct the pilot to adjust propeller pitch at this time. Lowering the nose to increase airspeed provides faster flow of cooling air to the engine cooling system. Several minutes of reduced throttle and increased cooling airflow are enough to allow the engine to be shut down.

If the engine is retractable, additional time after engine shutdown may be necessary to reduce engine temperature to acceptable limits prior to retracting and stowing the engine in the fuselage. Consult the GFM/POH for details. *[Figure 7-22]*

Retractable-engine self-launching gliders are aerodynamically more efficient when the engine is stowed, but produce high drag when the engine is extended and not providing thrust. Stowing the engine is critical to efficient soaring flight. Prior to stowing, the propeller must be aligned with the longitudinal axis of the glider, so the propeller blades do not interfere with the engine bay doors.

Since the engine/propeller installation in these gliders is aft of the pilot's head, these gliders usually have a mirror, enabling the pilot to perform a visual propeller alignment check prior to stowing the engine/propeller pod. Detailed instructions for stowing the engine and propeller are found in the GFM/POH for the particular glider. If a malfunction occurs during engine shutdown and stowage, the pilot cannot count on being able to get the engine restarted. The pilot should have a landing area within power-off gliding distance in anticipation of this eventuality.

Some self-launching gliders use a nose-mounted engine/propeller installation that resembles the typical installation found on single-engine airplanes. In these self-launching gliders, the shutdown procedure usually consists of operating the engine for a short time at reduced power to cool the engine down to acceptable shutdown temperature. After shutdown, the cowl flaps (if installed) should be closed to reduce drag and increase gliding efficiency. The manufacturer may recommend a time interval between engine shutdown and cowl flap closure to prevent excess temperatures from developing in the confined, tightly cowled engine compartment. These temperatures may not be harmful to the engine itself, but may degrade the structures around the engine, such as composite engine mounts or installed electrical components. Excess engine heat may result in fuel vapor lock.

If the propeller blade pitch can be controlled by the pilot while in flight, the propeller is usually set to coarse pitch. Some installations have a propeller feathering system that reduces propeller drag to a minimum for use during non-powered flight. Some self-launching gliders require the pilot to set the propeller to coarse pitch prior to engine shutdown. Other self-launching gliders require the pilot to shut down the engine first and then adjust propeller blade pitch to coarse pitch or setting to a feathered position. As always, pilots must follow the recommended shutdown procedures described in their GFM/POH.

Common errors during climb-out and shutdown procedures include:

- Failure to follow manufacturer's recommended procedure for engine shutdown, feathering, and stowing (if applicable).
- Failure to maintain positive aircraft control while performing engine shutdown procedures.
- Failure to follow proper engine extension and restart procedures.

Landing

If the self-launching glider is to land under power, the pilot should perform the engine restart procedures at an altitude that allows time to reconfigure. The pilot should follow the manufacturer's recommended engine start checklist. Once the engine is started, the pilot should allow time for it to warm up. After the engine is started, the pilot should ensure that all systems necessary for landing are operational, such as the electrical system and landing gear.

Caution: Follow the manufacturer's recommended engine extension and restart procedures or a loss of situational awareness could result in attempting a landing with the glider a high drag configuration. The pilot of a sustainer or self-launching glider should plan for the engines to fail to start and not have sufficient power to retract the engine and exhibit a much higher drag coefficient. Should the engine not start and retract, a glider pilot should have an alternate landing area available with the decreased performance available in the higher drag configuration.

The pilot should fly the traffic pattern to land into the wind and plan the approach path to avoid all obstacles. The landing area should be of sufficient length to allow for touchdown and roll-out within the performance limitations of the particular self-launching glider. The pilot should also take into consideration any crosswind conditions and the landing surface. After touchdown, the pilot should maintain direction control and slow the self-launching glider to clear the landing area. The after-landing checklist should be completed when appropriate.

Common errors during landing include:

- Poor judgment of approach path.
- Improper use of flaps, spoilers, and/or dive brakes.
- Improper approach and landing speed.
- Improper crosswind correction.
- Improper technique during flare and touchdown.
- Poor directional control after landing.
- Improper use of brakes.
- Failure to use the appropriate checklist.
- Failure to use proper radio communication procedures.

Gliderport/Airport Traffic Patterns and Operations

The pilot must be familiar with the approach and landing traffic pattern to a gliderport or airport because the approach actually starts some distance away. Gliderports and airport operators should comply with Federal Aviation Administration (FAA) recommended procedures established in Advisory Circulars (AC), the Aeronautical Information Manual (AIM), and current FAA regulations for operating in United States airspace. If glider operation is conducted in other countries, the air regulations for those countries would apply. These publications also serve as good references to ensure safe glider operations.

Pilots need to determine a proper visual reference point as an initial point (IP) from which to begin the approach for each landing area. The IP may be located over the center of the gliderport/airport or at a remote location near the traffic pattern. As shown in *Figure 7-26,* the sequence of a normal approach is from over the IP to the downwind leg, base leg, final approach, flare, touchdown, rollout, and stop. Some gliderports and airports have established procedures to follow when conducting flight operations in and out of their airfield. It is good pilot practice to review existing approach and departure procedures so as to always follow safe established procedures. Be aware that compensation for winds often requires modifying the traffic pattern to retain a safe approach angle.

Determining the IP comes with good training and experience. The IP should only be used as a visual reference point for proper positioning into the traffic pattern. Do not rely on these visual points, as when landing at a different gliderport/airports these points will change. Pilots should develop proper placement, altitude, and distances based on current conditions. Use proper alignment for winds and always consider other environmental factors. Flying the glider traffic pattern is basically the same as a power pattern; however, the glider pilot must consider other environmental factors that affect the landing.

Once over the IP, the pilot flies along the downwind leg of the planned landing pattern. The pilot should plan to be over the IP at an altitude of 800 to 1,000 feet AGL or as recommended by the local field operating procedures. During this time, it is important to look for other aircraft and, if installed, listen to the radio for other aircraft in the vicinity of the gliderport/airport. Glider pilots should plan to make any radio calls early in the pattern, so the pilot can concentrate and on the landing task without being distracted. Glider pilots should be aware of other activities located at the gliderport/airport, and it is important that they are familiar with good operating practices. Glider operations usually establish the patterns for their operation with other activities in mind. Pilots new to a gliderport/airport should obtain a thorough checkout before conducting any flights.

Pilots should complete the landing checklist prior to the downwind leg. A good landing checklist is known as FUSTALL. This checklist can be modified as necessary for any glider.

- **F**laps—set (if applicable)
- **U**ndercarriage—down and locked (if applicable)
- **S**peed—normal approach speed established (as recommended by the GFM/POH)
- **T**rim—set
- **A**ir brakes (spoilers/dive brakes)—checked for correct operation
- **L**anding area—look for wind, other aircraft, and personnel
- **L**and the glider

Normal Approach and Landing

Prior to entering the downwind leg and accomplishing the landing checklist, concentrate on judging the approach angle, distance from the landing area, and staying clear of other aircraft while monitoring approach airspeed. The normal approach speed, as recommended by the GFM/POH, is the speed for ideal flight conditions. Medium turns can be used in the traffic pattern, but do not exceed a 45° bank angle. The approach should be made using spoilers/dive brakes as necessary to dissipate excess altitude. Use the elevator to

