Abnormal and Emergency Procedures

Introduction

Training for abnormal and emergency procedures is an essential element in becoming a glider pilot. Knowledge of procedures is required for coping with control problems, instrument failure, or equipment malfunction. This is especially important in soaring activities. Understanding how to use emergency equipment and survival gear is a practical necessity.

Porpoising

Porpoising is a general term that refers to pitch oscillations that can occur in gliders and aircraft in general. In most cases, pilots induce these oscillations through overcontrolling the glider as they attempt to stop the oscillations from occurring in the first place.

Pilot-Induced Oscillations (PIOs)

The instability of a glider's attitude that arises when the pilot fails to recognize the lag time inherent in controlling the glider is known as a pilot-induced oscillation (PIO). Typically, PIOs occur when the glider fails to respond instantly to control input and the pilot quickly increases the pressure on the controls. By the time the pilot judges that the glider is responding satisfactorily, the extra control pressures have resulted in such a vigorous response that the glider overshoots the desired flight attitude. In an attempt to correct the situation, the pilot moves the controls rapidly in the opposite direction, overcompensating for the mistake. The undesired glider motion slows, stops for an instant, and then reverses. The alarmed pilot maintains significant control pressures to try to increase the rate of response. The glider, now in rapid motion in the desired direction in response to heavy-handed control inputs, again shoots past the desired attitude as the now thoroughly alarmed pilot jerks the flight controls in the opposite direction. Unless the pilot understands that these oscillations are the direct result of overcontrolling the glider, it is unlikely that the oscillations will cease. More likely, they increase in intensity until there is a complete loss of control.

Although PIOs can occur at anytime, these situations arise most commonly during primary training. Pitch instability is another result of center of gravity aft beyond limits. If a pilot encounters PIO, they should ensure the CG is within limits. Pitch instability tends to disappear as pilot experience grows because pilots gain familiarity with the lag time inherent in the flight controls. These types of oscillations may also occur when a pilot is making flights in unfamiliar types of gliders. For this reason, particular care must be taken when the pilot is preparing to fly a single-seat glider in which the pilot has no prior experience. When checking out a new make of single seat glider, the lag time of the flight controls must be learned without the obvious benefit of having an experienced glider flight instructor aboard during flight to offer advice or, if necessary, to intervene. While most PIO discussions are devoted to pitch oscillations, consideration should be given to roll-and-yaw induced oscillations.

The first step toward interrupting the PIO cycle is to recognize the lag time inherent in the glider's response. Any change in glider flight attitude takes an appreciable amount of time to accomplish as the flight controls take effect, and the mass of the glider responds to the pilot's control inputs. The second step is to modify control inputs to avoid overcontrolling the glider. The correct technique is to pressure the controls until the glider begins to respond in the desired direction, and then ease off the pressure. As the glider nears the desired attitude, center the appropriate flight control so that overshooting does not occur.

PIOs During Launch

PIOs are most likely to occur during launch because the glider's lag time changes rapidly as the glider accelerates. During the first moments of the takeoff roll, aerodynamic control is poor, the control feel of the glider is very sluggish, and lag time is great. Flight controls require a wide range of movement or input to have an effect on the glider's flightpath. As the glider gains speed, aerodynamic response improves, control feel becomes crisper, and lag time decreases. When the glider has acquired safe flying speed, lag time is short, the controls feel normal, and PIOs become much less likely.

Factors Influencing PIOs

The characteristics of the towhook/towline combination on pitch of the glider being flown may cause uncommanded pitch excursions if the pilot does not compensate for those effects. This can contribute to PIO during aerotow launch. In addition, the propwash and wing vortices of the towplane, through which the glider must pass if there is little or no crosswind, affect the flight attitude and control response of the glider, especially at low speeds during the start of the takeoff roll.

To minimize the influence of the towplane's wake, use a towline of adequate length—200 feet is the minimum length for normal towing operations. A longer towline provides more isolation from towplane wake during aerotow launch. Short towlines, on the other hand, keep the glider closer to the towplane and its turbulent wake, complicating the problem of controlling the glider.

There are several techniques that reduce the likelihood and severity of PIOs during aerotow launch. A pilot should not try to lift off until confident that flying speed and good aerodynamic control has been achieved. Also, just after the moment of lift-off, allow the glider to rise several feet above the runway before stabilizing the altitude of the glider. Two to three feet is high enough that minor excursions in pitch attitude, if corrected promptly, do not result in glider contact with the runway surface, but not high enough to lose sight of the towplane below the nose of the glider. Caution should be exercised if attempting to stabilize the glider just a few inches above the ground because it provides little margin for error if a PIO occurs.

Improper Elevator Trim Setting

The elevator trim control position also contributes to PIO in pitch attitude. The takeoff checklist includes a check to confirm the proper takeoff elevator trim setting. Trim set properly for takeoff results in normal elevator pressures felt through the control stick is normal, and the likelihood of PIO is reduced. If the elevator trim is set incorrectly, however, abnormal elevator pressure is felt through the control stick and may contribute to PIO.

Excessively nose-down trim requires the pilot to hold back pressure on the control stick to achieve and maintain the desired pitch attitude during launch and climb-out. If the trim is set excessively nose up, the pilot needs to hold forward pressure. The more pressure is needed, the more likely it is that the pilot overcontrols the glider.

Although all gliders exhibit these tendencies if the trim is improperly set, the effect is most pronounced on those gliders with an aerodynamic elevator trim tab or an antiservo tab on the elevator. The effect usually is less pronounced on those glider fitted with a simple spring system elevator trim. Regardless of the type of elevator trim installed in the glider, error prevention is superior to error correction. Use a comprehensive pretakeoff checklist and set the elevator trim in the appropriate position prior to launch to help prevent PIO attributable to elevator trim misuse. *[Figure 8-1]*

Improper Wing Flaps Setting

The likelihood of PIOs increases if the wing flaps are not correctly set in the desired takeoff position. For the majority of flap-equipped gliders, most Glider Flight Manuals/Pilot Operating Handbooks (GFM/POH) recommend that flaps be set at 0° for takeoff. Pilots should review their GFM/POH for the manufacturer recommendation for takeoff settings.

If the flaps are incorrectly set for takeoff, a positive flap setting increases wing camber and wing lift, the glider tends to rise off the runway prematurely, perhaps even before the elevator control is sufficient to control the pitch attitude. Attempting to prevent the glider from ballooning high above the runway, the pilot may exert considerable forward pressure on the control stick. As the glider continues to accelerate, this forward pressure on the control stick exerts a rapidly increasing nose-down force on the glider due to the increasing airflow over the elevator. When the glider eventually pitches down, the pilot may exert considerable back pressure on the stick to arrest the descent. Severe pitching or PIOs are likely to result. If allowed to continue, hard contact with the runway surface may result in glider damage and personal injury.

If the wing flaps are incorrectly set to a negative flap setting, decreasing wing camber and wing lift, then takeoff may be delayed so long that the towplane lifts off and begins to climb out while the glider is still rolling down the runway, unable to get airborne. Excessive back pressure on the control stick may eventually assist the glider in leaving the runway, but the relatively high airspeed at lift-off translates into a very effective elevator, and ballooning may occur as a result of the extreme elevator position. Overcorrecting for the ballooning with excessive forward pressure on the control stick increases the magnitude of this pitch excursion. A series of PIOs may result. If this condition is allowed to continue, the launch could lead to a premature termination of the tow.

Pilot-Induced Roll Oscillations During Launch

Pilot-induced roll oscillations occur primarily during launch, particularly via aerotow. As the tow pilot applies full power, the glider moves forward, balanced laterally on its main wheel by the wing-runner. After the wing-runner releases his or her balancing hold, aerodynamics or crosswind could cause a wing to drop. If a wingtip begins to drop toward the ground before the glider achieves significant speed, aileron control is marginal and considerable stick displacement must be applied to elicit a response from the glider's ailerons. As the glider accelerates, the control response improves and the latency of response from the glider shortens. As acceleration continues, the pilot must recognize the increased responsiveness of the glider to avoid overcontrolling the glider. *[Figure 8-2]*

Although roll oscillations can develop during ground launch operations, they occur less often than during aerotow operations because excellent aerodynamic control of the glider is quickly achieved due to the rapid acceleration. Since control improves as acceleration increases, operations that

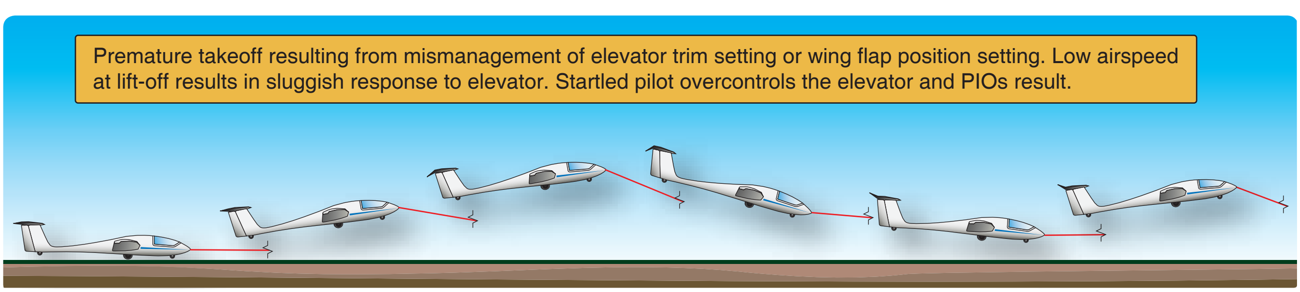

Figure 8-1. *Premature takeoffs and PIOs.*

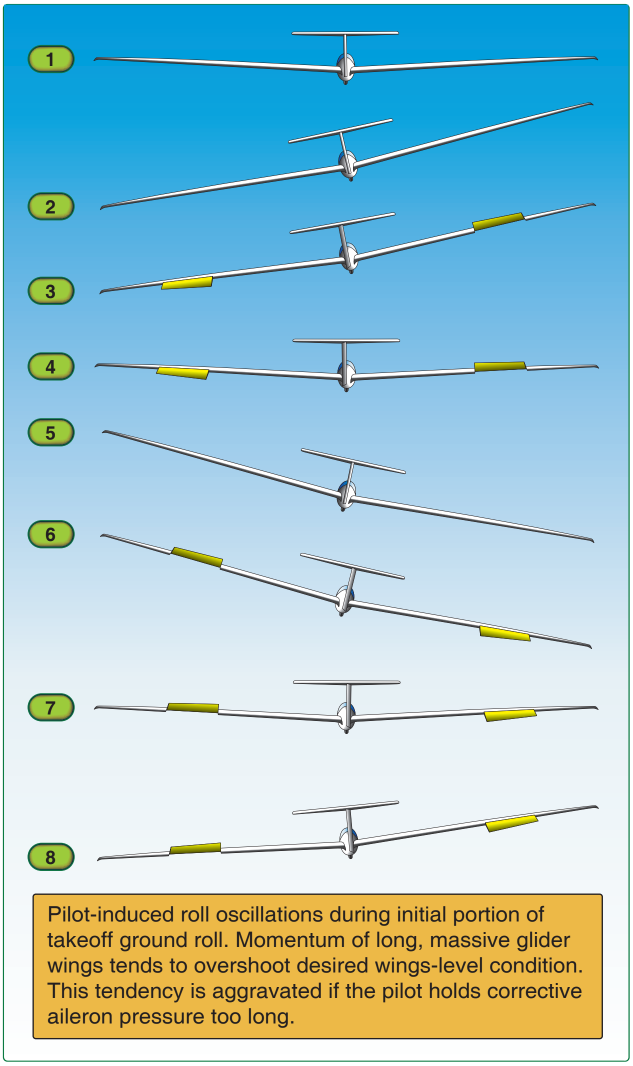

Figure 8-2. *Pilot-induced roll oscillations during takeoff roll.*

use a strong winch or launch vehicle are less likely to be hampered by oscillations.

Wing mass also affects roll oscillations. During low speeds, if the wings do not stay level, the pilot applies considerable aileron pressure to return the wings to level attitude. Because of the large mass and considerable aerodynamic damping that long-winged gliders exhibit, there is a considerable lag time from the moment pressure is applied until the moment the wings are level again. Inexperienced pilots maintain considerable pressure on the ailerons until the wings are level before releasing control pressure. The wings continue their rolling moment due to their mass, length, and momentum about the longitudinal axis of the glider. The pilot senses this momentum too late, and applies considerable pressure in the opposite direction in another attempt to level the wings.

After a time, the wings respond and roll back to level, whereupon the pilot centers the ailerons once again. As before, the momentum of the wings about the longitudinal axis is considerable, and the wings continue their motion in roll. This series of PIOs may continue until one wingtip contacts the ground, possibly with considerable force, causing wing damage or a ground loop and an aborted launch. To reduce the likelihood of this type of roll oscillation, anticipate the momentum of the glider wings about the longitudinal axis and reduce aileron control pressure as the wings approach the level position.

Pilot-Induced Yaw Oscillations During Launch

Pilot-induced yaw oscillations are usually caused by overcontrolling the rudder. As with roll oscillations, the problem is the failure of the pilot to recognize that the glider is accelerating and has considerable momentum. If the glider veers away from the towplane, rudder application in the appropriate direction helps correct the situation. If the rudder pressure is held too long, the large yaw momentum of the glider wings and fuselage results in overshooting the desired yaw position and veering off in the opposite direction. Overcompensating for large yaw, the pilot applies considerable rudder pressure in the direction opposite from the original rudder pressure. The alarmed pilot now applies considerable rudder pressure in the direction opposite the original rudder pressure. As the glider continues to accelerate, the power of the rudder increases and the lag time decreases. In extreme cases, the glider may veer off the runway and collide with runway border markers, airport lights, parked glider, or other obstacles. The cure for this type of yaw oscillation is anticipating the momentum of the glider wings and fuselage about the vertical axis and reduce rudder pedal pressure when the nose of the glider begins to yaw in the desired direction in response to rudder inputs. *[Figure 8-3]*

When a glider's wingtip contacts the ground during takeoff roll, an uncommanded yaw results. The drag of the wingtip on the ground induces a yaw in the direction of the grounded wingtip. The yaw usually is mild if the wingtip is on smooth pavement but much more vigorous if the wingtip is dragging through tall grass. If appropriate aileron pressure fails to raise the wingtip off the ground quickly, the only solution is to release the towline and abort the takeoff attempt before losing all control of the glider.