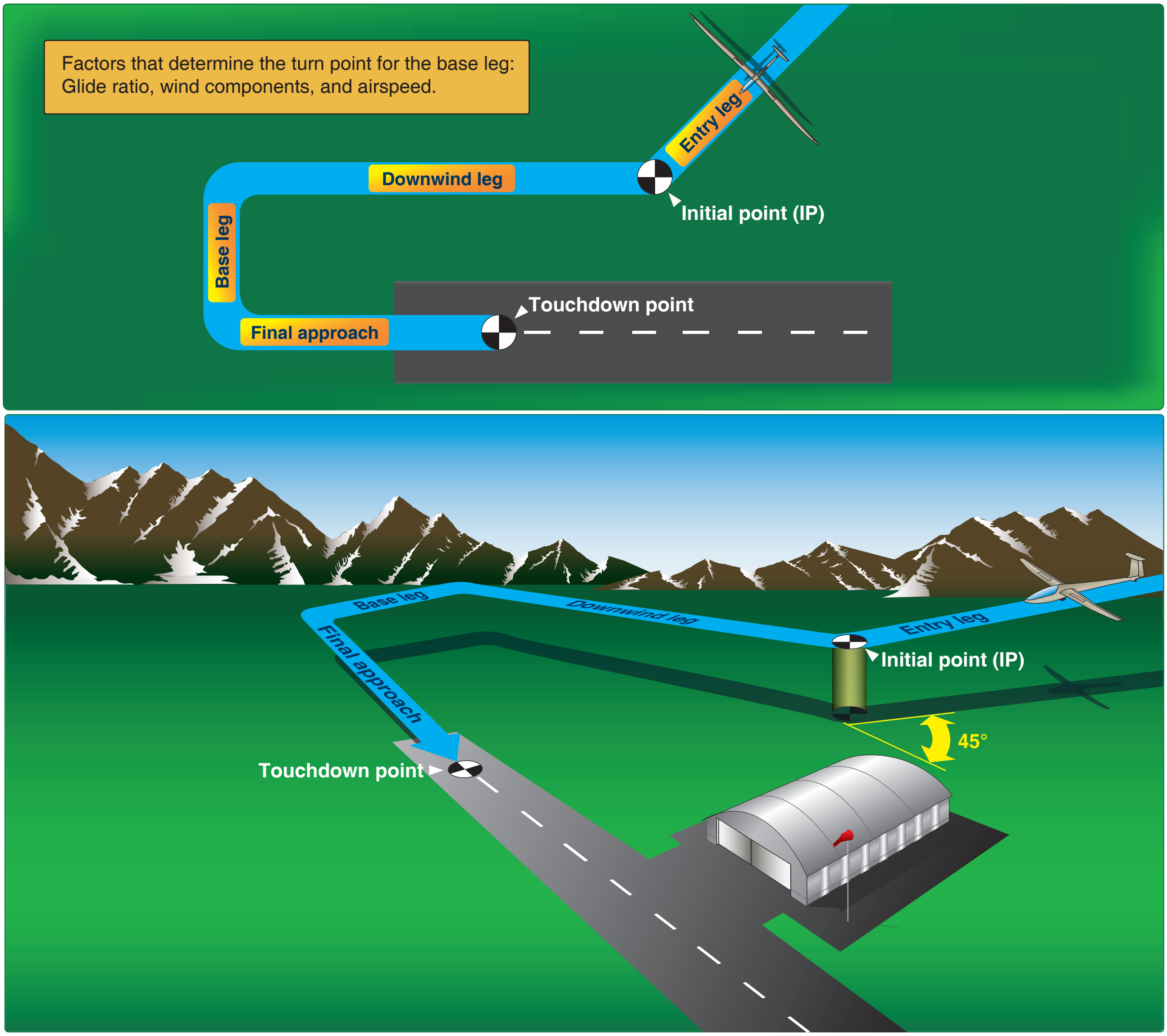


Figure 7-26. *Traffic pattern.*

maintain the recommended approach airspeed established by the manufacturer. If no approach speed is recommended by the manufacturer, use 1.5 V_{SO}. Establishing a proper pattern entry and normal approach speed is a foundation for a good approach to landing. During the entry into the traffic pattern, pilots need to ensure that the glider is in trim and keep the yaw string straight during these turns while maneuvering in the traffic pattern at all times.

Strong crosswinds, tailwinds, or high sink rates that are encountered in the traffic pattern require the pilot to modify the individual pattern leg (downwind, base, or final) and to adjust the approach speed as appropriate. It is recommended that half of the gust factor be added to the normal approach speed to compensate for wind gusts and sink. A strong tailwind or headwind requires a respective shortening or lengthening of the leg. A sudden encounter with a high sink rate may require the pilot to turn toward the landing area sooner than normal. The pilot should not conduct a 360° turn once established on the downwind leg. Throughout the traffic pattern, the pilot should be constantly aware of the approach speed and plan ahead by keeping the glider in trim and the yaw string straight.

When at an appropriate distance from the IP, the pilot should maneuver the glider to enter the downwind leg. The distance for a normal pattern from downwind leg to the landing area should be approximately one quarter to one half of a mile. Of course, this depends on current conditions and the type of glider. This varies at different locations. On the downwind leg, the glider should descend to arrive abeam the touchdown point at an altitude between 500 and 600 feet AGL. On the downwind leg, the groundspeed is higher if a tailwind is present. The pilot should use the spoilers/dive brakes as necessary to arrive at this altitude. The pilot should also monitor the glider's position with reference to the touchdown area. If the wind pushes the glider away from or toward the touchdown area, the pilot should stop the drift by establishing a wind correction angle into the wind. Failure to do so affects the point where the base leg should be started.

The base leg should not be started any later than when the touchdown point is approximately 45° over the pilot's shoulder looking back at the touchdown area, under a no-wind condition. Newer, higher glide ratio, faster gliders may need to extend the downwind leg somewhat, whereas lower ratio, slower gliders may need to turn to the base leg much sooner. Each glider pilot must determine the landing conditions and configure the glider for that landing under those conditions. Slip and drag devices can dissipate excess altitude, but nothing on a glider can make up for insufficient altitude to glide to the landing area. Base altitude should be no lower than approximately 500 feet AGL.

Once established on the base leg, the pilot should scan the extended final approach path to detect any aircraft that might be on long final approach to the landing area in use. If a radio is installed in the glider, this would be a good time to broadcast position for turn to final. The turn to the base leg should be timely enough to keep the point of intended touchdown area within easy gliding range. The pilot should adjust the turn to correct for wind drift encountered on the base leg and, if needed, make correction turns to ensure maintainance of the proper glide angle to the landing area. The pilot should also adjust the spoilers/dive brakes, as necessary, to position the glider at the desired glide angle.

NOTE: New pilots should learn to properly scan for another aircraft operating in the traffic pattern. Pilots should also review FAA AC 90-48C, Pilot's Role in Collision Avoidance.

The turn onto the final approach should not exceed a 45° bank and the glider should be on the appropriate approach angle to start the descent. The pilot should ensure that the yaw string is straight. Complete the turn to final to line up with the centerline of the touchdown area. The pilot should adjust the spoilers/dive brakes, as necessary, to fly the desired approach angle to the aim point and establish a stabilized approach at the recommended approach speed.

The stabilized approach is when the glider is at the proper glider path/angle with minimal spoilers/dive brakes deployed/extended, at the recommended approach speed for the current conditions (winds, gust, sink, etc.) and able to make the intended landing spot. The stabilized approach should be established no lower than 100 feet AGL. The final approach with spoilers/dive brakes extended approximately half open (not half travel of the spoiler/dive brake control handle) is ideal for most gliders. Avoid using full spoilers/dive brakes because this use causes a higher descent rate and increase in stall speed.

Minor adjustments in the spoilers/dive brakes may be needed to ensure proper glidepath control. Avoid pumping the spoilers/dive brakes from full open to full close. Under some conditions, the spoilers/dive brakes may have to be closed momentarily to correct the glidepath. The selected aim point should be prior to the touchdown point to accommodate the landing flare. The pilot may flare the glider at or about three to five feet AGL. The glider may float some distance until it touches down. If excess speed is used, the glider floats a considerable distance. Avoid using this technique as it uses a large amount of the intended landing area. Do not try to force the glider onto the ground at excessive speeds. This may introduce oscillations, such as porpoising and overcontrolling.

When within three to five feet of the landing surface, begin the flare with slight back elevator. As the airspeed decreases, the pilot holds the glider in a level or tail-low attitude to touchdown at the lowest possible speed for existing conditions, while the glider is still under aerodynamic control.

Pilots should avoid driving the glider into the ground by little or no flare. This type of landing puts excessive loads on the landing gear and wings. The pilot should hold the glider off as possible, but ensuring the touchdown is on the main wheel as stated in the GFM. In some gliders, the pilot can increase pitch attitude with slight back pressure to dissipate as much energy as possible prior to touchdown. The pilot should ensure that the glider touches down with a nose-high attitude, but not high enough to land tail first. A good glider landing in most gliders with a main wheel and tail wheel, or skid, is on the main wheel with the tail wheel just slightly touching or the tail wheel just barely off the surface. The main wheel is designed to withstand the shock of landings but the tail wheel is not. In some instances, the attach points or structure just in front of the empennage is the weakest point and may fail first. Pilots should always follow the GFM/POH recommendations of the manufacturer.

After touchdown, the pilot should concentrate on rolling out straight along the the centerline of the touchdown area, keeping full back stick on the elevator and the glider wings level. If an obstacle is detected (possible in an off-airport landing or landing out), a coordinated turn on the ground is needed to avoid the obstacle. Ensure that a wing is not allowed to contact the ground until the glider is at its lowest speed or stopped.

Tracking along a centerline of the touchdown area is an important consideration in gliders. The long, low wingtips of the glider are susceptible to damage from runway signage and runway lighting. Turning off the runway should be done only if and when the pilot has the glider under control.

Landing in high, gusty winds or turbulent conditions may require higher approach airspeed to improve controllability and provide a safer margin above stall airspeed. As a rule of thumb, pilots add one-half the reported gust factor to the normal recommended approach airspeed. This increased approach airspeed provides a safety margin and affords better penetration into the headwind on final approach.

Crosswind Landing

Crosswind landings require a crabbing, or slipping method, to correct for the effects of the wind on the final approach. Additionally, the pilot must land the glider without placing any unnecessary side load on the landing gear.

The crab method requires the pilot to point the nose of the glider into the wind and fly a straight track along the desired groundpath. The stronger the wind is, the greater the crab angle needs to be. The glider is in coordinated flight and tracking the extended centerline of the landing area. *[Figure 7-27A]* Prior to flare, the pilot must be prepared to align the glider with the landing direction. *[Figure 7-27B]* The pilot should use the rudder to align the glider prior to touchdown and deflect the ailerons into the wind to control the side drift caused by the crosswind.

In the slip method, the pilot uses rudder and ailerons to slip the glider into the wind to prevent drifting downwind of the touchdown area. The disadvantage of the slip method is that the sink rate of the glider increases, forcing the pilot to adjust the spoilers/dive brakes, as necessary, to compensate for this additional sink rate. Glider pilots should be ready to apply brakes to avoid leaving the runway or landing area as control authority is lost. The slip should be established no lower than 100 feet to ensure a stable approach.

Pilot selection of the slip or crab method for crosswind landing is personal preference and/or related to glider size and wingspan. The important action is to stabilize the approach early enough on final to maintain a constant approach angle and airspeed to arrive at the selected touchdown point.

Common errors during approach and landing include:

- Improper glidepath control.
- Improper use of flaps, spoilers/dive brakes.
- Improper airspeed control.
- Improper stabilize approach.
- Improper correction for crosswind.
- Improper procedure for touchdown/landing.
- Poor directional control during/after landing.
- Improper use of wheel brakes.

Slips

A slip is a descent with one wing lowered. It may be used for either of two purposes or both of them combined. A slip may be used to steepen the approach path without increasing the airspeed, as would be the case if the spoilers/dive brakes were inoperative, or to clear an obstacle. It can also be used to make the glider move sideways through the air to counteract the drift that results from a crosswind. Formerly, slips were used as a normal means of controlling landing descents to short or obstructed fields, but they are now primarily used in the performance of crosswind landings and short/off-field landings.

With the installation of effective spoilers/dive brakes on modern gliders, the use of slips to steepen or control the angle of descent is no longer the only procedure available

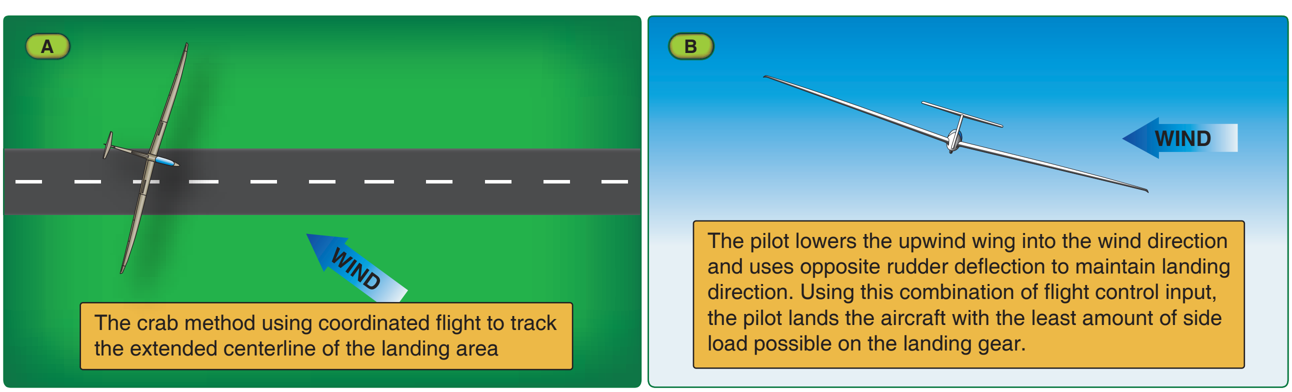


Figure 7-27. *Using the crab method to track the extended centerline of the landing area (A). Controlling side drift by adjusting the glider into the wind before landing (B).*

to the glider pilot. However, the pilot still needs proficiency in performance of forward slips to correct for possible errors in judgment of the landing approach.

The forward slip is a slip in which the glider's direction of motion remains the same as before the slip was begun. If there is any crosswind, the slip is much more effective if made into the wind. If the glider is originally in straight flight, the wing on the side that the slip is to be made should be lowered by using the ailerons. Simultaneously, the glider's nose must be yawed in the opposite direction by applying opposite rudder so the glider's longitudinal axis is at an angle to its original flightpath. The degree to which the nose is yawed in the opposite direction from the bank should be such that the original ground track is maintained. The nose should also be raised as necessary to prevent the airspeed from increasing.

The primary purpose of forward slips is to dissipate altitude without increasing the glider's airspeed, particularly in gliders not equipped with flaps or those with inoperative spoilers/dive brakes. There are many circumstances requiring the use of forward slips, such as in a landing approach over obstacles and in making off-field landings. It is always wise to allow an extra margin of altitude for safety in the original estimate of the approach. In the latter case, if the inaccuracy of the approach is confirmed by excess altitude when nearing the boundary of the selected field, slipping may dissipate the excess altitude.

The use of slips has definite limitations. Some pilots may try to lose altitude by violent slipping rather than by smoothly maneuvering, exercising good judgment, and using only a slight or moderate slip. In off-field landings, this erratic practice invariably leads to trouble since enough excess speed may result in preventing touchdown anywhere near the touchdown point, and very often results in overshooting the entire field.

A sideslip, as distinguished from a forward slip, is one during which the glider's longitudinal axis remains parallel to the original flightpath, but in which the flightpath changes direction according to the steepness of the bank. *[Figure 7-28]* The sideslip is important in counteracting wind drift during crosswind landings and is discussed in the crosswind landing section of this chapter.

Sideslip is used during the last portion of a final approach. The longitudinal axis of the glider must be aligned with the runway just prior to touchdown so the glider touches down in the direction in which it is moving. This requires timely action to decrease the slip to maintain ground track alignment with the landing zone. Failure to accomplish this alignment imposes severe sideloads on the landing gear and imparts violent ground looping tendencies.

Decreasing the slip is accomplished by leveling the wings and simultaneously releasing the rudder pressure while readjusting the pitch attitude to the normal glide attitude. If the pressure on the rudder is released abruptly, the nose swings too quickly into line and the glider tends to acquire excess airspeed.

Because of the location of the pitot tube and static vents, airspeed indicators in some gliders may have considerable error when the glider is in a slip. The pilot must be aware of this possibility and recognize a properly performed slip by the attitude of the glider, the sound of the airflow, and the feel of the flight controls.

Common errors when performing a slip include:

- Improper glidepath control.
- Improper use of slips.
- Improper airspeed control.
- Improper correction for crosswind.

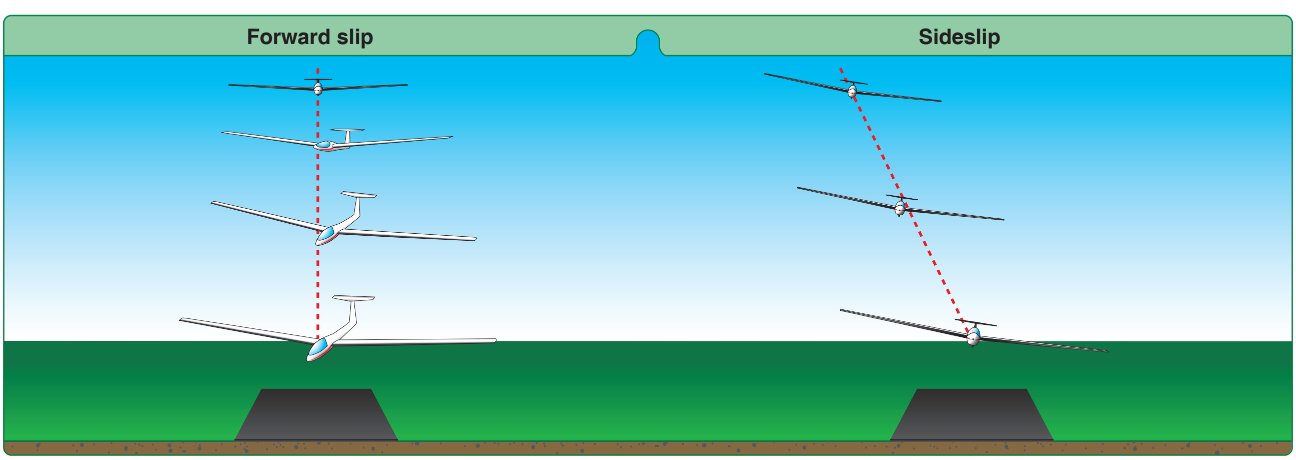


Figure 7-28. *Forward slip and sideslip.*

- Improper procedure for touchdown/landing.
- Poor directional control during/after landing.
- Improper use of spoilers, air brakes or dive brakes.

Downwind Landing

Downwind landings present special hazards and should be avoided when an into-the-wind landing is available. However, factors like gliderport/airport design, obstacles, or high terrain at one end of the runway, and runway slope may dictate a downwind procedure takeoff and landing procedures. Emergencies or a launch failure at low altitude can also require a downwind landing. The pilot must use the normal approach airspeed during a downwind landing. Any airspeed in excess only causes the approach area and runway needed for approach and landing to increase.

A tailwind increases the touchdown groundspeed and lengthens the landing roll. The increased distance for landing can be determined by dividing the actual touchdown speed by the normal touchdown speed, and squaring the result. For example, if the tailwind is 10 knots and the normal touchdown speed is 40 knots, the actual touchdown speed is 50 knots. This touchdown speed is 25 percent higher than the normal speed (10 divided by 40 = .25 × 100 = 25 percent), a factor of 1.25. A factor of 1.25 squared is approximately 1.56; the landing distance increases 56 percent over the normal landing distance.

On downwind approaches, a shallower approach angle should be used, depending on obstacles in the approach path. Use the spoilers/dive brakes and perhaps a forward slip, as necessary, to achieve the desired glidepath.

After touchdown, use the wheel brake and all available drag devices to reduce groundspeed and stop as soon as is practical. This is necessary to maintain control of the glider. Landing with a tail wind means a loss of control at a much higher ground speed and requires more braking action.

Common errors during downwind landing include:

- Improper glidepath control.
- Improper use of slips.
- Improper airspeed control.
- Improper correction for wind.
- Improper procedure for touchdown/landing.
- Poor directional control during/after landing.
- Improper use of wheel brakes.

After Landing and Securing

After landing, move or taxi the glider clear of all runways. If the glider is to be parked for a short interval between flights, choose a spot that does not inconvenience other gliderport/airport users. Protect the glider from wind by securing a wingtip with a weight or by tying it down. Consult the manufacturer's handbook for the recommended methods for securing the glider. Remember that even light winds can cause gliders to move about, turn sideways, or cause the higher wing in a parked glider to slam into the ground. Because gliders are particularly vulnerable to wind effects, the glider should be secured any time it is unattended.