The greater the wing mass is and the longer the wingspan is, the more momentum the glider exhibits whenever roll or yaw oscillations arise. Some very high performance gliders feature remarkably long and heavy wings; once in motion, they tend to remain in motion for a considerable time. This is true not only of forward momentum, but yaw and roll momentum as well. The mass of the wings, coupled with the very long moment arm of large-span wings, results in substantial lag times in response to aileron and rudder inputs

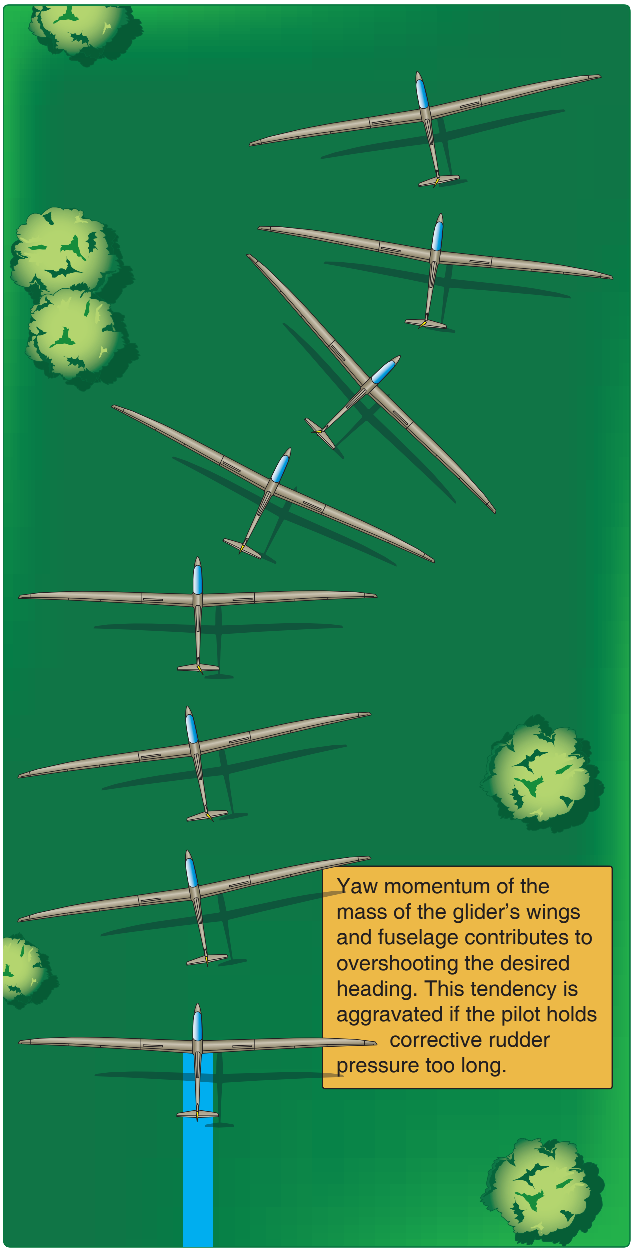

Figure 8-3. *Pilot-induced yaw oscillations during takeoff roll.*

during the early portion of the takeoff roll and during the latter portion of the landing rollout. Even highly proficient glider pilots find takeoffs and landings in these gliders to be challenging. Many of these gliders are designed for racing or cross-country flights and have provisions for adding water ballast to the wings. Adding ballast increases mass, which results in an increase in lag time.

Low time pilots and pilots new to such high performance gliders should review the GFM/POH thoroughly prior to flight. It is also recommended to review normal procedures, emergency procedures, and the glider's fight characteristics with a qualified pilot or instructor pilot before attempting flight in any high performance glider.

Gust-Induced Oscillations

Gusty headwinds can induce pitch oscillations because the effectiveness of the elevator varies due to changes in the speed of the airflow over the elevator. Crosswinds also can induce yaw and roll oscillations. In gusty crosswinds, the effects on glider control change rapidly depending on the speed and rate of the crosswind component. A crosswind from the right, for instance, tends to weathervane the glider into the wind, causing an uncommanded yaw to the right. Crosswinds tend to lift the upwind wing of the glider and push the tail downwind.

Local terrain can have a considerable effect on the wind. Wind blowing over and around obstacles can be gusty and chaotic. Nearby obstacles, such as hangars, groves or lines of trees, hills, and ridges can have a pronounced effect on low altitude winds, particularly on the downwind side of the obstruction. In general, the effect of an upwind obstacle is to induce additional turbulence and gustiness in the wind. These conditions are usually found from the surface to an altitude of 300 feet or more. If flight in these conditions cannot be avoided, the general rule during takeoff is to achieve a faster-than-normal speed prior to lift-off.

The additional speed increases the responsiveness of the controls and simplifies the problem of correcting for turbulence and gusts. This provides a measure of protection against PIOs. The additional speed also provides a safer margin above stall airspeed. This is very desirable on gusty days because variations in the headwind component have a considerable effect on indicated airspeed.

Caution: Do not exceed the glider's tow speed limitations when adding safety speed margins for takeoff in windy conditions.

Vertical Gusts During High-Speed Cruise

Although PIOs occur most commonly during launch, they can occur during cruising flight, even when cruising at high speed. Turbulence usually plays a role in this type of PIO, as does the elasticity and flexibility of the glider structure. An example is an encounter with an abrupt updraft during wings-level high-speed cruise. The upward-blowing gust increases the angle of attack of the wings, which bend upward very quickly, storing elastic energy in the wing spars. For a moment, the G-loading in the cabin is significantly greater than one G. Like a compressed coil spring seeking release, the wing spars reflex downward, lofting the fuselage higher. When the fuselage reaches the top of this motion, the wing spars are storing elastic energy in the downward direction, and the fuselage is sprung downward in response to the release of elastic energy in the wing spars. The pilot then experiences reduced G-load, accompanied perhaps by a head bang against the top of the canopy if the seat belt and shoulder harness are loosely fastened.

During these excursions, the weight of the pilot's hand and arm on the control stick may cause the control stick to move a significant distance forward or aft. During positive G-loading, the increased apparent weight of the pilot's arm tends to move the control stick aft, further increasing the angle of attack of the wing and G-load factor. During negative G-loading, the reduced apparent weight of the pilot's arm tends to result in forward stick motion, reducing the angle of attack and reducing the G-load factor still further. In short, this rapid cycle of induced flight control input affects load factor and increases the intensity of vertical gusts on the glider's airframe and the pilot. One protection against this is to reduce speed when cruising through turbulent air. Another protection is to brace both arms and use both hands on the control stick when cruising through turbulent air at high speed. It is worth noting that some glider designs incorporate a parallelogram control stick linkage to reduce the tendency toward PIO during high-speed cruise.

Pilot-Induced Pitch Oscillations During Landing

Instances of PIO may occur during the landing approach in turbulent air for the same reasons previously stated. Landing the glider involves interacting with ground effect during the flare and keeping precise control of the glider even as airspeed decays and control authority declines. A pilot can cause a PIO by overcontrolling the elevator during the flare, causing the glider to balloon well above the landing surface even as airspeed is decreasing. If the pilot reacts by pushing the stick well forward, the glider will quickly dive for the ground with a fairly rapid rate of descent. If the pilot pulls the control stick back to arrest this descent while still in possession of considerable airspeed, the glider balloons again and the PIO cycle continues. If airspeed is low when the pilot pulls back on the stick to avoid a hard landing, there will probably be insufficient lift available to arrest the descent. A hard or a nose-first landing may result.

To reduce ballooning during the flare, stabilize the glider at an altitude of 3 or 4 feet, and then begin the flare anew. Do not try to force the nose of the glider down on to the runway. If airspeed during the ballooning is low and the ballooning takes the glider higher than a normal flare altitude, it may be necessary to reduce the extension of the spoilers/dive brakes in order to moderate the descent rate of the glider. Care must be taken to avoid abrupt changes. Partial retraction of the spoilers/dive brakes allows the wing to provide a bit more lift despite decaying airspeed.

Another source of PIOs during the approach to landing is overly abrupt adjustment of the spoilers/dive brakes setting. The spoilers/dive brakes on most modern gliders provide a very large amount of drag when fully deployed, and they reduce the lift of the wing considerably. Excessive use of the spoilers/dive brakes during the approach to land can easily lead to oscillations in pitch attitude and airspeed changes. The easiest way to guard against these oscillations is to make smooth adjustments in the spoilers/dive brakes setting whenever spoilers/dive brakes adjustment is necessary. This becomes particularly important during the landing flare just prior to touchdown. A sudden increase in spoilers/dive brakes extension results in a high sink rate and possible hard contact with the runway. This can lead to a rebound into the air, setting the stage for a series of PIOs. As before, the cure is to stabilize the glider, then resume the flare. If the spoilers/dive brakes are retracted abruptly during the flare, the glider will probably balloon into the air because of the increased lift provided by the wings. Remember, spoiler/dive brakes provide drag and reduce lift. This extra lift and pilot reaction may result in overcontrolling and PIOs. The use of spoiler/dive brakes should be determined by flight conditions. If a wind gust has caused the glider to balloon, then spoiler/dive brake use is an option for the pilot to reestablish the flare attitude. If the spoilers/dive brakes must be adjusted, do so with a smooth, gentle motion.

Glider-Induced Oscillations

Pitch Influence of the Glider Towhook Position

The location of the glider's aerotow towhook influences pitch attitude control of the glider during aerotow operations. During these operations, the towline is under considerable tension. If the towline is connected to a glider towhook located more or less directly on the longitudinal axis of the glider, the towline tension has little effect on the pitch attitude of the glider.

On many gliders, the tow hook is located below the cockpit or just forward of the landing gear. Many European gliders have the towhook located on the belly of the glider, just forward of the main landing gear and below the longitudinal axis of the glider. The glider's center of mass is above the location of the towhook in this position. In fact, virtually all of the glider's mass is above the towhook. The mass of the glider has inertia and resists acceleration when the towline tension increases. In these tow hook configurations, an increase in tension on the towline causes an uncommanded pitch-up of the glider nose as shown in *Figure 8-4*. Decrease in towline tension results in an uncommanded pitch-down.

Rapid changes in towline tension, most likely to occur during aerotow in turbulent air, cause these effects in alternation. Naturally, on days when good lift is available, the aerotow is conducted in turbulent air. The potential for inducing pitch

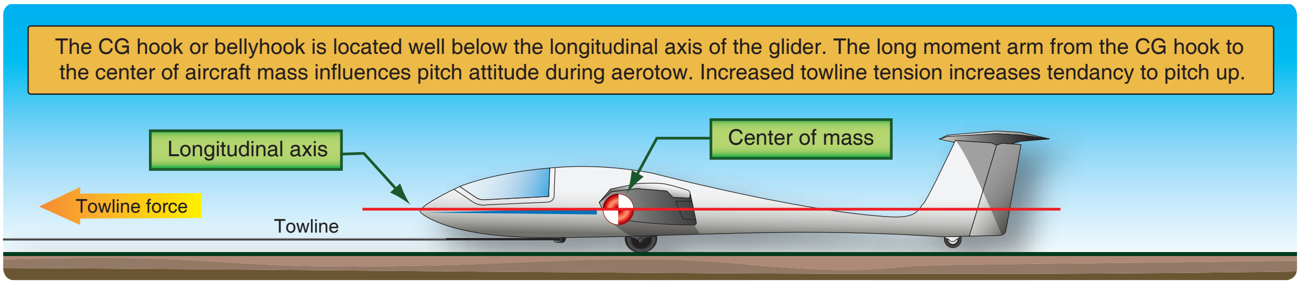

Figure 8-4. *Effects of increased towline tension on pitch altitude of bellyhook-equipped glider during aerotow.*

oscillations is obvious, as rapid alternations in towline tension induce rapid changes in the pitch attitude of the glider. To maintain a steady pitch attitude during aerotow, the pilot must be alert to variations in towline tension and adjust pressure on the flight controls to counteract the pitch effect of variations in towline tension.

Self-Launching Glider Oscillations During Powered Flight

In some self-launching gliders and gliders equipped with a sustainer engine, the engine is extended above the glider just behind the cockpit. The engine's propeller thrust vector is located above the glider's longitudinal axis and center of mass. *[Figure 8-5]* This combination of engine and airframe exhibits a complex relationship between power setting and pitch attitude. When power changes are made, the propeller's thrust line vector has a noticeable effect on the glider's pitch attitude. This includes the effects of propeller wash over the elevator causing variations in elevator effectiveness and adding to the complexities of flight. Prior to flight, study the GFM/POH carefully to discover what these undesired effects are and how to counteract them. When throttle settings must be changed, it is good practice to move the throttle control smoothly and gradually, coordinating with proper flight control input. This gives the pilot time to recognize and counteract the effect the power setting change has on pitch attitude. In most self-launching gliders, the effect is greatest when flying at or near minimum controllable airspeed (VMCA). Self-launching glider pilots should avoid slow flight when flying at low altitude under power. *[Figure 8-5]*

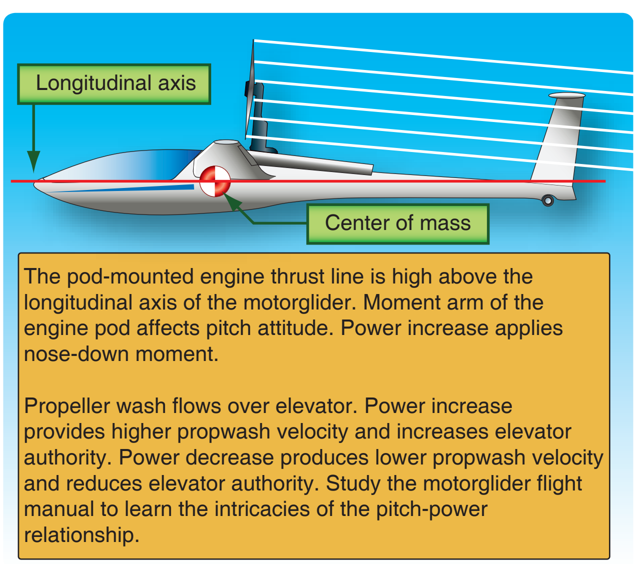

Figure 8-5. *Pitch attitude power setting relationships for self-launching glider with engine pod.*

Self-launching gliders may also be susceptible to PIOs during takeoff roll, particularly those with a pylon engine mounted high above the longitudinal axis. *[Figure 8-5]* The high thrust vector and the propeller wash influence on the air flow over the self-launching glider's elevator may tend to cause considerable change in the pitch attitude of the glider when power changes are made.

Nosewheel Glider Oscillations During Launches and Landings

Many tandem two-seat fiberglass gliders, and some single-seat fiberglass gliders, feature a three-wheel landing gear configuration. The main wheel is equipped with a traditional large pneumatic tire; the tailwheel and the nosewheel are equipped with smaller pneumatic tires. During ground operations, if the pneumatic nosewheel remains in contact with the ground, any bump compresses the nosewheel tire. When the pneumatic nosewheel tire rebounds, an uncommanded pitch-up occurs. If the pitch-up is sufficient, as is likely to be the case after hitting a bump at fast taxi speeds, the tailwheel contacts the runway, compresses, and rebounds. This can result in porpoising, as the nosewheel and tailwheel alternate in hitting the runway, compressing, and rebounding. In extreme cases, the fuselage of the glider may be heavily damaged. During takeoff roll, the best way to avoid porpoising in a nosewheel-equipped glider is to use the elevator to lift the nosewheel off the runway as soon as practicable, then set the pitch attitude so the glider's main wheel is the only wheel in contact with the ground. To avoid porpoising during landing, hold the glider off during the flare until the main wheel and tailwheel touch simultaneously. During roll out, use the elevator to keep the nosewheel off the ground for as long as possible.

Tailwheel/Tailskid Equipped Glider Oscillations During Launches and Landings

Most gliders have a tailwheel. When loaded and ready for flight, these gliders have the main wheel and the tailwheel or tailskid in contact with the ground. In these gliders, the center of gravity is aft of the main wheel(s). Because of this, any upward thrust on the main landing gear tends to pitch the nose of the glider upward unless the tailwheel or tailskid is in contact with the ground and prevents the change in pitch attitude.

Upward thrust on the main landing gear can occur in numerous circumstances. One cause is a bump in the runway surface during takeoff or landing roll. If the resultant pitch-up is vigorous enough, it is likely that the glider leaves the ground momentarily. If airspeed is slow, the elevator control is marginal. As the pilot reacts to the unexpected bounce or launch, overcontrolling the elevator results in a PIO. *[Figure 8-6]*

Improper landing technique in a tailwheel glider also can lead to upward thrust on the main landing gear and subsequent PIOs. Landing a tailwheel glider in a nose-down attitude, or even in a level pitch attitude, can lead to trouble. If the main wheel contacts the ground before the tailwheel or tailskid, the compression of the pneumatic tire and its inevitable rebound provides significant upward thrust. The glider nose may pitch up, the angle of attack increases, and the glider becomes airborne. As before, overcontrol of the elevator leads to PIOs.