When the glider has finished flying for the day, move it to the tiedown area. Secure the glider in accordance with the recommendation in the GFM/POH. The tiedown anchors should be strong and secure. Apply external control locks to the glider flight control surfaces. Control locks should be large, well marked, and brightly painted. If a cover is used to protect the pitot tube, the cover should be large and brightly colored. If a canopy cover is used, secure it so that the canopy cover does not scuff or scratch the canopy in windy conditions.

If the glider is stored in a hangar, be careful while moving the glider to avoid damaging it or other aircraft in the hangar. Chock the main wheel and tailwheel of the glider when it is in position in the hangar. If stored in a wings-level position, put a wing stand under each wingtip. If stored with one wing high, place a weight on the lowered wing to hold it down.

If the glider is to be disassembled and stored in a trailer, tow the glider to the trailer area and align the fuselage with the long axis of the trailer. Collect all tools and dollies required to disassemble and stow the glider. Secure the trailer so that loading the glider aboard does not move or upset the trailer or trailer doors. Follow the disassembly checklist in the GFM/POH. Stow the glider components securely in the trailer. When the glider has been stowed and secured, collect all tools and stow them properly. Close trailer doors and hatches. Secure the trailer against wind and weather by tying it down properly.

Performance Maneuvers

Straight Glides

To perform a straight glide, the glider pilot must hold a constant heading and airspeed. The heading reference should be some prominent point in front of the glider on the ground. The pilot also notes that, during a straight glide, each wingtip should be an equal distance above the ground. With the wings level, the pitch attitude is established with reference to a point on or below the horizon to establish a specified airspeed. Any change in pitch attitude results in a change in airspeed. There is a pitch attitude reference for best glide speed, another for the minimum sink speed, and another for slow flight. The pitch attitude is adjusted with the elevator to hold the specific airspeed. The glider elevator trim control allows the pilot to trim the glider to hold a constant pitch attitude and, therefore, a constant airspeed. Straight glides should be coordinated as indicated by a centered yaw string or slip-skid ball.

The glider pilot should also stay alert to airflow noise changes. At a constant airspeed in coordinated flight, wind noise should be constant. Any changes in airspeed or coordination cause a change in the wind noise. Gusts that cause the airspeed to change momentarily can be ignored. Holding the glider at a constant pitch attitude results in maintaining the desired airspeed control.

The glider pilot should learn to fly throughout a wide range of airspeeds, from minimum controllable airspeed to maximum allowable airspeed. This enables the pilot to learn the feel of the controls of the glider throughout its speed range. If the glider is equipped with spoilers/dive brakes and/or flaps, the glider pilot should become familiar with the changes that occur in pitch attitude and airspeed when these controls are used.

Common errors during straight glides include:

- Rough or erratic pitch attitude and airspeed control.
- Rough, uncoordinated, or inappropriate control applications.
- Failure to use trim or improper use of trim.
- Improper use of controls when using spoilers, dive brakes, and/or flaps.
- Prolonged uncoordinated flight—yaw or ball not centered.

Turns

The performance of turns involves coordination of all three flight controls: ailerons, rudder, and elevator. For purposes of this discussion, turns are divided into the following three classes as shown in *Figure 7-29*.

- Shallow turns are those in which the bank (less than approximately 20°) is so shallow that the inherent lateral stability of the glider levels the wings unless some aileron is applied to maintain the bank.
- Medium turns are those resulting from a degree of bank (approximately 20° to 45°) at which lateral stability is overcome by the overbanking tendency, resulting in no control inputs (other than elevator) being required to maintain the angle.

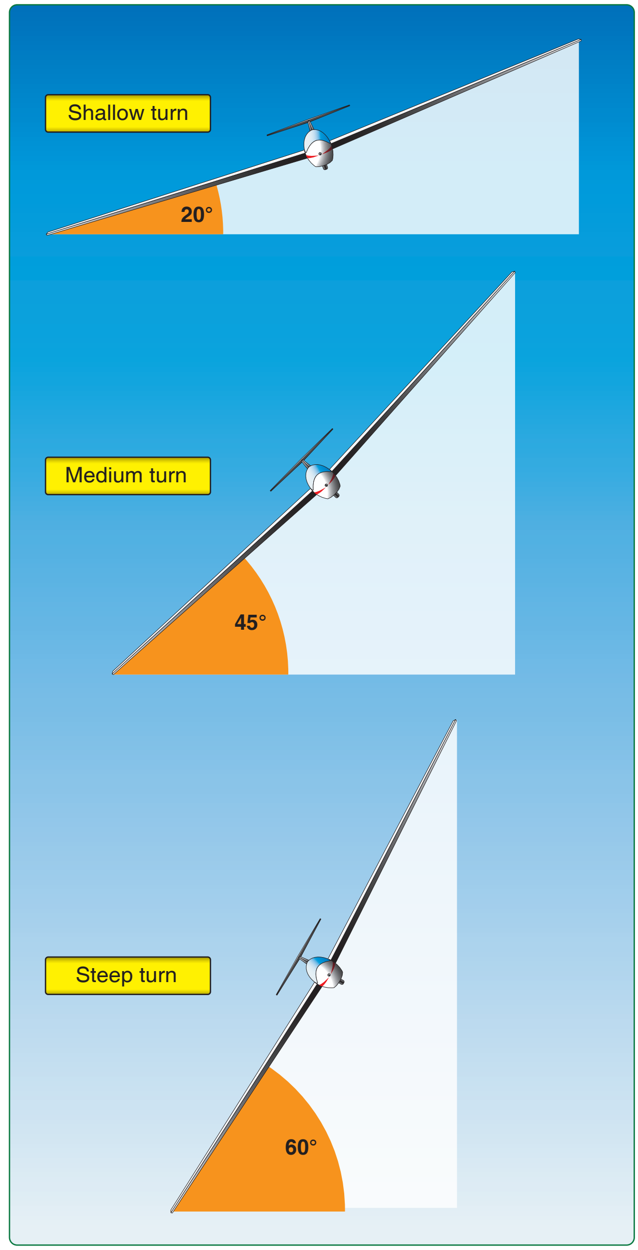


Figure 7-29. *Shallow, medium, and steep turns.*

- Steep turns are those resulting from a degree of bank (45° or more) at which the overbanking tendency of a glider overcomes stability, and the bank increases unless aileron is applied to prevent it.

Before starting any turn, the pilot must clear the airspace in the direction of the turn. A glider is turned by banking (lowering the wing in the direction of the desired turn, thus raising the other). When the glider is flying straight, the total lift is acting perpendicular to the wings and to the earth. As the glider is banked into a turn, total lift becomes the resultant of two components: 1) the vertical lift component continues to act perpendicularly to the earth and opposes gravity and 2) the horizontal lift component (centripetal) acts parallel to the earth's surface and opposes inertia (apparent centrifugal force). These two lift components act at right angles to each other, causing the resultant total lifting force to act perpendicular to the banked wing of the glider. It is the horizontal lift component that actually turns the glider, not the rudder.

Roll-In

When applying aileron to bank the glider, the aileron on the rising wing is lowered, producing a greater drag than the raised aileron on the lowering wing. This increased drag causes the glider to yaw toward the rising wing or opposite the direction of turn. To counteract this adverse yawing moment, rudder pressure must be applied in the desired direction of turn simultaneously with aileron pressure. This action is required to produce a coordinated turn.

After the bank has been established in a medium banked turn, all pressure applied to the aileron may be relaxed. The glider remains at the selected bank with no further tendency to yaw since there is no longer a deflection of the ailerons. As a result, pressure may also be relaxed on the rudder pedals, and the rudder is allowed to streamline itself with the direction of the slipstream. Rudder pressure maintained after establishing the turn causes the glider to skid to the outside of the turn. If a definite effort is made to center the rudder rather than let it streamline itself to the turn, it is probable that some opposite rudder pressure will be exerted inadvertently. This forces the glider to yaw opposite its turning path, causing the glider to slip to the inside of the turn. The yaw string or ball in the slip indicator is displaced off center whenever the glider is skidding or slipping sideways. In proper coordinated flight, there is no skidding or slipping.

In constant airspeed turns, it is necessary to increase the AOA of the wing as the bank progresses by adding nose-up elevator pressure. This is required because the total lift must be equal to the vertical component of lift plus the horizontal lift component. To stop the turn, coordinated use of the aileron and rudder pressure are added to bring the wings back to level flight as elevator pressure is relaxed.

There is a direct relationship between airspeed, bank angle, and rate and radius of turn. The rate of turn at any given true airspeed depends on the horizontal lift component. The horizontal lift component varies in proportion to the amount of bank. Therefore, the rate of turn at a given true airspeed increases as the angle of bank is increased. On the other hand, when a turn is made at a higher true airspeed at a given bank angle, the inertia is greater and the horizontal lift component required for the turn is greater, causing the turning rate to become slower. Therefore, at a given angle of bank, a higher true airspeed makes the radius of turn larger because the glider is turning at a slower rate.

As the angle of bank is increased from a shallow bank to a medium bank, the airspeed of the wing on the outside of the turn increases in relation to the inside wing. The additional lift developed by the bank balances the lateral stability of the glider. No aileron pressure is required to maintain the bank. At any given airspeed, aileron pressure is not required to maintain the bank. If the bank is increased from a medium bank to a steep bank, the radius of turn decreases even further. The greater lift of the outside wing then causes the bank to steepen, and opposite aileron is necessary to keep the bank constant.

As the radius of the turn becomes smaller, a significant difference develops between the speed of the inside wing and the speed of the outside wing. The wing on the outside of the turn travels a longer circuit than the inside wing, yet both complete their respective circuits in the same length of time. Therefore, the outside wing travels faster than the inside wing, and as a result, it develops more lift. This creates an overbanking tendency that must be controlled by the use of the ailerons. Because the outboard wing is developing more lift, it also has more induced drag. This causes a slip during steep turns that must be corrected by rudder usage.

To establish the desired angle of bank, the pilot should use visual reference points on the glider, the earth's surface, and the natural horizon. The pilot's posture while seated in the glider is very important, particularly during turns. It affects the interpretation of outside visual references. The beginning pilot may lean away from or into the turn rather than ride with the glider. This should be corrected immediately if the pilot is to properly learn to use visual references.

Applications of large aileron and rudder produces rapid roll rates and allow little time for corrections before the desired bank is reached. Slower (small control displacement) roll rates provide more time to make necessary pitch and bank corrections. As soon as the glider rolls from the wings-level attitude, the nose starts to move along the horizon, increasing its rate of travel proportionately as the bank is increased.

As the desired angle of bank is established, aileron and rudder pressures should be relaxed. This prevents increase in bank because the aileron and rudder control surfaces are neutral in their streamlined position. The up-elevator pressure should not be relaxed, but should be held constant to maintain the desired airspeed. Throughout the turn, the pilot should cross-check the airspeed indicator to verify the proper pitch is being maintained. The cross-check and instrument scan should include outside visual references. If the glider is gaining or losing airspeed, the pitch attitude should be adjusted in relation to the horizon. During all turns, aileron, rudder, and elevator are used to correct minor variations in pitch and bank just as they are in straight glides.

Roll-Out

The roll-out from a turn is similar to the roll-in except that coordinated flight controls are applied in the opposite direction. Aileron and rudder are applied in the direction of the roll-out or toward the high wing. As the angle of bank decreases, the elevator pressure should be relaxed, as necessary, to maintain airspeed.

Since the glider continues turning as long as there is any bank, the roll-out must be started before reaching the desired heading. The amount of lead required to roll out on the desired heading depends on the degree of bank used in the turn. Normally, the lead is one half the degrees of bank. For example, if the bank is 30°, lead the roll-out by 15°. As the wings become level, the control pressures should be smoothly relaxed so the controls are neutralized as the glider returns to straight flight. As the roll-out is being completed, attention should be given to outside visual references, as well as the airspeed and heading indicators to determine that the wings are being leveled and the turn stopped.

Common errors during a turn include:

- Failure to clear turn.
- Nose movement before the bank starts—rudder is being applied too soon.
- Commencement of bank before the nose starts turning, or nose movement in the opposite direction—the rudder is being applied too late.
- Up or down nose movement when entering a bank—excessive or insufficient elevator is being applied.
- Rough or uncoordinated use of controls during the roll-in and roll-out.
- Failure to establish and maintain the desired angle of bank.
- Overshooting/undershooting the desired heading.

In a slipping turn, the glider is not turning at the rate appropriate to the bank being used, since the glider is yawed toward the outside of the turning flightpath. The glider is banked too much for the rate of turn, so the horizontal lift component is greater than the centrifugal force. Equilibrium between the horizontal lift component and centrifugal force is reestablished either by decreasing the bank (ailerons), increasing yaw (rudder), or a combination of the two. *[Figure 7-30]*

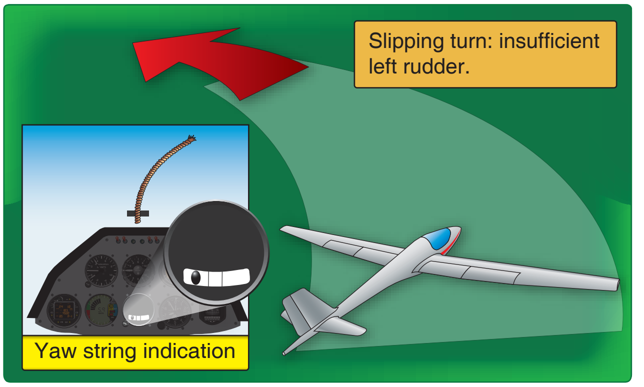


Figure 7-30. *Slipping turn.*

A skidding turn results from an excess of centrifugal force over the horizontal lift component, pulling the glider toward the outside of the turn. The rate of turn is too great for the angle of bank. Correction of a skidding turn thus involves a decrease in yaw (rudder), an increase in bank (aileron), or a combination of the two changes. *[Figure 7-31]*

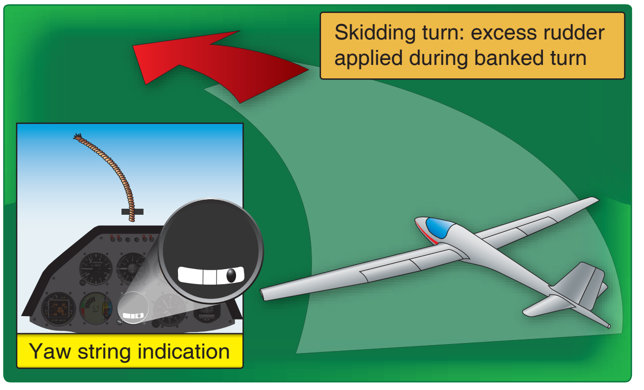


Figure 7-31. *Skidding turn.*

The yaw string identifies slips and skids. In flight, the rule to remember is simple: step on the head of the yaw string. If the head of the yaw string is to the right of the tail, then the pilot needs to apply right pedal. If the head of the yaw string is to the left of the tail, then the pilot should apply left pedal. *[Figure 7-32]*

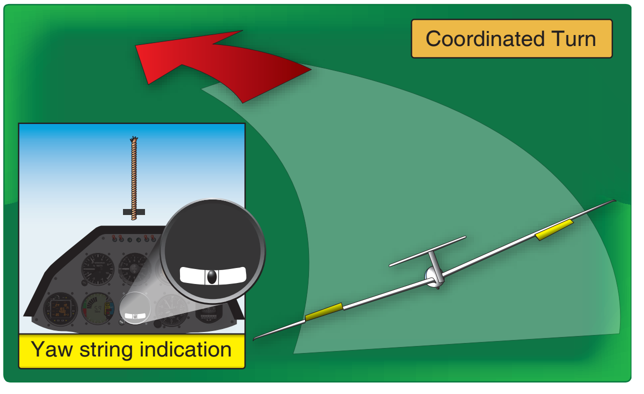


Figure 7-32. *Coordinated turn.*

The ball in the slip/skid indicator also indicates slips and skids. When using this instrument for coordination, apply rudder pressure on the side that the ball is offset (step on the ball). Correction for uncoordinated condition should be accomplished by using appropriate rudder and aileron control pressures simultaneously to coordinate the glider.

Steep Turns

Soaring flight requires competence in steep turns. In thermalling flight, small-radius turns are often necessary to keep the glider in or near the core of the thermal updraft where lift is usually strongest and rapid climbs are possible. At any given airspeed, increasing the angle of bank decreases the radius of the turn and increases the rate of turn. The radius of a turn at any given bank angle varies directly with the square of the airspeed at which the turn is made; therefore, the lower the airspeed is, the smaller the turn radius is. To keep the radius of turn small, it is necessary to bank steeply while maintaining an appropriate airspeed, such as minimum sink or best glide speed. The pilot must be aware that as the bank angle increases, the stall speed increases.

Before starting the steep turn, the pilot should ensure that the area is clear of other traffic since the rate of turn is quite rapid. After establishing the appropriate airspeed, the glider should be smoothly rolled into a coordinated steep turn with at least 45° of bank. The pilot should use outside visual reference to establish and maintain the desired bank angle. If the pilot does not add back pressure to maintain the desired airspeed after the bank is established, the glider has a tendency to enter a spiral. To counteract the overbanking tendency caused by the steep turn, the pilot should apply top aileron pressure. Because the top aileron pressure pulls the nose away from the direction of the turn, the pilot also must apply bottom rudder pressure. A coordinated (no slip or skid) steep turn requires back pressure on the elevator for airspeed control, top aileron pressure for bank control, and bottom rudder pressure to streamline the fuselage with the flightpath.

Common errors during steep turns include:

- Failure to clear turn.
- Uncoordinated use of controls.
- Loss of orientation.
- Failure to maintain airspeed within tolerance.
- Unintentional stall or spin.
- Excessive deviation from desired heading during roll-out.

Maneuvering at Minimum Controllable Airspeed

Maneuvering during slow flight demonstrates the flight characteristics and degree of controllability of a glider at minimum speeds. By definition, the term "flight at minimum controllable airspeed" means a speed at which any further increase in AOA or load factor causes an immediate stall. Pilots must develop an awareness of the particular glider flight characteristics in order to recognize and avoid stalls that may inadvertently occur during the low airspeeds used in takeoffs, climbs, thermaling, and approaches to landing.

The objective of maneuvering at minimum controllable airspeed is to develop the pilot's sense of feel and ability to use the controls correctly, and to improve proficiency in performing maneuvers that require low airspeeds. Maneuvering at minimum controllable airspeed should be performed using outside visual reference. It is important that pilots form the habit of frequently referencing the pitch attitude of the glider for airspeed control while flying at low speeds.

The maneuver is started from either best glide speed or minimum sink speed. The pitch attitude is smoothly and gradually increased. While the glider is losing airspeed, the position of the nose in relation to the horizon should be noted and should be adjusted as necessary until the minimum controllable airspeed is established. During these changing flight conditions, it is important to retrim the glider, as necessary, to compensate for changes in control pressures. Back pressure that is excessive or too aggressive on the elevator control may result in an abrupt increase in pitch attitude and a rapid decrease in airspeed, which lead to a higher AOA and a possible stall. When the desired pitch attitude and airspeed have been established, it is important to continually cross-check the pitch attitude on the horizon and the airspeed indicator to ensure accurate control is being maintained.