To prevent this type of PIO, do not allow the glider to settle onto the landing surface with a nose-down attitude or with excess airspeed. During the landing flare, hold the glider a few inches above the ground with gentle backpressure on the control stick as necessary. The speed decays and the pitch attitude gradually changes to a slightly nose-up pitch attitude. The ideal touchdown is simultaneous gentle contact of main wheel and tailwheel or tailskid. Delaying the touchdown just a small amount results in the tailwheel or tailskid contacting the landing surface an instant before the mainwheel. This type of landing may be acceptable and desirable for many tailwheel gliders because it makes a rebound into the air very unlikely. Consult the GFM/POH for the glider being flown for further information about recommended procedure for touchdown.

Aerotow Abnormal and Emergency Procedures

Abnormal Procedures

Mechanical equipment failure, environmental factors, and pilot error can cause abnormal aerotow occurrences during climb-out. Mechanical equipment failures can be caused by towline and towhook failures, towplane mechanical failures, and glider mechanical failures. Towline failure (one that breaks unexpectedly) can result from using a weak or worn towline. Towline failures can be avoided by using appropriately rated towline material, weak links when necessary, proper tow rings, and proper towline maintenance.

Towhook system failures include uncommanded towline releases or the inability to release. These failures can occur in either the towplane or the glider towhook system. Proper preflight and maintenance of these systems should help to avoid these types of failures. Towplane mechanical failures can involve the powerplant or airframe. When the tow pilot or glider pilot encounters a mechanical failure, he or she should signal the glider pilot to release immediately. *[Figure 8-7]* This is one of many situations that make it vitally important that both the tow pilot and glider pilot have a thorough knowledge of aerotow visual signals.

Glider mechanical failure can include towhook system malfunctions, flight control problems, and improper assembly or rigging. If a mechanical failure occurs, the glider pilot must assess the situation to determine the best course of action. In some situations, it may be beneficial to remain on the aerotow, while other situations may require immediate release.

If the glider release mechanism fails, the tow pilot should be notified either by radio or tow signal and the glider should maintain the high tow position. The tow pilot should tow the glider over the gliderport/airport and release the glider from the towplane. The towline should fall back and below the glider. The design of the Schweizer towhook mechanism is such that the line pulls free from the glider by its own weight.

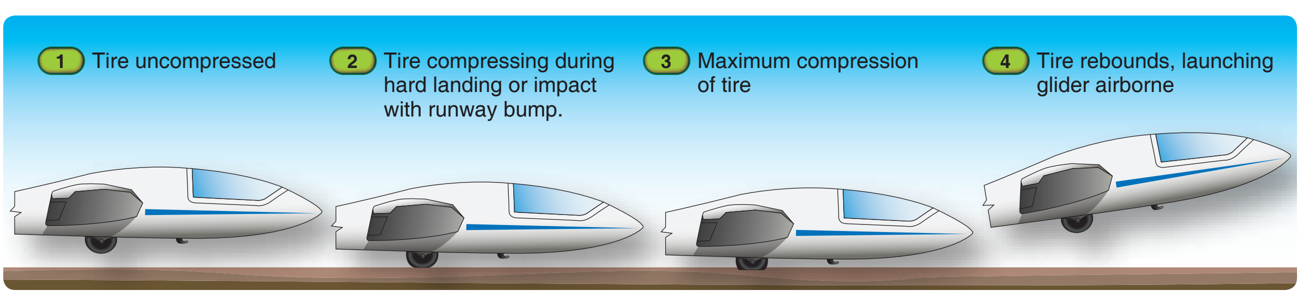

Figure 8-6. *Pneumatic tire rebound.*

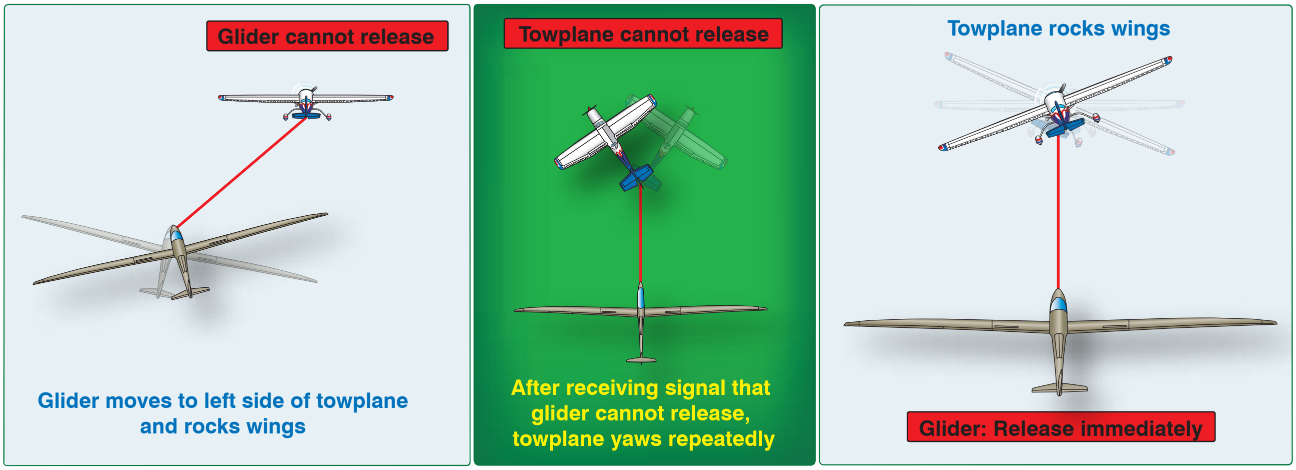

Figure 8-7. *Towplane and glider signal due to release mechanism failure.*

Since some gliders do not back release, the glider pilot should pull the release to ensure the towline is in fact released.

Towplanes are usually fitted with a variant of the Schweizer or Tost glider tow hitch. *[Figures 8-8* and *8-9]* The hitch is usually located at the extreme end of the rear fuselage below the rudder. The specific rings used to attach towlines to these hitch types can be seen in *Figure 8-10*. The wing runner must be familiar with the correct method of attachment. If the towplane has the Schweizer tow hitch, it is possible for the tow ring to rotate forward so that it traps the sleeve that locks the tow hitch in place. This may prevent the tow pilot from releasing the towline. *[Figure 8-11]*

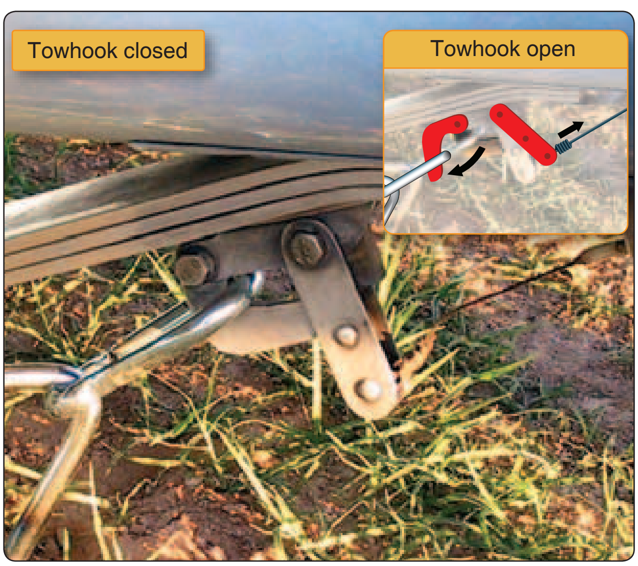

Figure 8-8. *A Schweizer tow hitch.*

Failure of both towplane and glider release mechanisms is extremely rare. If it occurs, however, radio or tow signals between glider pilot and tow pilot should verify this situation. The glider pilot should move down to the low tow position

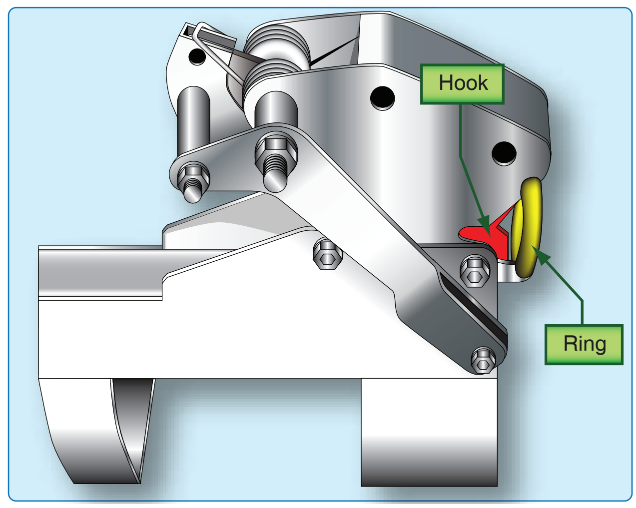

Figure 8-9. *A Tost tow hitch.*

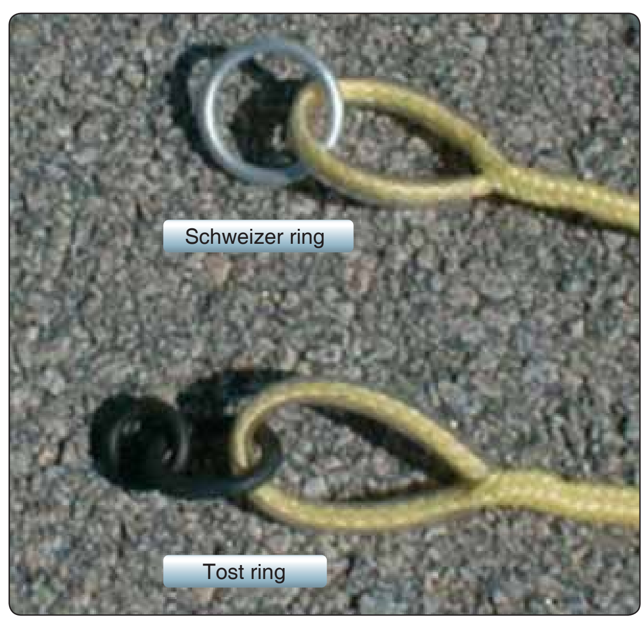

Figure 8-10. *Examples of Schweizer and Tost tow rings.*

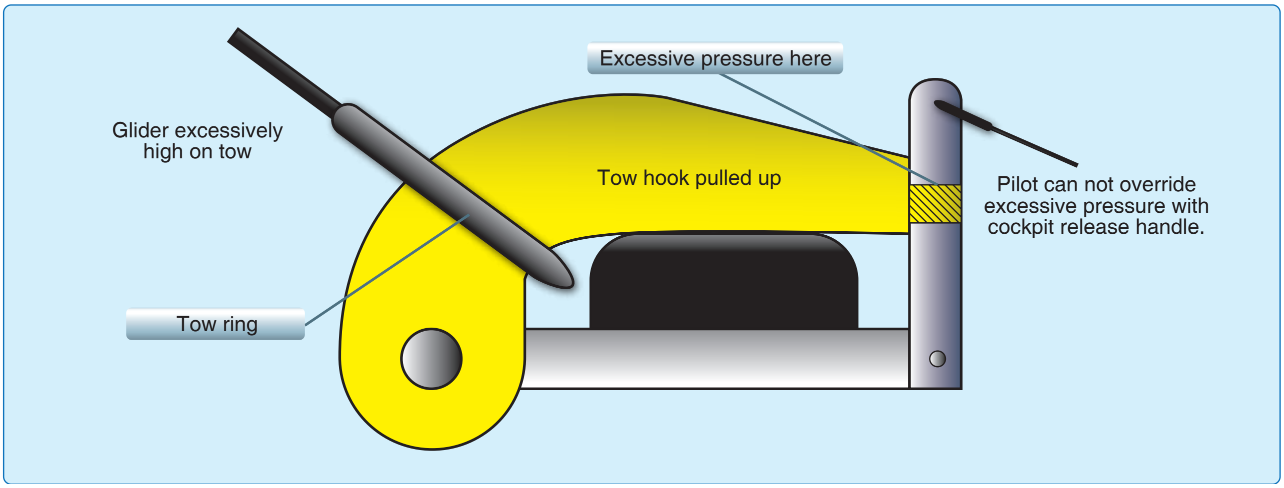

Figure 8-11 *A Schweizer tow hitch.*

once the descent has started to the gliderport/airport. The glider pilot needs to use spoilers/dive brakes to maintain the low tow position and to avoid overtaking the towplane. The tow pilot should plan the approach to avoid obstacles. The approach should be shallow enough for the glider to touch down first. The glider pilot should use the spoilers/dive brakes to stay on the runway, and use the wheel brake as necessary to avoid overtaking the towplane. Excessive use of the glider wheel brake may result in a hard landing for the towplane because the towline could slow the towplane below flying speed. Another valid method would be to stay on tow until well within gliding distance of the airport and then breaking the towline. The best experience to date suggests the procedure to break the towline would be by climbing above and diving down to develop slackline, then fully extending the dive brakes and/or spoilers to set up the overload condition as the towplane begins to accelerate without the load of the glider and the glider is decelerating due to the increase in drag. Once the towline breaks, the glider lands using the procedures of having the line attached, in case the line did not break at the gliders weak link.

Environmental factors for terminating the tow include encountering clouds, mountain rotors (area of turbulence created by wind and mountainous terrain), or restricted visibility. Any of these factors may require the glider pilot to release from the aerotow. During the aerotow, each pilot is responsible for avoiding situations that would place the other pilot at risk.

For the towplane pilot, examples of pilot error include deliberately starting the takeoff before the glider pilot has signaled the glider is ready for launch, using steep banks during the aerotow without prior consent of the glider pilot, or frivolous use of aerotow signals, such as "release immediately!" For the glider pilot, examples of pilot error include rising high above the towplane during takeoff and climb or leaving air brakes open during takeoff and climb.

The glider pilot may choose to deliberately terminate the tow/launch anytime it may appear to be a safer course of action. For example, the pilot discovers control binding once air pressure builds on the surfaces, releasing the towline is the better alternative than getting too high to stop and too low to bailout.

Towing Failures

Premature terminations of the tow have been a leading cause of glider accidents and incidents according to the Soaring Safety Foundation. Towing failure incidents related to rope breaks are not as common as other distractions in the glider cockpit. Extension of spoilers/dive brakes, unlocked canopies, and other distractions are major causes of the tow failure incidents leading to a towline break. Prevention is achieved with the proper use checklists and proper prelaunch discipline. There are five planning situations regarding in-motion towline breaks, uncommanded release, or power loss of the towplane and are listed below. While the best course of action depends on many variables, such as runway length, airport environment, density altitude, and wind, all tow failures or emergency release have one thing in common: the need to maintain control of the glider. Two possibilities are stalling the glider or dragging a wingtip on the ground during a low altitude turn.

On takeoff, all towplanes may plan to drift downwind if there is a wind present. If there is no wind or traffic, then the tow pilot should select an area on the take path/profile that has the fewest obstacles for both the towplane and glider. The tow pilot should plan to drift in that direction. This downwind drift does a few things for the glider pilot, the most important of which is that it ensures the glider has maneuverability if a tow failure occurs. This downwind drift allows the glider pilot to complete the course reversal without the need of extensive lower altitude turns to line up on the runway, reducing the possibility of dragging a glider wingtip on the ground during a low altitude turn. The tow pilot must initiate this drift. Remember, tow pilots need to know wind direction and plan accordingly to allow the glider pilot maneuverability options.

If the towplane proceeds straight out, the glider pilot may need to make the last alignment turn at a low altitude. The first turn is the course reversal; a second turn aligns the glider with the landing area. As mentioned, the low altitude turn may be difficult or impossible to complete. Winds may compound the situation if the turn is not planned properly. Pilots under these high-stress conditions sometimes cross-control the glider, compounding the issue. Remember, keep the yaw string or ball centered.

Tow Failure With Runway To Land and Stop

If a tow failure occurs or is inadvertently or deliberately released prior to towplane liftoff, the standard procedure is for the towplane either to continue the takeoff and clear the runway or abort the takeoff and remain on the left side of the runway. If the towplane loses power during the takeoff, the tow pilot should maneuver the towplane to the left side of the runway. If the glider is still on the runway, the glider pilot should pull the release, decelerate using the wheel brake, and be prepared to maneuver to the right side of the runway. If the line breaks, is inadvertently released, or the towplane loses power after the glider is airborne, the glider pilot should pull the towline release, land ahead, and be prepared to maneuver to the right side of the runway. *[Figure 8-12, panel 1]* Pulling the towline release in either case ensures that the rope is clear of the glider. Since local procedures vary, both glider pilot and tow pilot must be familiar with the specific gliderport/airport procedures.

Tow Failure Without Runway To Land Below Returning Altitude

If an inadvertent release, towline break, or a signal to release from the towplane occurs at a point at which the glider has insufficient runway directly ahead and has insufficient altitude (200 feet above ground level AGL) to make a safe turn, the best course of action is to land the glider ahead. *[Figure 8-12, panel 2]* When flying at higher elevations, a higher altitude return may be necessary to return to the runway due to increased ground speed and air density. After touchdown, use the wheel brake to slow and stop as conditions permit. Attempting to turn at low altitude prior to landing is very risky because of the likelihood of dragging a wingtip on the ground or stalling the glider. Landing ahead and slowing the glider as much as possible prior to touching down and rolling onto unknown terrain is usually the safest course of action. Low speed means low impact forces, which reduce both the likelihood of injury and risk of significant damage to the glider. Gliders pilots should always be looking on both sides and ahead trying to plan for the best area to land in the event of a premature landing. The greater amount of altitude the glider pilot has the greater number of options that are open to them during an emergency. Landing under control is always preferable to the “perfect” landing area almost within glide distance.

Tow Failure Above Return to Runway Altitude

A downwind landing on the departure runway may be attempted if an inadvertent release, towline break, or signal to release from the towplane occurs after the towplane and glider are airborne, and the glider possesses sufficient altitude to make a course reversal, which is determined by wind crab angle, wind velocity, and glider groundspeed. *[Figure 8-12, panel 3]*

The course reversal and downwind landing option should be used only if the glider is within gliding distance of the airport or landing area. In ideal conditions, a minimum altitude of 200 feet above ground level (AGL) is required to complete this maneuver safely. Such factors as a hot day, weak towplane, strong wind, or other traffic may require a greater altitude to make a return to the airport a viable option.

The responsibility of the glider pilot is to avoid the towplane, if the tow is terminated due to a towplane emergency; the tow pilot is also dealing with an emergency situation and may maneuver the aircraft abruptly. The glider pilot should never follow the towplane down if the towplane is experiencing engine problems or engine failure.

After releasing from the towplane at low altitude, if the glider pilot chooses to make a turn of approximately 180° and a downwind landing, the first responsibility is to maintain flying speed. The pilot must immediately lower the nose to achieve the proper pitch attitude necessary to maintain the appropriate approach airspeed. If a rope break occurred in the process, the glider pilot should release the rope portion still attached to the glider to avoid any entanglement on landing with the glider.

Make the initial turn into the wind. Use a 45° to 60° bank angle as necessary to make the course reversal to the departure. This provides a safe margin above stall speed and allows a course reversal turn to be completed in a timely manner. Using a bank angle that is too shallow may not allow enough time for the glider to align with the landing area. An excessively steep bank angle may result in an accelerated stall or wingtip ground contact. If the turn is made into the wind, only minor course corrections should be necessary to align the glider with the intended landing area

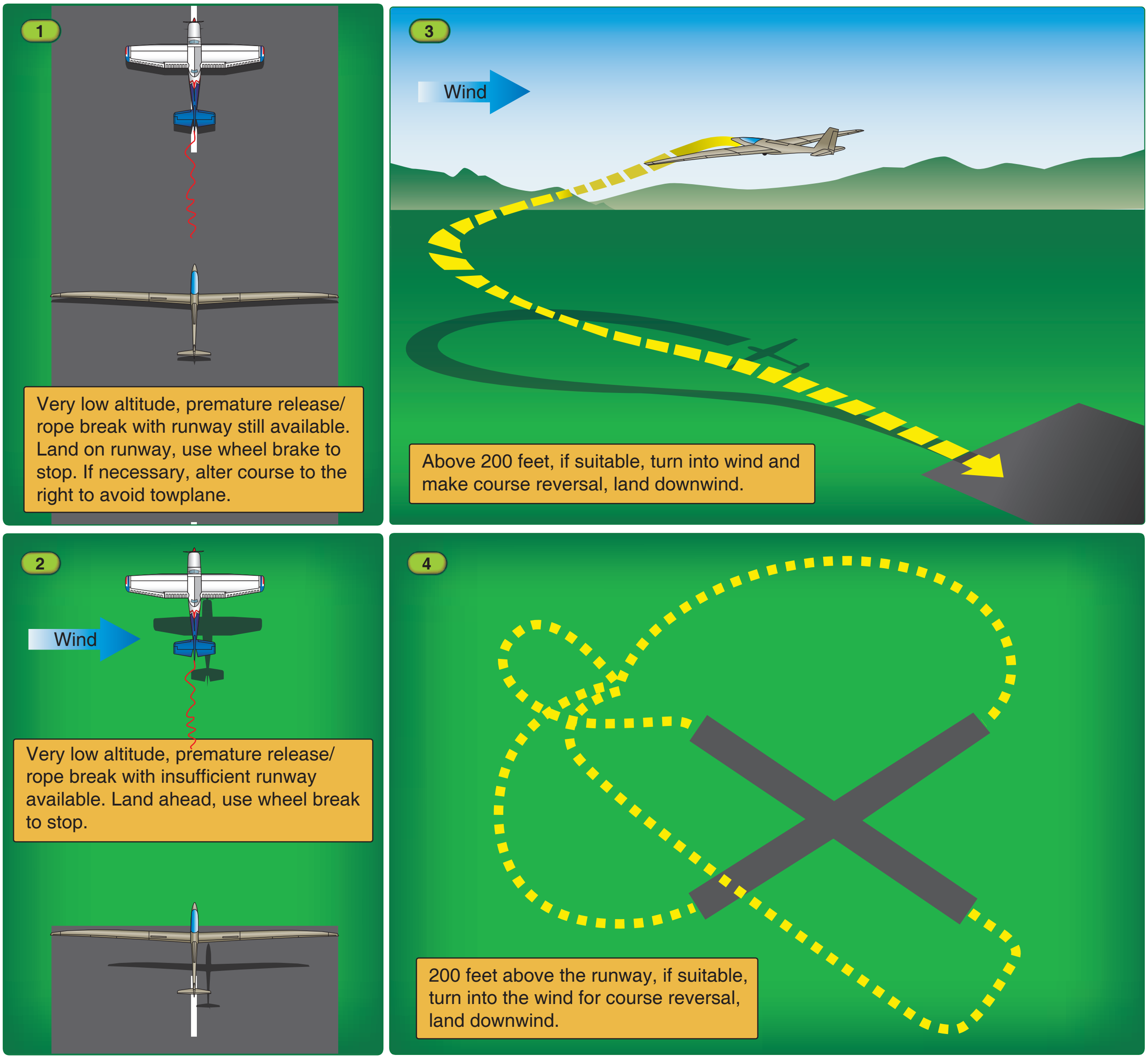

Figure 8-12. *Situations for towline break, uncommanded release, or power loss of the towplane.*

if the glider was allowed to drift downwind. Throughout the maneuver, the pilot must maintain the appropriate approach speed and proper coordination. Remember to keep the yaw string straight and ball centered (see Turns section for more information on the yaw string).

Downwind landings result in higher groundspeed due to the effect of tailwind. The glider pilot must maintain the appropriate approach airspeed. During the straight-in portion of the approach, spoilers/dive brakes should be used as necessary to control the descent path. Landing downwind results in a shallower than normal approach. Groundspeed is higher during a downwind landing and is especially noticeable during the flare. After touchdown, spoilers/dive brakes and wheel brakes should be used as necessary to slow and stop the glider as quickly as possible. During the later part of the rollout, the glider feels unresponsive to the controls despite the fact that it is rolling along the runway at a higher than normal groundspeed. It is important to stop the glider before any loss of directional control.

Tow Failure Above 800' AGL

When the emergency occurs at or above 800 feet above the ground, the glider pilot may have more time to assess the situation. Depending on the gliderport/airport environment, the pilot may choose to land on a cross runway, into the wind on the departure runway, or on a taxiway. *[Figure 8-12, panel 4]* In some situations, an off-gliderport/ off-airport landing may be safer than attempting to land on the gliderport/airport.

Tow Failure Above Traffic Pattern Altitude

If an emergency occurs above the traffic pattern altitude, the glider pilot should maneuver away from the towplane, release the towline if still attached, and turn toward the gliderport/airport. The glider pilot should evaluate the situation to determine if there is sufficient altitude to search for lift or if it is necessary to return to the gliderport/airport for a landing. Pilots should remember their obligation when dropping objects from an aircraft according to Title 14 of the Code of Federal Regulations part 91, section 91.15, and not create a hazard to persons and property on the ground. *[Figure 8-12, panel 4]*

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 8-13]*

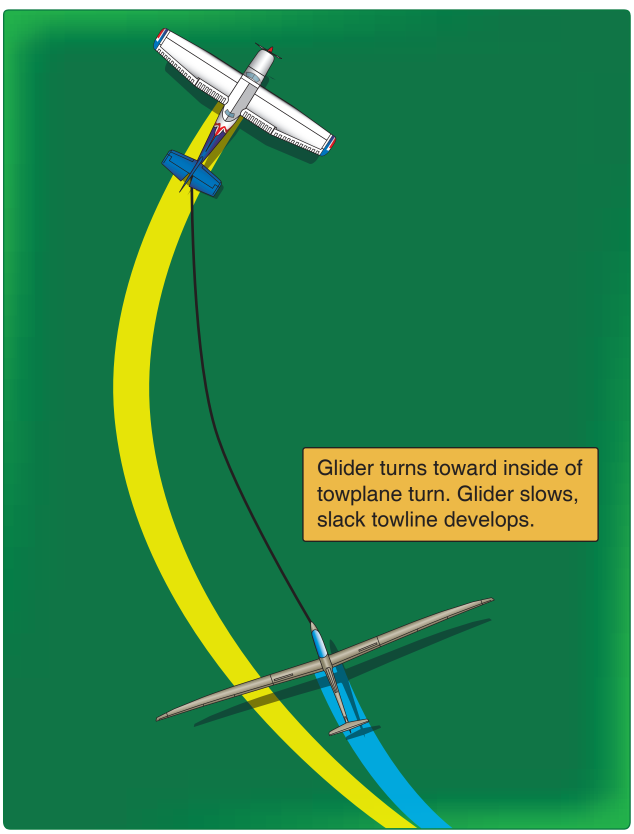

Figure 8-13. *Glider bank is steeper than that of towplane, causing slack in towline.*

- Updrafts and downdrafts
- Abrupt recovery from a wake box corner position *[Figure 8-14]*

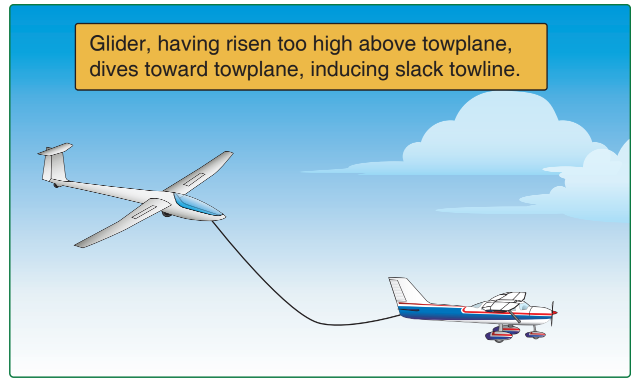

Figure 8-14. *One method of generating towline slack.*

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 by increasing drag.

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 motion fails to reduce the slack sufficiently, careful use of spoilers/dive brakes can decelerate the glider and take up the slack. As the towline begins to tighten, 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.
- Failure to decrease drag as towline slack decreases.

Ground Launch Abnormal and Emergency Procedures

Abnormal Procedures

The launch equipment operator manages ground launch towline speed. Because the launch equipment operator is remote from the glider, it is not uncommon for initial tow to be too fast or too slow. If the towline speed is too great, the glider is not able to climb very high because of excessive airspeed. If the towline speed is too low, the glider may be incapable of lift-off or could stall after becoming airborne. Once airborne, the glider could be incapable of further climb. The pilot should use appropriate signals to direct the launch operator to increase or decrease speed. The pilot must anticipate and be prepared to deal with these situations. In the event these abnormal situations develop, the pilot's only alternative may be to release the towline and land ahead.

Wind gradient (a sudden increase in windspeed with height) can have a noticeable effect on ground launches. If the wind gradient is significant or sudden, or both, and the pilot maintains the same pitch attitude, indicated airspeed increases that could exceed the maximum ground launch tow speed could occur. The pilot must adjust the airspeed to deal with the effect of the gradient. When encountering a wind gradient, the pilot should push forward on the stick to reduce the indicated airspeed. *[Figure 8-15]* The only way for the glider to resume climb without exceeding the maximum ground launch airspeed is for the pilot to signal the launch operator to reduce tow speed. After the reduction of the towing speed, the pilot can resume normal climb. If the tow speed is not reduced, the glider may be incapable of climbing to safe altitude.

Ground launch may be interrupted by a ground launch mechanism malfunction. A gradual deceleration in rate of climb and/or airspeed may be an indication of such a malfunction. If a launch mechanism malfunction is suspected, release and land ahead.

Emergency Procedures

A broken towline is the most common type of problem when doing a ground launch. *[Figure 8-16]* When there is a towline failure, the glider pilot must pull the release handle and immediately lower the nose of the glider to achieve and maintain a safe airspeed. The distinguishing features of the ground launch are nose-high pitch attitude and a relatively low altitude for a significant portion of the launch and climb. If a towline break occurs and the glider pilot fails to respond promptly, the nose-high attitude of the glider may result in a stall. Altitude may be insufficient for recovery unless the pilot recognizes and responds to the towline break by lowering the nose.

If the glider tow release mechanism fails, the pilot should fly at airspeeds no lower than best lift over drag (L/D) airspeed. He or she should fly over and then past the ground launch equipment. This method allows the glider towhook back release to activate or the towline weak link to fail. The ground launch equipment is also equipped with an emergency release mechanism in the event the glider tow release fails. If a winch is used, it is equipped with a guillotine to cut the towline. If a motor vehicle is used as a ground launch, it should be equipped with some form of backup release mechanism.