When minimum controllable airspeed is established in straight flight, turns should be practiced to determine the glider's controllability characteristics at this selected airspeed. During the turns, the pitch attitude may need to be decreased in order to maintain the airspeed. If a steep turn is encountered, and the pitch attitude is not decreased, the increase in load factor may result in a stall. A stall may also occur as a result of abrupt or rough control movements resulting in momentary increases in load factor. Abruptly raising the flaps during minimum controllable airspeed results in sudden loss of lift and possibly causing a stall.

Minimum controllable airspeed should also be practiced with extended spoilers/dive brakes. This provides additional understanding of the changes in pitch attitude caused by the increase in drag from the spoilers/dive brakes.

Actual minimum controllable airspeed depends upon various conditions, such as the gross weight and CG location of the glider and the maneuvering load imposed by turns and pull-ups. Flight at minimum controllable airspeed requires positive use of rudder and ailerons. The diminished effectiveness of the flight controls during flight at minimum controllable airspeed helps pilots develop the ability to estimate the margin of safety above the stalling speed.

Common errors during maneuvers at minimum controllable airspeed include:

- Failure to establish or to maintain minimum controllable airspeed.
- Improper use of trim.
- Rough or uncoordinated use of controls.
- Failure to recognize indications of a stall.

Stall Recognition and Recovery

All pilots must be proficient in stall recognition and recovery. A stall can occur at any airspeed and at any attitude. In the case of the self-launching glider under power, a stall can also occur with any power setting. A stall occurs when the smooth airflow over the glider's wing is disrupted and the wings stop producing enough lift. This occurs when the wing exceeds its critical AOA.

The practice of stall recovery and the development of stall awareness are of primary importance in pilot training. The objectives in performing intentional stalls are to familiarize the pilot with the conditions that produce stalls, to assist in recognizing an approaching stall, and to develop the habit of taking prompt preventive or corrective action.

Intentional stalls should be performed so the maneuver is completed by 1,500 feet above the ground with a landing area within gliding distance, in the event lift cannot be found. Although it depends on the degree to which a stall has progressed, most stalls require some loss of altitude during recovery. The longer it takes to recognize the approaching stall, the more complete the stall is likely to become, and the greater the loss of altitude to be expected.

Pilots must recognize the flight conditions that are conducive to stalls and know how to apply the necessary corrective action since most gliders do not have an electrical or mechanical stall warning device. Pilots should learn to recognize an approaching stall by sight, sound, and feel. The following cues may be useful in recognizing the approaching stall.

1. Vision—useful in detecting a stall condition by noting the attitude of the glider versus the horizon.
2. Hearing—also helpful in sensing a stall condition. In the case of a glider, a change in sound due to loss of airspeed is particularly noticeable. The lessening of the noise made by the air flowing along the glider structure as airspeed decreases is quite noticeable, and when the stall is almost complete, the pilot starts to feel airframe buffeting or aerodynamic vibration as the stall occurs.
3. Feeling
   a. Kinesthesia, or the sensing of changes in direction or speed of motion, is an important intuitive indicator to the trained and experienced pilot. If this sensitivity is properly developed, it warns of a decrease in speed or the beginning of a settling, or mushing, of the glider.
   b. The feel of control pressures is also very important. As speed is reduced, the resistance to pressure on the controls becomes progressively less. Pressures exerted on the controls tend to become movements of the control surfaces. As the airflow slows and stalls, the aerodynamic controls (ailerons, elevator, and rudder) have significantly less authority and require much more movement to create the same amount of directional change as compared to the normal flight regime responses. As the wing airflow stalls and the stalling strongly affects the controls, the controllability of the glider can become questionable. Properly designed and certificated gliders should retain marginal control authority when the wing is stalled. The lag between these movements and the response of the glider becomes greater until in a complete stall.

Signs of an impending stall include the following:

- Nose-high attitude for higher wing loading with possible increasing trend.
- Low airspeed indication with a decreasing trend.
- Low airflow noise and decreasing.
- Back pressure increasing, requiring more elevator trimming and/or not having anymore aft trim.
- Poor control responses from the glider and decreasing feedback pressures from control movements.
- Wing (airframe) buffeting as stalling begins.
- Yaw string (if equipped) movement from normal flight position.

Always make clearing turns before performing stalls. During the practice of intentional stalls, the real objective is not to learn how to stall a glider, but to learn how to recognize an approaching stall and take prompt corrective action. The recovery actions must be taken in a coordinated manner.

First, at the indication of a stall, the pitch attitude and AOA must be decreased positively and immediately. Since the basic cause of a stall is always an excessive AOA, the cause must first be eliminated by releasing the back-elevator pressure that was necessary to attain that AOA or by moving the elevator control forward. This lowers the nose and returns the wing to an effective AOA. The amount of elevator control pressure or movement to use depends on the design of the glider, the severity of the stall, and the proximity of the ground. In some gliders, a moderate movement of the elevator control—perhaps slightly forward of neutral—is enough, while others may require a forcible push to the full forward position. An excessive negative load on the wings caused by excessive forward movement of the elevator may impede, rather than hasten, the stall recovery. The object is to reduce the AOA, but only enough to allow the wing to regain lift. *[Figure 7-33]*

If stalls are practiced or encountered in a self-launching glider, the maximum allowable power should be applied during the stall recovery to increase the self-launching glider's speed and assist in reducing the wing's AOA. Generally, the throttle should be promptly, but smoothly, advanced to the maximum allowable power. Although stall recoveries should be practiced with and without power, in self-launching gliders during actual stalls, the application of power is an integral part of the stall recovery. Usually, the greater the applied power is, the less the loss of altitude is. Maximum allowable power applied at the instant of a stall usually does not cause overspeeding of an engine equipped with a fixed-pitch propeller, due to the heavy air load imposed on the propeller at low airspeeds. However, it is necessary to reduce the power as airspeed is gained after the stall recovery so the airspeed does not become excessive.

When performing intentional stalls, pilots should never allow the engine to exceed its maximum designed rpm limitation. The maximum rpm is marked by a red line on the engine tachometer gauge. Exceeding rpm limitations can cause damage to engine components.

Whether in a towed glider or self-launching glider, stall recovery is accomplished by leveling the wings and returning to straight flight using coordinated flight controls. The first few practice sessions should consist of approaches to stalls with recovery initiated at the first airframe buffet or when partial loss of control is noted. Using this method, pilots become familiar with the initial indications of an approaching stall without fully stalling the glider.

Stall accidents usually result from an inadvertent stall at a low altitude in which a recovery was not accomplished prior to contact with the surface. As a preventive measure, stalls should be practiced at an altitude that allows recovery at no lower than 1,500 feet AGL and within gliding distance of a landing area.

Different types of gliders have different stall characteristics. Most gliders are designed so the wings stall progressively outward from the wing roots (where the wing attaches to the fuselage) to the wingtips. This is the result of designing the wings so the wingtips have a smaller angle of incidence than the wing roots. When exceeding the critical angle of attack results in a stall, the inner wing does not support normal aerodynamic flight, but the outer part of the wing does retain some aerodynamic effectiveness. Wings are designed in this manner so aileron control is available at high AOA (low airspeed) and to give the glider more stable stalling characteristics. When the glider is in a stalled condition, the wingtips continue to provide some degree of lift, and the ailerons still have some control effect. During recovery from a stall, the return of lift begins at the tips and progresses toward the roots. Thus, the ailerons can be used to level the wings.

Using the ailerons requires finesse to avoid an aggravated stall condition. For example, if the right wing drops during the stall and excessive aileron control is applied to the left to raise the wing, the aileron that deflects downward (right wing) would produce a greater AOA (and drag). Possibly a more complete stall would occur at the tip, because the critical AOA would be exceeded. The increase in drag created by the

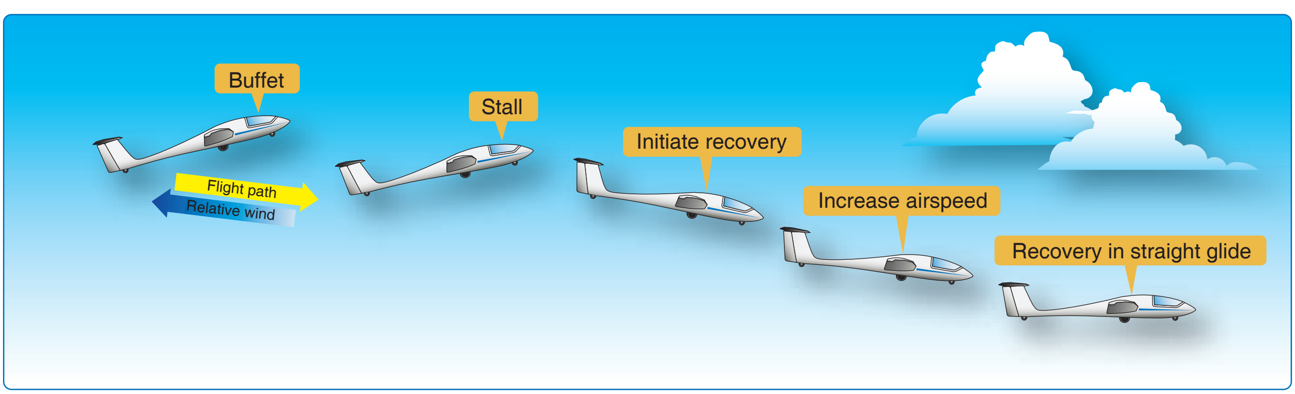


Figure 7-33. *Stall recovery.*

high AOA on that wing might cause the airplane to yaw in that direction. This adverse yaw could result in a spin unless directional control were maintained by rudder and/or aileron control is sufficiently reduced.

Even though excessive aileron pressure may have been applied, a spin does not occur if directional (yaw) control is maintained by timely application of coordinated rudder pressure. Therefore, it is important that the rudder be used properly during both entry and recovery from a stall. The primary use of the rudder in stall recovery is to counteract any tendency of the glider to yaw. The correct recovery technique would be to decrease the pitch attitude by applying forward elevator pressure to reduce the AOA while simultaneously maintaining directional control with coordinated use of the aileron and rudder.

Due to engineering design variations, the stall characteristics for all gliders cannot be specifically described; however, the similarities found in gliders are noteworthy enough to be considered. The factors that affect the stalling characteristics of the glider are weight and balance, bank and pitch attitude, coordination, and drag. The pilot should learn the stall characteristics of the glider being flown and the proper correction procedures. It should be reemphasized that a stall can occur at any airspeed, in any attitude, or at any power setting in the case of a self-launching or sustaining glider, depending on the total value of factors affecting the particular glider.

Whenever practicing stalls while turning, a constant bank angle should be maintained until the stall occurs. After the stall occurs, coordinated control inputs should be made to return the glider to wings-level flight.

Advanced stalls include secondary, accelerated, and crossed-control stalls. These stalls are extremely useful for pilots to expand their knowledge of stall/spin awareness.

Secondary Stalls

A secondary stall occurs after a recovery from a preceding stall. It is caused by attempting to hasten the completion of a stall recovery with abrupt control input before the glider has regained sufficient flying speed and the critical AOA is again exceeded. When this stall occurs, the back-elevator pressure should again be released as in a normal stall recovery. When sufficient airspeed has been regained, the glider can then be returned to wings-level, straight flight.

Accelerated Stalls

Although the stalls already discussed normally occur at a specific airspeed, the pilot must thoroughly understand that all stalls result solely from attempts to fly at excessively high angles of attack. During flight, the AOA of a glider wing is determined by a number of factors, the most important of which are airspeed, gross weight of the glider, and load factors imposed by maneuvering.

At gross weight, the glider consistently stalls at the same indicated airspeed if no acceleration is involved. However, the glider stalls at a higher indicated airspeed when excessive maneuvering loads are imposed by steep turns, pull-ups, or other abrupt changes in its flightpath. Stalls entered from such flight situations are called “accelerated maneuver stalls, a term that has no reference to the airspeeds involved. Stalls that result from abrupt maneuvers tend to be more rapid or severe than the unaccelerated or steady state stall. Accelerated stalls occur at higher-than-normal airspeeds and may be unexpected by pilots. These accelerated stalls result when the AOA exceeds the angle necessary to stall the airflow over the wing. The relative wind angle increases as the loads on the wings require more lift to change direction, either vertically or horizontally, and inertia pushes the wings into the airmass resulting in an increased AOA. Depending on the wing configuration and quality of coordination, one wing may stall prior to the other wing resulting in a wingover entry into a spiral or spin. If the wings have a slight or pronounced sweep, one wing can easily develop more lift than the other wing almost instantaneously resulting in a wingover before the pilot can react. This is the common killer scenario of a pilot turning too tightly in the traffic pattern and crashing upside down.

Accelerated maneuver stalls should not be performed in any glider in which this maneuver is prohibited by the GFM/POH. If they are permitted, they should be performed with a bank of approximately 45° and never at a speed greater than the glider manufacturer’s recommended airspeeds or the design maneuvering speed specified for the glider. The design maneuvering speed is the maximum speed at which the glider can be stalled or the application of full aerodynamic control will not exceed the glider’s limit load factor. At or below this speed, the glider is designed so that it stalls before the limit load factor can be exceeded. The objective of demonstrating accelerated stalls is not to develop competency in setting up the stall, but rather to learn how they may occur and to develop the ability to recognize a prestall situation immediately and then take the proper recovery action. It is important that recovery is made at the first indication of a stall, or immediately after the stall has fully developed; a prolonged stall condition should never be allowed.

A glider stalls during a coordinated turn as it does from straight flight, except the pitching and rolling actions tend to be more sudden. If the glider is slipping toward the inside of the turn at the time the stall occurs, it tends to roll rapidly toward the outside of the turn as the nose pitches down because the outside wing stalls before the inside wing. If the glider is skidding toward the outside of the turn, it has a tendency to roll to the inside of the turn because the inside wing stalls first. If the coordination of the turn at the time of the stall is accurate, the glider's nose pitches away from the pilot just as it does in a straight flight stall, since both wings stall simultaneously. The configuration of the wings has a strong influence on exactly how a glider reacts to different airflows. The safe approach is to fly the specific glider into these situations at higher altitudes to determine how that glider reacts. The glider pilot should commit those newly discovered prestall conditions and indications to memory to avoid those conditions at lower altitudes where recovery is improbable or impossible.

Glider pilots enter an accelerated stall demonstration by establishing the desired flight attitude and then, with smooth actions, firmly and progressively increasing the AOA until a stall occurs. Because of the rapidly changing flight attitude, sudden stall entry, and possible loss of altitude, it is extremely vital that the area be clear of other aircraft. Entry altitudes should be adequate for safe recovery.

Actual accelerated stalls occur most frequently during turns in the traffic pattern close to the ground while maneuvering the glider for the approach. The demonstration of an accelerated stall is accomplished by exerting excessive back elevator pressure. It usually occurs during improperly executed steep turns, stall and spin recoveries, and pullouts from steep dives. The objectives are to determine the stall characteristics of the glider and develop the ability to instinctively recover at the onset of a stall at other-than-normal stall speed or flight attitudes. An accelerated stall, although usually demonstrated in steep turns, may actually be encountered any time excessive back-elevator pressure is applied and/or the AOA is increased too rapidly.

From straight flight at maneuvering speed or less, the glider should be rolled into a steep banked (45° maximum) turn and back-elevator pressure gradually applied. After the bank is established, back-elevator pressure should be smoothly and steadily increased. The resulting apparent centrifugal force pushes the pilot's body down in the seat, increases the wing loading, and decreases the airspeed. Back-elevator pressure should be firmly increased until a definite stall occurs.

When the glider stalls, recovery should be made promptly by releasing back-elevator pressure. If the turn is uncoordinated, one wing may tend to drop suddenly, causing the glider to roll in that direction. If this occurs, the glider should be returned to wings-level, straight flight with coordinated control pressure.

A glider pilot should recognize when an accelerated stall is imminent and take prompt action to prevent a completely stalled condition. It is imperative that prolonged stalls, excessive airspeed, or loss of altitude, and spins be avoided.

Crossed-Control Stalls

The objective of a crossed-control stall demonstration maneuver is to show the effect of improper control technique and to emphasize the importance of using coordinated control pressures whenever making turns. This type of stall occurs with the controls crossed—aileron pressure applied in one direction and rudder pressure in the opposite direction—and the critical AOA is exceeded. *[Figure 7-34]*

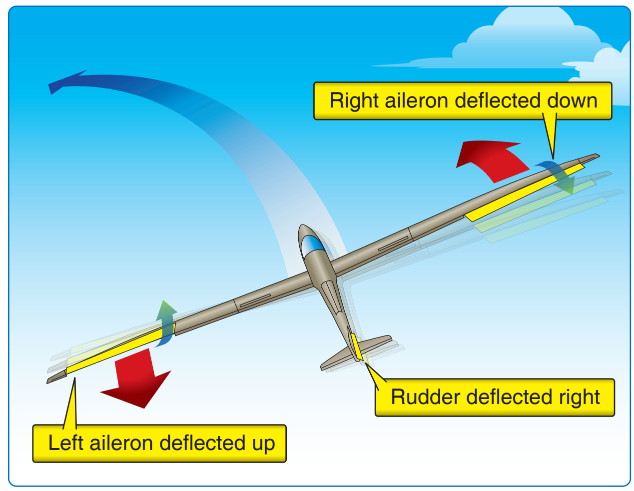


Figure 7-34. *Crossed-control approach to a stall.*

This is a stall that is most likely to occur during a poorly planned and executed base-to-final approach turn, and often is the result of overshooting the centerline of the runway during that turn. Normally, the proper action to correct for overshooting the runway is to increase the rate of turn by using coordinated aileron and rudder. At the relatively low altitude of a base-to-final approach turn, improperly trained pilots may be apprehensive of steeping the bank to increase the rate of turn.

The addition of rudder pressure on the inside of the turn causes the speed of the outer wing to increase, creating greater lift on that wing. To keep that wing from rising and to maintain a constant angle of bank, opposite aileron pressure is required. The added inside rudder pressure also causes the nose to lower in relation to the horizon. Consequently, additional back-elevator pressure would be required to maintain a constant pitch attitude. The resulting condition is a turn with rudder applied in one direction, aileron in the opposite direction, and excessive back-elevator pressure—a pronounced crossed-control condition.

Since the glider is in a skidding turn during the crossed-control condition, the wing on the outside of the turn increases speed and produces more lift than the inside wing, and the glider starts to increase its bank. The down aileron on the inside of the turn helps drag that wing back, slowing it and decreasing its lift. This further causes the glider to roll. The roll may be so fast that it is possible the bank will be vertical or past vertical before it can be stopped.