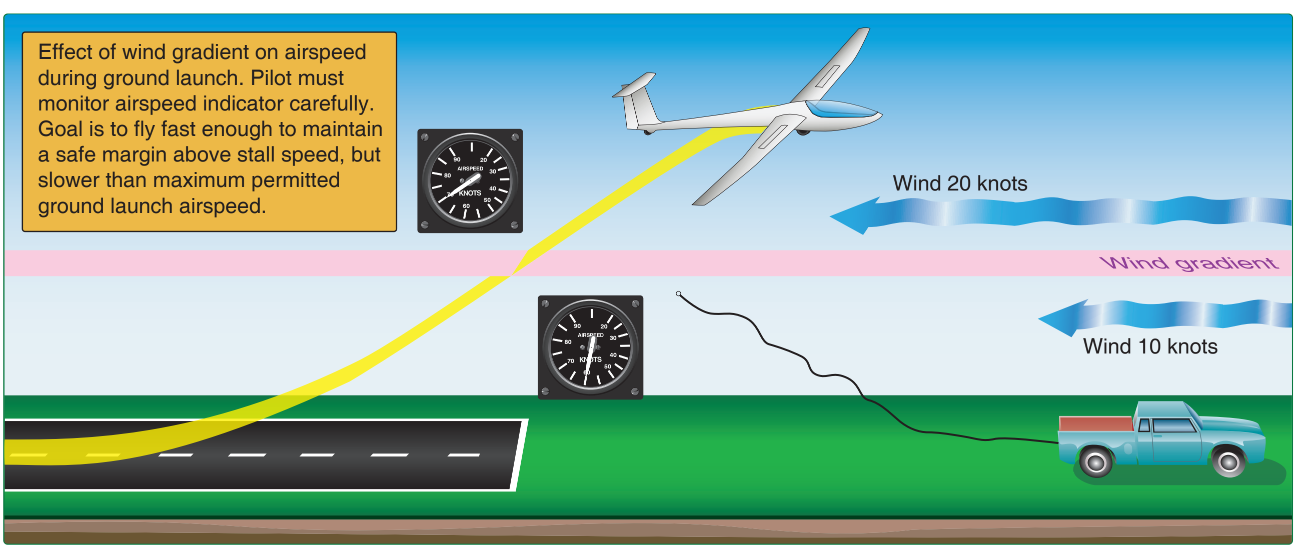

Figure 8-15. *Ground launch wind gradient.*

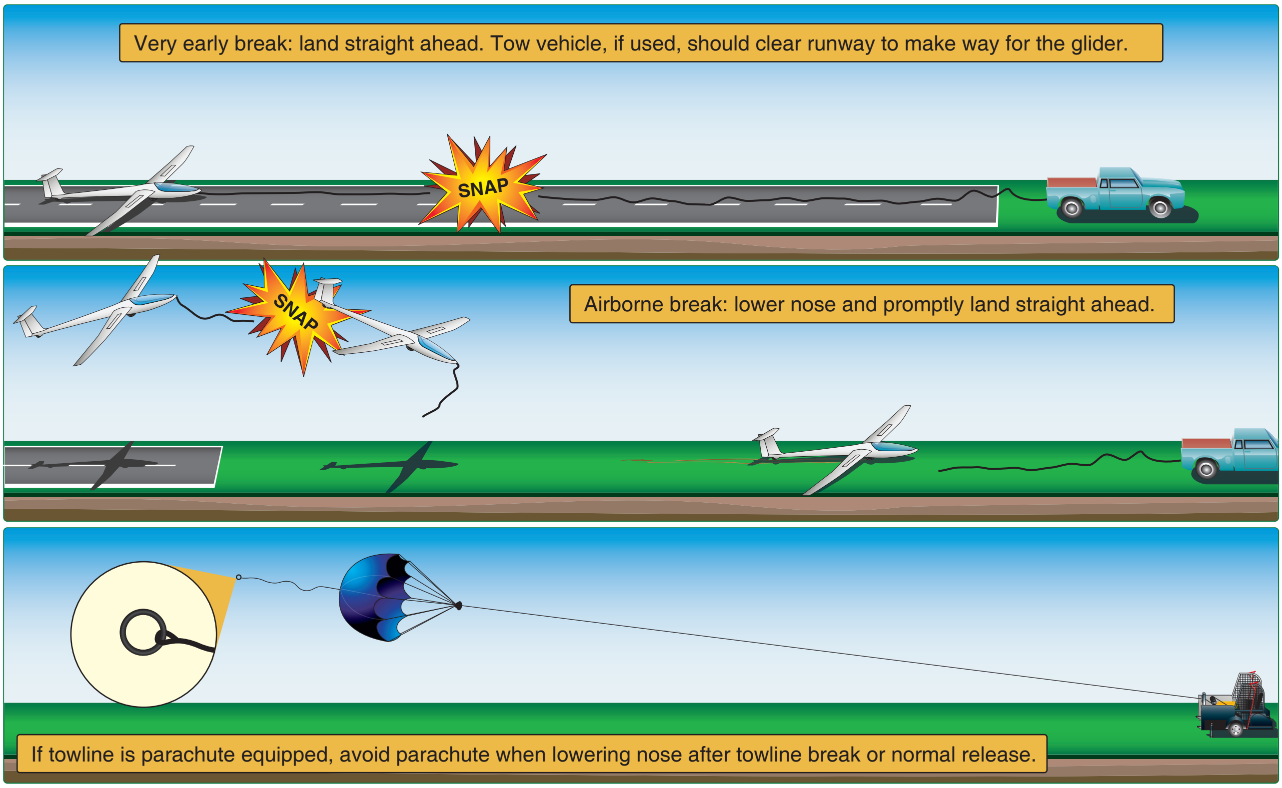

Figure 8-16. *Ground launch towline break.*

Self-Launch Takeoff Emergency Procedures

Emergency Procedures

The pilot of a self-launching glider should formulate emergency plans for any type of failure that might occur. Thorough knowledge of aircraft performance data, normal takeoff/landing procedures, and emergency procedures as outlined in the GFM/POH are essential to the successful management of any emergency situation.

Mismanagement of the aircraft systems through lack of knowledge may cause serious difficulty. For instance, if the spoilers/dive brakes are allowed to open during takeoff and climb, the self-launching glider may be incapable of generating sufficient power to continue climbing. Other emergency situations may include inflight fire, structural failure, encounters with severe turbulence/wind shear, canopy failure, and inadvertent encounter with instrument meteorological conditions (IMC).

Possible options for handling emergencies are influenced by the altitude above the terrain, wind, and weather conditions. As a part of preflight planning, pilots should review the effects of density altitude on glider performance. The takeoff runway length and landing areas near the gliderport and existing air traffic affect the pilot's approach and landing decision. Emergency options may include landing ahead on the remaining runway, landing off field, or returning to the gliderport to land on an available runway. The appropriate emergency procedures may be found in the GFM/POH for the specific self-launching glider.

Spiral Dives

Allowing the nose of the glider to get excessively low during a steep turn may result in a significant increase in airspeed and loss in altitude, creating a spiral dive. If the pilot attempts to recover from this situation by applying only back elevator pressure, the limiting load factor may be exceeded, causing structural failure. To recover from a spiral dive properly, the pilot should first reduce the angle of bank with coordinated use of the rudder and aileron, then smoothly increase pitch to the proper attitude.

Common errors during spiral dives include:

- Failure to recognize when a spiral dive is developing.
- Rough, abrupt, and/or uncoordinated control application during recovery.
- Improper sequence of control applications.

Spins

All flight instructor applicants must be proficient in spins. A spin may be defined as an aggravated stall that results in autorotation wherein the glider follows a downward corkscrew path. As the glider rotates around a vertical axis, the rising wing is less stalled than the descending wing, creating a rolling, yawing, and pitching motion. The glider is basically being forced downward by rolling, yawing, and pitching in a spiral path. *[Figure 8-17]*

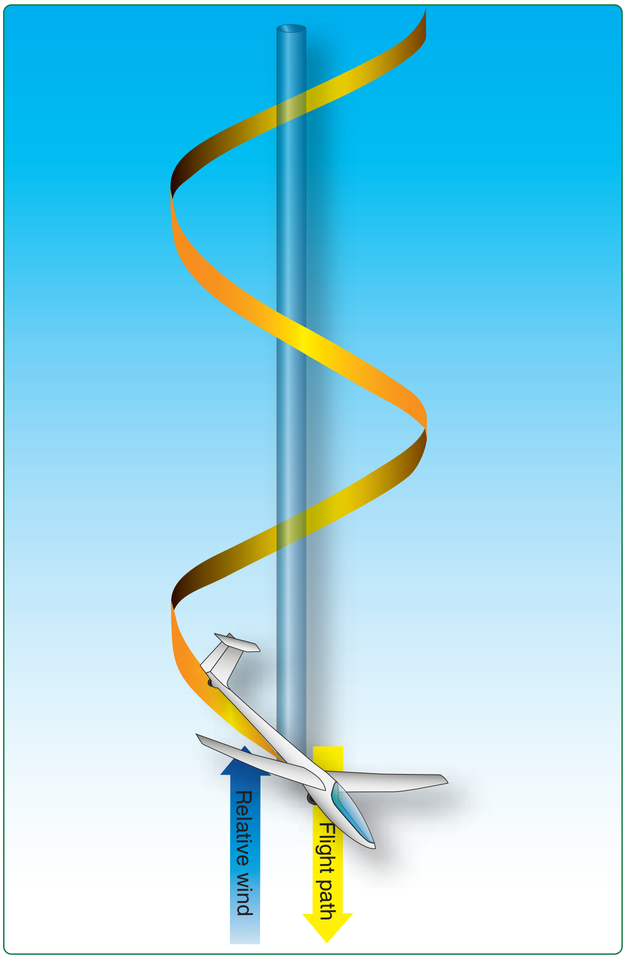

Figure 8-17. *Autorotation of spinning glider.*

The autorotation results from an unequal angle of attack on the glider's wings. The rising wing has a decreasing angle of attack in which the relative lift increases and the drag decreases. In effect, this wing is less stalled. Meanwhile, the descending wing has an increasing angle of attack, past the wing's critical angle of attack (stall) where the relative lift decreases and drag increases.

A spin is caused when the glider's wing exceeds its critical angle of attack (stall) with a sideslip or yaw acting on the glider at, or beyond, the actual stall. During this uncoordinated maneuver, a pilot may not be aware that a critical angle of attack has been exceeded until the glider yaws out of control toward the lowering wing. If stall recovery is not initiated immediately, the glider may enter a spin. If this stall occurs while the glider is in a slipping or skidding turn, this can result in a spin entry and rotation in the direction that the rudder is being applied, regardless of which wingtip is raised.

Many gliders must be forced to spin and require good judgment and technique to get the spin started. These same gliders may be put into a spin accidentally by mishandling the controls in turns, stalls, and flight at minimum controllable airspeeds. This fact is additional evidence of the necessity for the practice of stalls until the ability to recognize and recover from them is developed.

Often a wing drops at the beginning of a stall. When this happens, the nose attempts to move (yaw) in the direction of the low wing. This is when use of the rudder is important during a stall. The correct amount of opposite rudder must be applied to keep the nose from yawing toward the low wing. By maintaining directional control and not allowing the nose to yaw toward the low wing before stall recovery is initiated, a spin is averted. If the nose is allowed to yaw during the stall, the glider begins to skid in the direction of the lowered wing and enters a spin.

A glider must be stalled in order to enter a spin; therefore, continued practice of stall recognition helps the pilot develop a more instinctive and prompt reaction in recognizing an approaching spin. It is essential to learn to apply immediate corrective action any time it is apparent the glider is approaching spin conditions. If it is impossible to avoid a spin, the pilot should immediately execute spin recovery procedures.

The flight instructor should demonstrate spins and spin recovery techniques with emphasis on any special spin procedures or techniques required for a particular glider. Before beginning any spin operations, the following items should be reviewed:

- GFM/POH limitations section, placards, or type certification data sheet, to determine if the glider is approved for spins
- Weight and balance limitations
- Proper recommended entry and recovery procedures
- The requirements for parachutes. It would be appropriate to review current Title 14 of the Code of Federal Regulations (14 CFR) part 91 for the latest parachute requirements.

A thorough glider preflight should be accomplished with special emphasis on excess or loose items that may affect the weight, CG, and controllability of the glider. Slack or loose control cables (particularly rudder and elevator) could prevent full antispin control deflections and delay or preclude recovery in some gliders.

Prior to beginning spin training, the flight area above and below the glider must be clear of other air traffic. Clearing the area may be accomplished while slowing the glider for the spin entry. All spin training should be initiated at an altitude high enough for a completed recovery at or above 1,500 feet AGL within gliding distance of a landing area. There are four phases of a spin: entry, incipient, developed, and recovery.

Entry Phase

In the entry phase, the pilot provides the necessary elements for the spin, either accidentally or intentionally. The entry procedure for demonstrating a spin is similar to a stall. As the glider approaches a stall, smoothly apply full rudder in the direction of the desired spin rotation while applying full back (up) elevator to the limit of travel. Always maintain the ailerons in the neutral position during the spin procedure unless the GFM/POH specifies otherwise.

Incipient Phase

The incipient phase takes place between the time the glider stalls and rotation starts until the spin has fully developed. This change may take up to two turns for most gliders. An incipient spin that is not allowed to develop into a steady-state spin is the most commonly used in the introduction to spin training and recovery techniques. In this phase, the aerodynamic and inertial forces have not achieved a balance. As the incipient spin develops, the indicated airspeed should be near or below stall airspeed. The incipient spin recovery procedure should be commenced prior to the completion of 360° of rotation. The pilot should apply full rudder opposite the direction of rotation.

Developed Phase

The developed phase occurs when the glider's angular rotation rate, airspeed, and vertical speed are stabilized while in a flightpath that is nearly vertical. This is, when glider aerodynamic forces and inertial forces are in balance and the attitude, angles, and self-sustaining motions about the vertical axis are constant or repetitive, the spin is in equilibrium.

Recovery Phase

The recovery phase occurs when the angle of attack of the wings drops below the critical angle of attack and autorotation slows. Then, the nose drops below the spin pitch attitude and rotation stops. This phase may last for a quarter turn to several turns. To recover, control inputs are initiated to disrupt the spin equilibrium by stopping the rotation and stall. To accomplish spin recovery, the manufacturer's recommended procedures should be followed. In the absence of the manufacturer's recommended spin recovery procedures, the following steps for general spin recovery are recommended:

1. Position the ailerons to neutral. Ailerons may have an adverse effect on spin recovery. Aileron control in the direction of the spin may increase the rate of rotation and delay the recovery. Aileron control opposite the direction of the spin may cause the down aileron to move the wing deeper into the stall and aggravate the situation. The best procedure is to ensure that the ailerons are neutral. If the flaps are extended prior to the spin, they should be retracted as soon as possible after spin entry.
2. Apply full opposite rudder against the rotation. Ensure that full (against the stop) opposite rudder has been applied.
3. When rotation stops, apply a positive and brisk, straightforward movement of the elevator control past neutral to break the stall. The forceful movement of the elevator decreases the excessive angle of attack and breaks the stall. The controls should be held firmly in this position.
4. After spin rotation stops, neutralize the rudder. If the rudder is not neutralized at this time, the ensuing increased airspeed acting upon a deflected rudder causes a yawing effect. Slow and overly cautious control movements during spin recovery must be avoided. In certain cases, it has been found that such movements result in the glider continuing to spin indefinitely, even with antispin inputs. A brisk and positive technique, on the other hand, results in a more positive spin recovery.
5. Begin applying back-elevator pressure to raise the nose to level flight. Caution must be used not to apply excessive back-elevator pressure after the rotation stops. Excessive back-elevator pressure can cause a secondary stall and result in another spin. Care should be taken not to exceed the G-load limits and airspeed limitations during recovery.

It is important to remember that the above spin recovery procedures are recommended for use only in the absence of the manufacturer's procedures. Before any pilot attempts to begin spin training, the pilot must be familiar with the procedures provided by the manufacturer for spin recovery.

The most common problems in spin recovery include pilot confusion in determining the direction of spin rotation and whether the maneuver is a spin or a spiral. If the airspeed is increasing, the glider is no longer in a spin but in a spiral. In a spin, the glider is stalled and the airspeed is at or below stalling speed.

Common errors when encountering/practicing spins include:

- Failure to clear area before a spin.

- Failure to establish proper configuration prior to spin entry.
- Failure to correct airspeed for spin entry.
- Failure to recognize conditions leading to a spin.
- Failure to achieve and maintain stall during spin entry.
- Improper use of controls during spin entry, rotation, and/or recovery.
- Disorientation during spin.
- Failure to distinguish a spiral dive from a spin.
- Excessive speed or secondary stall during spin recovery.
- Failure to recover with minimum loss of altitude.
- Failure to recover above minimum altitude with a landing area within gliding distance.