For the demonstration of the maneuver, it is important that it be entered at a safe altitude because of the possible extreme nose-down attitude and loss of altitude that may result. Before demonstrating this stall, the pilot should clear the area for other air traffic. While the gliding attitude and airspeed are being established, the glider should be retrimmed. When the glide is stabilized, the glider should be rolled into a medium banked turn to simulate a final approach turn that would overshoot the centerline of the runway. During the turn, excessive rudder pressure should be applied in the direction of the turn but the bank held constant by applying opposite aileron pressure. At the same time, increased back-elevator pressure is required to keep the nose from lowering.

All of these control pressures should be increased until the glider stalls. When the stall occurs, releasing the control pressures and simultaneously decreasing the AOA initiates the recovery. In a crossed-control stall, the glider often stalls with little warning. The nose may pitch down, the inside wing may suddenly drop, and the glider may continue to roll to an inverted position. This is usually the beginning of a spin. It is obvious that close to the ground is no place to allow this to happen.

Recovery must be made before the glider enters an abnormal attitude (vertical spiral or spin); it is a simple matter to return to wings-level, straight flight by coordinated use of the controls. The pilot must be able to recognize when this stall is imminent and must take immediate action to prevent a completely stalled condition. It is imperative that this type of stall not occur during an actual approach to a landing, since recovery may be impossible prior to ground contact due to the low altitude.

Common errors during advanced stalls include:

- Improper pitch and bank control during straight-ahead and turning stalls.
- Rough or uncoordinated control procedures.
- Failure to recognize the first indications of a stall.
- Failure to achieve a stall.
- Poor recognition and recovery procedures.
- Excessive altitude loss or airspeed or encountering a secondary stall during recovery.

Operating Airspeeds

Minimum Sink Airspeed

Minimum sink airspeed is defined as the airspeed at which the glider loses the least altitude in a given period of time. Minimum sink airspeed varies with the weight of the glider. Glider manufacturers publish altitude loss in feet per minute or meters per second (e.g., 122 ft/min or 0.62 m/sec) at a specified weight. Flying at minimum sink airspeed results in maximum duration in the absence of convection in the atmosphere.

The minimum sink airspeed given in the GFM/POH is based on the following conditions.

- The glider is wings level and flying a straight flightpath; load factor is 1.0 G.
- The glider flight controls are perfectly coordinated.
- Wing flaps are set to zero degrees and air brakes are closed and locked.
- The wings are free of bugs or other contaminants.
- The glider is at a manufacturer-specified weight.

While flying in a thermaling turn, the proper airspeed is the minimum sink airspeed appropriate to the load factor, or G-load, that the glider is undergoing. The glider's stall speed increases with load factor. The minimum sink speed needs to be increased with an increase in load factor. Another factor that always needs to be considered is that the gross weight and stall speed of the glider can vary if equipped with water ballast, which affects the minimum sink airspeed. For most gliders, the following weights will be of greatest interest:

1. Maximum gross weight with full water and both seats occupied
2. Maximum gross weight with both seats occupied and no water ballast
3. One pilot on board

The effect of only weight on stall speed can be expressed by using the basic lift formula that is manipulated and simplified to derive the necessary information. The modified lift formula is:

$$\frac{V_S2}{V_S1} = \frac{\sqrt{W2}}{W1}$$

V_S1 = stall speed corresponding to some gross weight, W1
V_S2 = stall speed corresponding to a different gross weight, W2

This can be manipulated into V_S times the square root of the load factor (which equals weight × G loading).

For example, if a glider stall speed is 34 knots, consider the following formula (34 × √1.2 (load factor) = 34 × 1.10 = 37 at 30°) for thermalling:

- In a 30° banked turn, load factor is 1.2 Gs. The approximate square root of 1.2 is 1.1. Now multiply 34 knots times 1.1 yields a 37-knot stall speed. Since the minimum sink speed is 40 which is still above the stall speed but by only approximately 3 knots, the margin of safety is decreasing and the pilot should consider increasing the minimum airspeed by a factor proportionate to the stall speed increase, in this case 44 knots (40 × √1.2 (load factor) = 40 × 1.10 = 44 at 30°).
- In a 45° banked turn, load factor is 1.18 (34 × √1.4 = 34 × 1.18 = 40.12 knots at 45°). Now multiply 34 knots times 1.18 which yields a 41-knot stall speed. The minimum sink speed of 40 knots is now below the stall speed. The pilot should increase the minimum airspeed proportionately to the stall airspeed, and the new speed would be 48 knots (40 × √1.4 (load factor) = 41 × 1.18 = 48 at 45°), a 7-knot safety factor.
- In a 60° banked turn, load factor is 2.0 Gs. The approximate square root of 2.0 is 1.4 (34 × √2.0 = 34 × 1.41 = 48 knots at 60°). Now multiply 34 knots times 1.4 which yields a 48-knot stall speed. The minimum sink speed of 40 knots is now below the stall speed. The pilot should increase the minimum airspeed proportionately to 57 knots, yielding an 9-knot safety (40 × √2.0 (load factor) = 40 × 1.41 = 56.4 at 60°).

Minimum sink airspeed is always lower than best L/D airspeed at any given operating weight. If the operating weight of the glider is noticeably less than maximum gross weight, then the actual minimum sink airspeed at that operating weight is lower than that published by the manufacturer.

Common errors regarding minimum sink airspeed include:

- Improper determination of minimum sink speed.
- Failure to maintain proper pitch attitude and airspeed control.

Best Glide Airspeed

Best glide (L/D) airspeed is defined as the airspeed that results in the least amount of altitude loss over a given distance. This allows the glider to glide the greatest distance in still air. This performance is expressed as glide ratio. The manufacturer publishes the best glide airspeed for specified weights and the resulting glide ratio. For example, a glide ratio of 36:1 means that the glider loses 1 foot of altitude for every 36 feet of forward movement in still air at this airspeed. The glide ratio decreases at airspeeds above or below best glide airspeed. The best glide speed can be found from the glider polars in Chapter 5, Performance Limitations.

Common errors regarding best glide airspeed include:

- Improper determination of best airspeed to fly and not factoring in lift and headwinds.
- Failure to maintain proper pitch attitude and airspeed control.

Speed to Fly

Much is said about the importance of maintaining the best gliding speed, but what is important is to maintain an optimum glide speed, a penetration speed that takes atmospheric conditions into account (e.g., sinking air or a headwind). The gliding community refers to this as the speed to fly. The normal recommendation for countering a headwind is to add one-third to one-half of the estimated wind speed to V_{BG}, which increases the rate of sink but also increases the ground speed. For a tailwind, deduct one-third to one-half the estimated wind speed from V_{BG}, which reduces both the rate of sink and the groundspeed. Bear in mind that, for safety, it is better to err towards higher rather than lower airspeeds.

To illustrate this, the polar curve in *Figure 7-35* indicates the optimum glide speed when adjusted for headwind, tailwind or sinking air. For a tailwind (A), the starting point on the horizontal scale has been moved a distance to the left corresponding to the tailwind velocity. Consequently, the black tangential line contacts the curve at an optimal glide speed that is lower than the best L/D no-wind glide (B), with a slightly lower rate of sink. This is the opposite for a headwind (C), shown by the purple line, and sinking air (D), shown

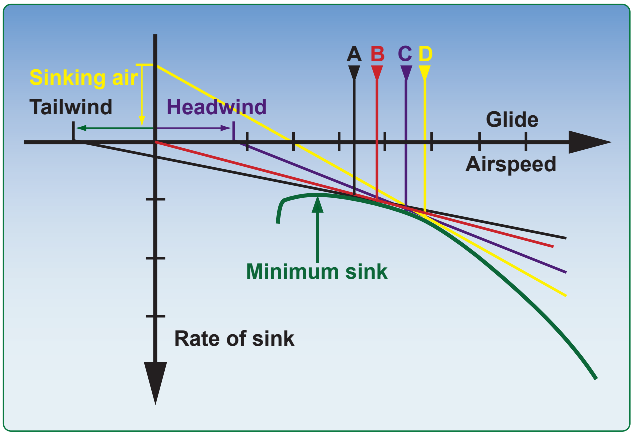


Figure 7-35. *Polar curve for optimum glide speed adjusted for headwind, tailwind, and sinking air.*

by the yellow line. For sinking air, the starting point on the vertical scale has been moved up a distance corresponding to the vertical velocity of the air. Consequently, the red tangential line contacts the curve at a glide speed higher than best glide speed.

Speed to fly depends on:

1. The rate of climb the pilot expects to achieve in the next thermal or updraft.
2. The rate of ascent or descent of the air mass through which the glider is flying.
3. The glider's inherent sink rate at all airspeeds between minimum-sink airspeed and never-exceed airspeed.
4. Headwind or tailwind conditions.

The object of speed to fly is to minimize the time and/or altitude required to fly from the current position to the next thermal and to minimize time in sink and maximize time in lift. Speed-to-fly information is presented to the pilot in one or more of the following ways:

- By placing a speed-to-fly ring (MacCready ring) around the variometer dial.
- Using the appropriate table or chart.
- Using an electronic flight computer that displays the current optimum speed to fly.

The pilot determines the speed to fly during initial planning and then constantly updates this information in flight. The pilot must be aware of changes in the flying conditions in order to be successful in conducting cross-country flights or during a soaring competition.

Common errors regarding speed to fly are:

- Improper determination of speed to fly.
- Failure to maintain proper pitch attitude and airspeed control.
- Not transitioning from cruise speed to climb speed in lift as needed and not changing to cruise speed when leaving lift in a prudent manner.