Off-Field Landing Procedures

The possibility of an off-field landing is present on virtually every cross-country soaring flight, even when flying in a self-launching glider. If the engine or power system fails and there is no airport within gliding range, an off-field landing may be inevitable. It should be noted that many glider pilots not flying cross-country have faced the necessity of performing an off-field landing. Causes of off-field landings while soaring in the vicinity of the launching airport, include rapid weather deterioration, a significant change in wind direction, unanticipated amounts of sinking air, disorientation, lack of situational awareness, tow failures, and other emergencies requiring an off-field landing. In these situations, it usually is safer to make a precautionary off-field landing than it is to attempt a low, straight-in approach to the airport. If the glide back to the airport comes up short for any reason, the landing is likely to be poorly executed and may result in damage to the glider or injury to the pilot.

On cross-country soaring flights, off-field landings are not usually considered emergency landings. As a matter of fact, they are expected and are considered while preparing for flight. On the other hand, if equipment failure leads to the necessity of performing an off-field landing, then the landing can be characterized or described as an emergency landing. Whatever the reason for the off-field landing, each glider pilot must be prepared at all times to plan and execute the landing safely.

Unlike airport landings, no off-field landing is entirely routine. An extra measure of care must be undertaken to achieve a safe outcome. The basic ingredients for a successful off-field landing are awareness of wind direction, wind strength at the surface, and approach path obstacles. The glider pilot must be able to identify suitable landing areas, have the discipline to select a suitable landing area while height remains to allow sufficient time to perform a safe approach and landing, and the ability to make consistently accurate landings in the glider type being flown.

These basic ingredients for a successful off-field landing can be summarized as follows:

- Recognizing the possibility of imminent off-field landing.
- Selecting a suitable area, then a suitable landing field within that area.
- Planning the approach with wind, obstacles, and local terrain in mind.
- Executing the approach, land, and then stopping the glider as soon as possible.
- Attempting to contact ground crew and notifying them of off-field landing location.

The most common off-field landing planning failure is denial. The pilot, understandably eager to continue the flight and return to an airport, is often reluctant to initiate planning for an off-field landing because, in the pilot's mind, to do so probably results in such a landing. It would be better, the pilot thinks, to concentrate on continuing the flight and finding a way to climb back up and fly away. The danger of this false optimism is that there is little or no time to plan an off-field landing if the attempt to climb away does not succeed. It is much safer to thoroughly understand the techniques of planning an off-field landing and to be prepared for the occurrence at any time.

Wind awareness, knowing wind direction and intensity, is key when planning an off-field landing. Flying downwind offers a greater geographical area to search than flying upwind. The tailwind during downwind cruise results in a greater range; a headwind during upwind cruise reduces the range. Wind awareness is also essential to planning the orientation and direction of the landing approach. Visualize the wind flowing over and around the intended landing area. Remember that the area downwind of hills, buildings, and other obstructions will probably be turbulent at low altitude. Also, be aware that landing into wind shortens landing rolls.

Decision heights are altitudes at which pilots take critical steps in the off-field landing process. If the terrain below is suitable for landing, select a general area no lower than 2,000 feet above ground level (AGL). Select the intended landing field no lower than 1,500 feet AGL. At 1,000 feet AGL, commit to flying the approach and landing off field. If the terrain below is not acceptable for an off-field landing, the best course of action is to move immediately toward more suitable terrain.

For many pilots, there is a strong temptation during the off-field landing process to select a landing location based primarily on the ease of glider retrieval. The convenience of an easy retrieval is of little consequence if the landing site is unsuitable and results in damage to the glider or injury to the pilot. Select the landing site with safety as the highest priority. During an off-field landing approach, the precise elevation of the landing site is usually unavailable to the pilot. This renders the altimeter more or less useless. Fly the approach and assess the progress by recognizing and maintaining the angle that puts the glider at the intended landing spot safely. If landing into a strong headwind, the approach angle is steep. If headwind is light or nonexistent, the approach angle is shallower unless landing over an obstacle. When landing with a tailwind (due to slope or one-way entry into the selected field due to terrain or obstacles), the angle is shallower. Remember to clear each visible obstacle with safe altitude, clearing any poles and wires by a safe margin. Always keep in mind that from the air, wires are basically invisible until they are right in front of you, whereas towers are visible from a distance. Any time there are two supporting structures (telephone poles) it is safe to assume that there are wires connecting them.

Select a field of adequate length and, if possible, one with no visible slope. Any slope that is visible from the air is likely to be steep. Slope can often be assessed by the color of the land. High spots often are lighter in color than low spots because soil moisture tends to collect in low spots, darkening the color of the soil. If level landing areas are not available and the landing must be made on a slope, it is better to land uphill than downhill. Even a slight downhill grade during landing flare allows the glider to float prior to touchdown, which may result in collision with objects on the far end of the selected field.

Knowledge of local vegetation and crops is also very useful. Tall crops are generally more dangerous to land in than low crops. Know the colors of local seasonal vegetation to help identify crops and other vegetation from the air. Without exception, avoid discontinuities such as lines or crop changes. Discontinuities usually exist because a fence, ditch, irrigation pipe, or some other obstacle to machinery or cultivation is present. Other obstacles may be present in the vicinity of the chosen field. Trees and buildings are easy to spot, but power and telephone lines and poles are more difficult to see from pattern altitude. Take a careful look around to find them. Assume every pole is connected by wire to every other pole. Also assume that every pole is connected by wire to every building, and that every building is connected by wire to every other building. Plan the approach to overfly the wires that may be present, even if you cannot see them. The more visible the landing area is during the approach, the fewer unpleasant surprises there are likely to be.

The recommended approach procedure is to fly the following legs in the pattern:

- Crosswind leg on the downwind side of the field
- Upwind leg
- Crosswind leg on the upwind side of the field
- Downwind leg
- Base leg
- Final approach

This approach procedure provides the opportunity to see the intended landing area from all sides. Use every opportunity while flying this approach to inspect the landing area and look for obstacles or other hazards. *[Figure 8-18]*

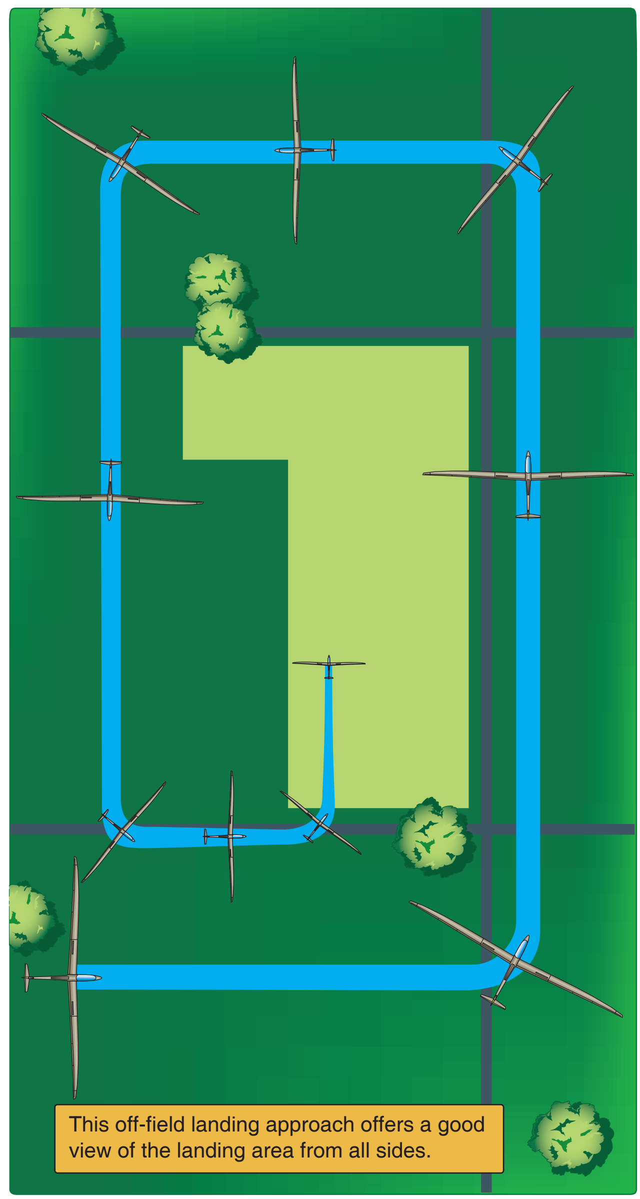

Figure 8-18. *Off-field landing approach.*

Landing over an obstacle or a wire requires skill and vigilance. The first goal in landing over an obstacle is to clear the obstacle! Next, consider how the obstacle affects the length of landing area that is actually going to be available for touchdown, roll out, and stopping the glider. If an obstacle is 50 feet high, the first 500 feet or so of the landing area needs to be overflown during the descent to flare and land. If the field selected has obstacles on the final approach path, remember that the field must be long enough to accommodate the descent to flare altitude after clearing the obstacle.

Hold the glider off during the flare and touch down at the lowest safe speed manageable. After touchdown, use the wheel brake immediately and vigorously to stop the glider as soon as possible. Aggressive braking helps prevent collision with small stakes, ditches, rocks, or other obstacles that cannot easily be seen, especially if the vegetation in the field is tall.

Afterlanding Off Field

Off-Field Landing Without Injury

If uninjured, tend to personal needs and then secure the glider. Make contact with the retrieval crew or emergency crew as promptly as possible. If the wait is likely to be long, use the daylight to remove all items necessary for darkness and cold. It is worth remembering that even a normal retrieval can take many hours if the landing was made in difficult terrain or in an area served by relatively few roads. If cellular service is available, use a cell phone to call 911 if you are concerned about personal safety. Glider pilots should always consider alternate means of communication to include satellite telephones and ham radios as cell phone service is not always available. To help identify position, relay the GPS coordinates, if available, to ease the job for the retrieval crew or rescue personnel. It is a good idea to write down the GPS coordinates if the GPS battery is exhausted or if the GPS receiver shuts down for any reason. Use the glider two-way radio to broadcast needs on the international distress frequency 121.5 MHz. Many aircraft, including civil airliners, routinely monitor this frequency. Their great height gives the line-of-sight aviation transceiver tremendous range when transmitting to, or receiving from, these high-altitude aircraft. Calling other glider pilots in the area on the glider-to-glider radio frequency can hasten retrieval or rescue. Another tool for pilots is the personal locator device offered by several companies as a rescue device. These devices use the 406 MHz satellite signal, and global positioning system (GPS) technology to accurately track and relay the pilot's location in the event of an off-field landing requiring assistance.

Once contact has been made with outsiders to arrange for retrieval, attend to minor items, such as collecting any special tools that are needed for glider derigging or installing gust locks on the glider's flight controls.

Off-Field Landing With Injury

If injured, tend to critical injuries first. At the first opportunity, make contact with emergency response personnel, with other aircraft, or any other source of identifiable assistance. Use the glider radio, if operable, to broadcast a Mayday distress call on emergency frequency 121.5 MHz. Also, try any other frequency likely to elicit a response. Some gliders have an Emergency Locator Transmitter (ELT) on board. If the glider is equipped with an ELT and assistance is needed, turn it on. The ELT broadcasts continuous emergency signals on 121.5 MHz. Search aircraft can hone in on this ELT signal using radio equipment designed for search and rescue (SAR). These SAR-equipped aircraft reduce the time spent searching for the pilot's exact location. To transmit a voice message on an operable two-way radio at 121.5 MHz, turn the ELT switch to OFF for the voice message to be heard. The newer ELTs, like the 406 MHz Emergency Position Indicating Radio Beacons (EPIRBs), are becoming more popular because of their substantial benefits. Only ATC ground stations routinely monitor 121.5 MHz anymore and that is line-of-sight reception only. The newer EPIRBs have stronger signals, transmit longer, and are monitored by the satellite network. According to CFR part 91, gliders are not airplanes and therefore old very high frequency (VHF) ELTs are not required, which is why a EPIRB would make a much better choice when flying a glider. If mobile (cell) phone coverage is available, dial 911 to contact emergency personnel. If possible, include a clear description of the location. If the glider is in a precarious position, secure it, if possible, but do not risk further personal injury in doing so. If it is clearly unsafe to stay with the glider, move to a nearby location for shelter but leave clear written instructions in a prominent location in the glider detailing where to find you.

It is best to stay with the glider if at all possible. The glider bulk is likely to be much easier to locate from the air than is an individual person. The pilot might obtain a measure of protection from the elements by crawling into the fuselage or crawling under a wing, or using the parachute canopy to rig a makeshift tent around the glider structure. After attending to medical needs and contacting rescue personnel, attend to clothing, food, and water issues. The pilot should make every attempt to conserve energy.

System and Equipment Malfunctions

Flight Instrument Malfunctions

Instrument failures can result from careless maintenance practices and from internal or external causes. An example of careless maintenance is removal and replacement of the airspeed indicator but failure to connect the instrument correctly to pitot and static lines. A pitot tube clogged by insects or water ingress is an example of an external cause of instrument failure.

Pilots should always be aware of the glider's normal attitudes for all flight regimes. Then, when presented with an instrument failure or erroneous indication, the pilot has a general sense of the glider's normal attitude from outside flying cues to make a safe return and landing. Judging the altitude or airspeed of the glider without the guidance of instruments should not constitute a panic in the cockpit as many pilots can make precision approaches and landings without the use of an altimeter. In fact, many older and vintage gliders do not require an operational altimeter in the cockpit.

Airspeed Indicator Malfunctions

If the airspeed indicator appears to be erratic or inaccurate, fly the glider by pitch attitude. Keep the nose of the glider at the proper pitch attitude for best glide or minimum sink airspeed. Additional cues to airspeed include control "feel" and wind noise. At very low airspeeds, control feel is very mushy and wind noise is generally low. At higher airspeeds, control feel is crisper and wind noise takes on a more insistent hissing quality. The sound of the relative wind can be amplified and made more useful in airspeed control by opening the sliding window installed in the canopy and by opening the air vent control. During the landing approach, maintain adequate airspeed using cues other than the airspeed indicator. Fly the approach with an adequate margin above stall airspeed. If conditions are turbulent or the wind is gusty, additional airspeed is necessary to penetrate the convection and to ensure adequate control authority. If in doubt, it is better to be flying 10 knots faster than optimum airspeed than it is to be 10 knots slower.

Altimeter Malfunctions

Altimeter failure may result from internal instrument failure or from external causes, such as water ingress in the static lines. Regardless of the cause, it is important to maintain sufficient altitude to allow a safe glide to a suitable landing area. During the approach to land without a functioning altimeter, it is necessary to rely on perception of maintaining a safe gliding angle to the target landing area. The primary risk to safety is entering the approach from an altitude that is lower than normal. It is better to enter the approach from a normal height, or even from a higher-than-normal height. During the approach, judge the angle to the target area frequently. If the angle is too steep, apply spoilers/dive brakes to steepen the descent path. If necessary, apply a forward slip or turning slip to lose additional altitude. If the approach angle is beginning to appear shallow, close the spoilers/dive brakes and, if necessary, modify the approach path to shorten the distance necessary to glide to make it to the target landing area.

Static line contamination affects both the altimeter and the airspeed indicator. If it is suspected that either instrument is malfunctioning because of static line contamination, remember that the indications of the other instrument(s) connected to the static line may also be incorrect. Use the external cues described above to provide multiple cross-checks on the indications of all affected instruments. If in doubt about the accuracy of any instrument, it is best to believe the external cues and disregard the instrument indications. After landing and prior to the next flight, have an aviation maintenance professional evaluate the instrument system.

It is essential that a glider pilot be familiar with the procedures for making a safe approach without a functioning airspeed indicator or altimeter. Being accompanied by a glider flight instructor during the flight review provides an excellent opportunity to review these procedures.

Variometer Malfunctions

Variometer failure can make it difficult for the pilot to locate and exploit sources of lift. If an airport is nearby, a precautionary landing should be made so the source of the problem can be uncovered and repaired. If no airport is nearby, search for clues to sources of lift. Some clues may be external, such as a rising smoke column, a cumulus cloud, a dust devil, or a soaring bird. Other sources are internal, such as the altimeter. Use the altimeter to gauge rate of climb or descent in the absence of a functioning variometer. Tapping the altimeter with the forefinger often overcomes internal friction in the altimeter, allowing the hand to move upward or downward. The direction of the movement gives an idea of the rate of climb or descent over the last few seconds. When lift is encountered, stay with it and climb.

Compass Malfunctions

Compass failure is rare, but it does occur. If the compass performs poorly or not at all, cross-check current position with aeronautical charts and with electronic methods of navigation, such as GPS, if available. The position of the sun, combined with knowledge of the time of day, can help with orientation also. Being familiar with section lines and major roads often provides helpful cues to orientation and the direction of flight.

Glider Canopy Malfunctions

Glider Canopy Opens Unexpectedly

Canopy-related emergencies are often the result of pilot error. The most likely cause is failure to lock the canopy in the closed position prior to takeoff. Regardless of the cause, if the canopy opens unexpectedly during any phase of flight, the first duty is to fly the glider. It is important to maintain adequate airspeed while selecting a suitable landing area.

If the canopy opens while on aerotow, it is vital to maintain a normal flying attitude to avoid jeopardizing the safety of the glider occupants and the safety of the towplane pilot. Only when the glider pilot is certain that glider control can be maintained should any attention be devoted to trying to close the canopy. If flying a two-seat glider with a passenger on board, fly the glider while the other person attempts to close and lock the canopy. If the canopy cannot be closed, the glider may still be controllable. Drag is higher than normal; when flying the approach, plan a steeper-than-normal descent path. The best prevention against unexpected opening of the canopy is proper use of the pretakeoff checklist.

Broken Glider Canopy

If the canopy is damaged or breaks during flight, the best response is to land as soon as practicable. Drag increases if the canopy is shattered, so plan a steeper-than-normal descent path during the approach.

Frosted Glider Canopy

Extended flight at high altitude or in low ambient temperatures may result in obstructed vision as moisture condenses as frost on the inside of the canopy. Open the air vents and the side window to ventilate the cabin and to evacuate moist air before the moisture can condense on the canopy. Descend to lower altitudes or warmer air to reduce the frost on the canopy. Flight in direct sunlight helps diminish the frost on the canopy.

Water Ballast Malfunctions

Water ballast systems are relatively simple and major failures are not very common. Nevertheless, ballast system failures can threaten the safety of flight. One example of ballast failure is asymmetrical tank draining (one wing tank drains properly but the other wing tank does not). The result is a wing-heavy glider that may be very difficult to control during slow flight and during the latter portion of the landing rollout. Another example is leakage. Some water ballast systems drain into a central pipe that empties through the landing gear wheel well. If the drain connections from either wing leak significantly, water from the tanks can collect in the fuselage. If the water flows far forward or far aft in the fuselage, pitch control of the glider may be severely degraded. Pitch control can be augmented by flying at mid to high airspeeds, giving the elevator more control authority to correct for the out-of-balance situation, and affording time to determine whether the water can be evacuated from the fuselage. If pitch control is dangerously degraded, abandoning the glider may be the safest choice. The best prevention for water ballast problems is regular maintenance and inspection combined with periodic tests of the system and its components.

Retractable Landing Gear Malfunctions

Landing gear difficulties can arise from several causes. Landing gear failures arising from mechanical malfunction of the gear extension mechanism generally cannot be resolved during flight. Fly the approach at normal airspeed. If the landing gear is not extended, the total drag of the glider is less than it is normally during an approach with the landing gear extended. It may be necessary to use more spoiler/dive brake than normal during the approach. Try to land on the smoothest surface available, preferably an area that has good turf to help reduce the damage to the glider. The landing must be under control and as soft as possible. Slightly above stall speed soft touchdowns are preferable to full stall landings resulting in hard landings. This helps avoid a tailwheel first landing, and a hard touchdown of the glider onto the runway. Avoiding the hard touchdown helps to avoid injury and lessen damage to the glider components.

The glider makes considerable noise as it slides along the runway, and wingtip clearance above the ground is reduced. Keep the wings level for as long as possible. Try to keep the glider going as straight as possible using the rudder to guide the glider. The primary goal is to avoid collision with objects on the ground or along the runway border, including runway lighting and signage. Accept the fact that minor skin damage to the glider is inevitable if the gear cannot be extended and locked. Concentrate on personal safety during the approach and landing. Any damage to the glider can be repaired after an injury-free landing.

Primary Flight Control Systems

Failure of any primary flight control system presents a serious threat to safety. The most frequent cause of control system failure is incomplete assembly of the glider in preparation for flight. To avoid this, use a written checklist to guide each assembly operation and inspect every connection and safety pin thoroughly. Do not allow interruptions during assembly. If interruption is unavoidable, start the checklist again from the very beginning. Perform a positive control check with the help of a knowledgeable assistant. Do not assume that any flight surface and flight control is properly installed and connected during the post-assembly inspection. Instead, assume that every connection is suspect. Inspect and test until certain that every component is ready for flight.

Elevator Malfunctions

The most serious control system malfunction is a failure of the elevator flight control. Causes of elevator flight control failure include the following:

- An improper connection of the elevator control circuit during assembly.
- An elevator control lock that was not removed before flight.
- Separation of the elevator gap seal tape.

- Interference of a foreign object with free and full travel of the control stick or elevator circuit.
- A lap belt or shoulder harness in the back seat that was used to secure the control stick and not removed prior to flight.
- A structural failure of the glider due to overstressing or flutter.

To avoid a failure, ensure that control locks are removed prior to flight, that all flight control connections have been completed properly and inspected, and that all safety pins have been installed and latched properly. Ensure that a positive control check against applied resistance has been performed.

If the elevator irregularity or failure is detected early in the takeoff roll, release the towline (or reduce power to idle), maneuver the glider to avoid obstacles, and use the brakes firmly to stop the glider as soon as possible. If the elevator control irregularity or failure is not noticed until after takeoff, a series of complicated decisions must be made quickly. If the glider is close to the ground and has a flat or slightly nose-low pitch attitude, releasing the towline (or reducing power to zero) is the best choice. If this is an aerotow launch, consider the effect the glider has on the safety of the tow pilot. If there is sufficient elevator control during climb, then it is probably best to stay with the launch and achieve as high an altitude as possible. High altitude gives more time to abandon the glider and deploy a parachute, if worn.

If the decision is to stay with the glider and continue the climb, experiment with the effect of other flight controls on the pitch attitude of the glider. These include the effects of various wing flap settings, spoilers/dive brakes, elevator trim system, and raising or lowering the landing gear. If flying a self-launching glider, experiment with the effect of power settings on pitch attitude.

If aileron control is functioning, bank the glider and use the rudder to moderate the attitude of the nose relative to the horizon. When the desired pitch attitude is approached, adjust the bank angle to maintain the desired pitch attitude. Forward slips may have a predictable effect on pitch attitude and can be used to moderate it. Usually, a combination of these techniques is necessary to regain some control of pitch attitude. While these techniques may be a poor substitute for the glider elevator itself, they are better than nothing. If an altitude sufficient to permit bailing out and using a parachute is achieved, chances of survival are good because parachute failures are exceedingly rare.

Elevator gap seal tape, if in poor condition, can degrade elevator responsiveness. If the adhesive that bonds the gap seal leading edge to the horizontal stabilizer begins to fail, the leading edge of the gap seal may be lifted up by the relative wind. This provides, in effect, a small spoiler that disturbs the airflow over the elevator just aft of the lifted seal. Elevator blanking that occurs across a substantial portion of the span of the elevator seriously degrades pitch attitude control. In extreme cases, elevator authority may be compromised so drastically that the glider elevator is useless.

The pilot may be forced to resort to alternate methods to control pitch attitude as described above. Bailing out may be the safest alternative. Inspection of the gap seal bonds for all flight control surfaces prior to flight is the best prevention.

Aileron Malfunctions

Aileron failures can cause serious control problems. Causes of aileron failure include:

- Improper connection of the aileron control circuit during assembly.
- Aileron control lock that was not removed before flight.
- Separation of the aileron gap seal tape.
- Interference of a foreign object with free and full travel of the control stick or aileron circuit.
- Seat belt or shoulder harness in the back seat that was used to secure the control stick and not removed prior to flight.
- Structural failure and/or aileron flutter.

These failures can sometimes be counteracted successfully, partly because there are two ailerons. If one aileron is disconnected or locked by an external control lock, the degree of motion still available in the other aileron may exert some influence on bank angle control. Use whatever degree of aileron is available to maintain control of the glider. The glider may be less difficult to control at medium to high airspeeds than at low airspeeds.

If the ailerons are not functioning adequately and roll control is compromised, the secondary effect of the rudder can be used to make gentle adjustments in the bank angle so long as a safe margin above stall speed is maintained. The primary effect of the rudder is to yaw the glider. The secondary effect of the rudder is subtler and takes longer to assert itself. In wings-level flight, if left rudder is applied, the nose yaws to the left. If the pressure is held, the wings begin a gentle bank to the left. If right rudder pressure is held and applied, the glider yaws to the right, then begins to bank to the right. This secondary banking effect by the rudder is useful if the pilot must resort to using the rudder to bank the glider wings. The secondary effect of the rudder works best when the wings are level or held in a very shallow bank, and is enhanced at medium to high airspeeds. Try to keep all banks very shallow. If the bank angle becomes excessive, it is difficult or impossible to recover to wings-level flight using the rudder alone. If the bank is becoming too steep, use any aileron influence available, as well as all available rudder to bring the wings back to level. If a parachute is available and the glider becomes uncontrollable at low airspeed, the best chance to escape serious injury may be to bail out of the glider from a safe altitude.

Rudder Malfunctions

Rudder failure is extremely rare because removing and installing the vertical fin/rudder combination is not part of the normal sequence of rigging and de-rigging the glider (as it is for the horizontal stabilizer/elevator and for the wing/aileron combinations). Poor directional control is so obvious to the pilot from the very beginning of the launch that, if rudder malfunction is suspected, the launch can be aborted early.

Rudder malfunctions are most likely to occur after failure to remove the rudder control lock prior to flight or when an unsecured object in the cockpit interferes with the free and full travel of the rudder pedals. Preflight preparation must include removal of all flight control locks and safe stowage of all items on board. The pretakeoff checklist includes checking all primary flight controls for correct, full travel prior to launch.

Although rudder failure is quite rare, the consequences are serious. If a control lock causes the problem, it is possible to control the glider airspeed and bank attitude, but directional control is compromised due to limited rudder movement. In the air, some degree of directional control can be obtained by using the adverse yaw effect of the ailerons to yaw the glider. During rollout from an aborted launch or during landing rollout, directional control can sometimes be obtained by deliberately grounding the wingtip toward the direction of desired yaw. Putting the wingtip on the ground for a fraction of a second causes a slight yaw in that direction; holding the wingtip firmly on the ground usually causes a vigorous yaw or ground loop in the direction of the grounded wingtip.

Careless stowage of cockpit equipment can result in rudder pedal interference at any time during a flight. During flight, if an object is interfering with or jamming the rudder pedals, attempt to remove it. If removal is not possible, attempt to deform, crush, or dislodge the object by applying force on the rudder pedals. It also may be possible to dislodge the object by varying the load factor, but ensure that dislodging the object does not result in its lodging in a worse place where it could jam the elevator or aileron controls. If the object cannot be retrieved and stowed, a precautionary landing may be required.

Commonly misplaced objects that can cause flight control interference include:

- Water bottles,
- Cameras,
- Electronic computers,
- Containers of food and similar items,
- Clothing, and
- Sunglasses.

Control these items by proper planning and good cockpit discipline.

Secondary Flight Controls Systems

Secondary flight control systems include the elevator trim system, wing flaps, and spoilers/dive brakes. Problems with any of these systems can be just as serious as problems with primary controls.

Elevator Trim Malfunctions

Compensating for a malfunctioning elevator trim system is usually as simple as applying pressure on the control stick to maintain the desired pitch attitude, then bringing the flight to safe conclusion. Inspect and repair the trim system prior to the next flight.

Spoiler/Dive Brake Malfunctions

Spoiler/dive brake system failures can arise from rigging errors or omissions, environmental factors, and mechanical failures. Interruptions or distractions during glider assembly can result in failure to properly connect control rods to one or both spoilers/dive brakes. Proper use of a comprehensive checklist reduces the likelihood of assembly errors. If neither of these spoilers/dive brakes is connected, then one or both of the spoilers/dive brakes may deploy at any time and retraction becomes impossible. This is a very hazardous situation for several reasons. One reason is that the spoilers/dive brakes are likely to deploy during the launch or the climb, causing a launch emergency and a possible tow failure incident. Another reason is that the spoilers/dive brakes might deploy asymmetrically: one spoiler/dive brake retracted and the other spoiler/dive brake extended, resulting in yaw and roll tendencies that do not arise when the spoilers/dive brakes deploy symmetrically. A pilot expecting a smooth ,symmetrical deployment would be faced with a control issue that compromises flight safety. Finally, it is not possible to correct the situation by retracting the spoiler/dive brake(s) because the failure to connect the controls properly usually means that pilot control of the spoiler/dive brake has been lost.

If asymmetrical spoiler/dive brake extension occurs and the extended spoiler/dive brake cannot be retracted, several choices must be made. Roll and yaw tendencies due to asymmetry must be overcome or eliminated. One way to solve this problem is to deploy the other spoiler/dive brake to restore the symmetry. The advantages include immediate relief from yaw and roll tendencies and protection against stalling with one spoiler/dive brake extended and the other retracted, which could result in a spin. The disadvantage of deploying the other spoiler/dive brake is that the glide ratio is reduced. If the spoiler/dive brake asymmetry arises during launch or climb, the best choice is to abort the launch, extend the other spoiler/dive brakes to relieve the asymmetry, and make a precautionary or emergency landing.

Environmental factors include low temperature or icing during long, high altitude flights, which may occur during a mountain wave flight. Low temperature causes contraction of all glider components. If the contraction is uneven, the spoilers/dive brakes may bind and be difficult or impossible to deploy. Icing can also interfere with operation of the spoilers/dive brakes. High temperature, on the other hand, causes all glider components to expand. If the expansion is uneven, the spoilers/dive brakes may bind in the closed position. This is most likely to occur while the glider is parked on the ground in direct summer sunlight. The heating can be very intense, particularly for a glider with wings painted a color other than reflective white.

Mechanical failures can cause asymmetrical spoiler/dive brake extension. For example, the spoiler/dive brake extend normally during the prelanding checklist but only one spoiler/dive brake retracts on command. The other spoiler/dive brake remains extended, due perhaps to a broken weld in the spoiler/dive brake actuator mechanism, a defective control connector, or other mechanical failure. The glider yaws and banks toward the wing with the extended spoiler/dive brake. Aileron and rudder are required to counteract these tendencies. To eliminate any possibility of entering a stall/spin, maintain a safe margin above stall airspeed. If the decision to deploy the other spoiler/dive brake is made to relieve the asymmetry, controlling the glider becomes much easier but gliding range is reduced due to the additional drag of the second spoiler/dive brake. This may be a significant concern if the terrain is not ideal for landing the glider. Nevertheless, it is better to make a controlled landing, even in less than ideal terrain, than it is to stall or spin.

Miscellaneous Flight System Malfunctions

Towhook Malfunctions

Towhooks can malfunction as can any other mechanical device. Failure modes include uncommanded towline release and failure to release on command. Pilots must be prepared to abort any towed launch, whether ground or aerotow launch, at any time. Uncommanded towline release must be anticipated prior to every launch. Assess the wind and the airport environment, and then form an emergency plan prior to launch. If the towhook fails to release on command, try to release the towline again after removing tension from the line. Pull the release handle multiple times under varying conditions of towline tension. If the towline still cannot release, alert the towpilot and follow the emergency procedures described in Chapter 7, Flight Maneuvers and Traffic Patterns.

Oxygen System Malfunctions

Oxygen is essential for flight safety at high altitude. If there is a suspected or detected failure in any component of the oxygen system, descend immediately to an altitude at which supplemental oxygen is not essential for continued safe flight. Remember, the first sign of oxygen deprivation is a sensation of apparent well-being. Problem-solving capability is diminished. If the pilot has been deprived of sufficient oxygen, even for a short interval, critical thinking capability has been compromised. Do not be lulled into thinking that the flight can safely continue at high altitude. Descend immediately and breathe normally at these lower altitudes for a time to restore critical oxygen to the bloodstream. Try to avoid hyperventilation, which prolongs the diminished critical thinking capability. Give enough time to recover critical thinking capability before attempting an approach and landing.

Drogue Chute Malfunctions

Some gliders are equipped with a drogue chute to add drag during the approach to land. This drag supplements the drag provided by the spoilers/dive brakes. The drogue chute is packed and stowed in the aft tip (tail cone) of the fuselage or in a special compartment in the base of the rudder. Drogue chutes are very effective when deployed properly and make steep approaches possible. The drogue chute is deployed and jettisoned on pilot command, such as would be necessary if the drag of the glider was so great that the glider would not otherwise have the range to make it to the spot of intended landing. There are several failure modes for drogue chutes. If it deploys accidentally or inadvertently during the launch, the rate of climb seriously degrades and it must be jettisoned. During the approach to land, an improperly packed or damp drogue chute may fail to deploy on command. If this happens, use the rudder to sideslip for a moment, or use the rudder to yaw the tail back and forth. Make certain to attain safe flying speed before attempting the slip or yawing motion. Either technique increases the drag force on the drogue chute compartment that pulls the parachute out of the compartment.

If neither technique deploys the drogue chute, the drogue canopy may deploy at a later time during the approach without further control input from the pilot. This results in a considerable increase in drag. If this happens, be prepared to jettison the drogue chute immediately if sufficient altitude to glide to the intended landing spot has not been reached.

Another possible malfunction is failure of the drogue chute to inflate fully. If this happens, the canopy "streams" like a twisting ribbon of nylon, providing only a fraction of the drag that would occur if the canopy had fully inflated. Full inflation is unlikely after streaming occurs, but if it does occur, drag increases substantially. It is much better to fly with a known drag configuration and adjust for it rather than be faced with a substantially increased drag coefficient at a place and time where a safe landing is no longer possible. If in doubt regarding the degree of deployment of the drogue chute, the safest option may be to jettison the drogue. Regardless of the malfunction type, the pilot should review approach and landing options for the drogue chute conditions.

Self-Launching Gliders

In addition to the standard flight control systems found on all gliders, self-launching gliders have multiple systems to support flight under power. These systems may include but are not limited to the following:

- Fuel tanks, lines, and pumps
- Engine and/or propeller extension and retraction systems
- Electrical system including engine starter system
- Lubricating oil system
- Engine cooling system
- Engine throttle controls
- Propeller blade pitch controls
- Engine monitoring instruments and systems

The complexity of these systems demands thorough familiarity with the GFM/POH for the self-launching glider being flown. Any malfunction of these systems can make it impossible to resume powered flight.

Self-Launching/Sustainer Glider Engine Failure During Takeoff or Climb

Engine failures are the most obvious source of equipment malfunction in self-launching gliders. Engine failures can be subtle (a very slight power loss at full throttle) or catastrophic and sudden (engine crankshaft failing during a full-power takeoff). High on the list of possible causes of power problems are fuel contamination and exhaustion.

To provide adequate power, the engine system must have fuel and ignition, as well as adequate cooling and lubrication. Full power operation is compromised if any of these requirements is not satisfied. Monitor the engine temperature, oil pressure, fuel pressure, and revolutions per minute (rpm) carefully to ensure engine performance is not compromised. Warning signs of impending difficulty include excessively high engine temperatures, abnormal engine oil temperatures, low oil pressure, low rpm despite high throttle settings, low fuel pressure, and erratic engine operation (surging, backfiring, and missing). Abnormal engine performance may be a precursor to complete engine failure. Even if total engine failure does not occur, operation with an engine that cannot produce full power translates into an inability to climb or perhaps an inability to hold altitude despite application of full throttle. The best course of action, if airborne, is to make a precautionary landing first and then discover the source of the trouble.

Regardless of the type of engine failure, the pilot's first responsibility is to maintain flying airspeed and adequate control of the glider. If power failure occurs, lower the nose as necessary to maintain adequate airspeed. Pilots flying self-launching gliders with a pod-mounted external engine above the fuselage need to lower the nose much more aggressively in the event of total power loss than those with an engine mounted in the nose. In the former, the thrust of the engine during full power operations tends to provide a nose-down pitching moment. If power fails, the nose-down pitching moment disappears and is replaced by a nose-up pitching moment due to the substantial parasite drag of the engine pod high above the longitudinal axis of the fuselage. Considerable forward motion on the control stick may be required to maintain flying airspeed. If altitude is low, there is not enough time to stow the engine and reduce the drag that it creates. Land the glider with the engine extended. Glide ratio in this configuration is poor due to the drag of the extended engine and propeller. The authoritative source for information regarding the correct sequence of pilot actions in the event of power failure is contained in the GFM/POH. The pilot must be thoroughly familiar with its contents to operate a self-launching glider safely.

If the power failure occurs during launch or climb, time to maneuver may be limited. Concentrate on flying the glider and selecting a suitable landing area. Remember that the high drag configuration of the glider may limit the distance of the glide without power. Keep turns to a minimum and land the glider as safely as possible. Do not try to restart the engine while at very low altitude because it distracts from the primary task of maintaining flying airspeed and making a safe precautionary landing. Even if power in the engine system were restored, chances are that full power is not available. The problem that caused the power interruption in the first place is not likely to solve itself while trying to maneuver from low altitude and climb out under full power. If the problem recurs, as it is likely to do, the pilot may place the glider low over unlandable terrain with limited gliding range and little or no engine power to continue the flight. Even if the engine continues to provide limited power, flight with partial power may quickly put the glider in a position in which the pilot is unable to clear obstacles, such as wires, poles, hangars, or nearby terrain. If a full power takeoff or climb is interrupted by power loss, it is best to make a precautionary landing. The pilot can sort out the power system problems after returning safely to the ground.

Inability to Restart a Self-Launching/Sustainer Glider Engine While Airborne

Power loss during takeoff roll or climb are serious problems, but they are not the only types of problems that may confront the pilot of a self-launching glider. Other engine failures include an engine that refuses to start in response to airborne start attempts. This is a serious problem if the terrain below is unsuitable for a safe off-field landing.

One of the great advantages of the self-launching glider is having the option to terminate a soaring flight by starting the engine and flying to an airport/gliderport for landing. Nearly all self-launching gliders have a procedure designed to start the engine while airborne. This procedure would be most valuable during a soaring flight with engine off during which the soaring conditions have weakened. The prospect of starting the engine and flying home safely is ideal under such conditions.

As a precaution, an airborne engine start should be attempted at an altitude high enough that, if a malfunction occurs, there is sufficient time to take corrective action. If the engine fails to start promptly, or fails to start at all, there may be little time to plan for a safe landing. If there is no landable area below, then failure to start the engine results in an emergency off-field landing in unsuitable terrain. Glider damage and personal injury may result. To avoid these dangers, self-launching glider pilots should never allow themselves to get into a situation that can only be resolved by starting the engine and flying up and away. It is best to keep a landable field always within easy gliding range.

There are many reasons that a self-launching glider engine may fail to start or fail to provide full power in response to efforts to resume full power operations while airborne. These include lack of fuel or ignition, low engine temperature due to cold soak, low battery output due to low temperatures or battery exhaustion, fuel vapor lock, lack of propeller response to blade pitch controls, and other factors. It is important for the pilot to have an emergency plan in the event that full engine power is not available during any phase of flight.

Self-Launching Glider Propeller Malfunctions

Propeller failures include propeller damage and disintegration, propeller drive belt or drive gear failure, or failure of the variable blade pitch control system. To perform an air-driven engine restart, for example, many self-launching gliders require that the propeller blades be placed in a particular blade pitch position. If the propeller blades cannot be properly adjusted, then the propeller will not deliver enough torque to start the engine. The result is a failure to obtain an air-driven engine start.

Self-Launching Glider Electrical System Malfunctions

An electrical system failure in a self-launching glider may make it impossible to control the propeller pitch if the propeller is electrically controlled. It may also result in the inability to deploy a pod engine successfully for an air restart attempt. Self-launching gliders that require a functioning electric starter for an air restart are unable to resume flight under power. If an airport is within gliding range, an on-airport precautionary landing can be made. If there is no airport within gliding range and the flight can be safely continued without electrical power, the pilot may be able to soar to the vicinity of an airport and land safely. If no airport is within gliding range and flight cannot be sustained without power, an emergency off-airport landing has to be made.

Some self-launching gliders are occasionally used for night flight, cruising under power. All night flights must be conducted in accordance with FAA regulation and the glider must have the appropriate aeronautical lighting required for night time operations (14 CFR part 91, section 91.209). If carrying a passenger(s), the pilot must be qualified to operate the glider at night in accordance with 14 CFR part 61, section 61.57(b).

If an electrical system failure occurs during night operations, pilots of nearby aircraft are not able to see the self-launching glider due to the extinguished position lights. Inside the cockpit, it is difficult or impossible to see the flight instruments or electrical circuit breakers. According to 14 CFR part 135, section 135.159(f), and part 121, section 121.549(b), the FAA requires that commercial and airline pilots have a flashlight "having at least two size D cells or equivalent" for such an emergency. It makes good practical sense for other pilots to follow the same rules.

If smoke or the smell of smoke is present, make no attempt to reset any circuit breakers. In accordance with CE-10-11R, Special Airworthiness Information Bulletin, dated January 14, 2010, and available for download at http://rgl.faa.gov/Regulatory_and_Guidance_Library/rgSAIB.nsf/(LookupSAIBs)/CE-10-11R1?OpenDocument, the best and safest practice is to not reset circuit breakers in the air unless absolutely necessary for safe flight. Resetting a circuit breaker may result in a greater overload and possible fire. *[Figure 8-19]* Head directly for the nearest airport and prepare for a precautionary landing there. Follow nighttime procedures and requirements. The aviation transceiver installed in the instrument panel may not function if electrical failure is total, so it is a good idea to have a portable battery-operated aviation two-way radio onboard for use in such an emergency. It may be necessary to receive landing instruction by air traffic control (ATC) light-signal. Pilot should review 14 CFR part 91, section 125, and the Aeronautical Information Manual (AIM) section 4-2-13, Traffic Control Light Signals, for the proper response.

In-flight Fire

An in-flight fire is the most serious emergency a pilot can encounter. If a fire has ignited, or if there is a smell of smoke or any similar smell, do everything possible to reduce the possibilities that the fire spreads and land as soon as possible. The self-launching glider GFM/POH is the authoritative source for emergency response to suspected in-flight fire. The necessary procedures are:

- Reduce throttle to idle,
- Shut off fuel valves,
- Shut off engine ignition,
- Land immediately and stop as quickly as possible, and
- Evacuate the self-launching glider immediately.

Figure 8-19. *Self-launching glider circuit breakers.*

After landing, distance yourself from the glider and try to stay upwind to avoid the harmful fumes. Keep onlookers away from the glider as well. The principal danger after evacuating the glider is fuel ignition and explosion, with the potential to injure personnel at a considerable distance from the glider.

CAUTION: Modern gliders are composed of composite materials and resins that can produce very poisonous fumes. The glider pilot should do whatever is necessary to avoid the fumes to include jettisoning of the canopy, which allows breathable air in and elimination of fumes from the cockpit. This same modern construction also means a fire can spread very quickly. A quick landing or abandoning the glider for a parachute landing may be the only option for the pilot. If the fire is spreading to the wings, bailout at a safe altitude may be the safest choice if the airframe will not last until the landing.

Emergency Equipment and Survival Gear

Emergency equipment and survival gear is essential for safety of flight for all soaring flights.

Survival Gear Checklists

Checklists help the pilot to assemble the necessary equipment in an orderly manner. The essentials for survival include reliable and usable supplies of water, food, and air or oxygen. Maintenance of an acceptable body temperature, which is difficult to manage in extreme cold or extreme heat, is also important. Blankets and appropriate seasonal clothing help to ensure safe body temperatures.

Food and Water

An adequate supply of water and food (especially high-energy foods such as energy bars, granolas, and dried fruits) are of utmost importance during cross-country flight. Water from ballast tanks can be used in an emergency if free of contaminants, such as antifreeze. Water and food should be available and easily accessible during the entire flight.

Clothing

Pilots also need seasonal clothing that is appropriate to the local environment, including hat or cap, shirts, sweaters, pants, socks, walking shoes, space blanket, and gloves or mittens. Layered clothing provides flexibility to meet the demands of the environment. Desert areas may be very hot in the day and very cold at night. Prolonged exposure to either condition can be debilitating. Layered clothing traps air between layers, increasing heat retention. The parachute canopy can be used as an effective layered garment when wrapped around the body to conserve body heat or to provide relief from excessive sunlight. Eye protection, such as sunglasses, is more than welcome if conditions during the day are bright, as they often are on good soaring days.

Communication

Communication can be electronic, visual, or audible. Radios, telephones, and cell phones are electronic methods. Signal mirrors, flashlight or light beacons at night, signal fire flames at night, signal smoke during daylight hours, signal flares, and prominent parachute canopy displays are visual methods. Shouting and other noisemaking activities are audible methods but usually have very limited range. A whistle provides a good method for making sound.

Coin, cash, or credit cards are often necessary to operate pay phones. Charged batteries are required to operate cell phones, two-way radios, and emergency locator transmitters. Batteries are also necessary to operate flashlights or position lights on the glider for signal purposes. A list of useful telephone numbers aids rapid communication. The aviation transceiver can be tuned to broadcast and receive on the emergency frequency 121.5 MHz or any other useable frequency that elicits a response. The ELT can be used to provide a continuous signal on 121.5 MHz and/or the newer 406 MHz SAR system. A 406 MHz beacon on a downed aircraft activates either automatically or manually. The ELT transmits a digital identification code to the first satellite that comes into range. The satellites receive the signal and relay it to a ground station. If there is no ground station in view, the satellite records the digital signal in its onboard memory and downloads it to the next ground station. The ground station processor measures the Doppler shift of the signal and calculates its position; this calculation is usually accurate to within 1.5 nautical miles on the first satellite pass and is refined further with each pass. If the beacon has an integrated GPS or is connected into the onboard NAVCOM, the position is imbedded into the initial digital data stream.

After the ground station has completed processing, it transmits the identification and position to the United States Mission Control Center (USMCC). The USMCC attaches the information contained in the 406 MHz beacon registration database for that particular ELT and generates an alert message. If the location lies within the continental U.S., the alert is sent to the Air Force Rescue Coordination Center (AFRCC) at Langley Air Force Base, Virginia. The AFRCC then takes the registration data and attempts to ascertain the aircraft's disposition. By calling the emergency contact numbers, or by calling flight service stations with the N-number, they can quickly determine whether or not the aircraft is safe on the ground.

Since most activations are false alarms, the ability to resolve them over the phone saves the AFRCC (i.e., U.S. taxpayers) millions of dollars. More importantly, it saves SAR assets for actual emergencies. If the AFRCC in unable to verify the aircraft is safe on the ground, they launch a Search and Rescue mission. This normally involves assigning the search to the USAF Auxiliary Civil Air Patrol and may include requesting assistance from the local SAR responders or law enforcement personnel.

The unique digital code of each 406 MHz beacon allows it to be associated with a particular aircraft. The registration contains information, such as tail number, home airport, type and color of aircraft, and several emergency points of contact. This provides rapid access to flight plans and other vital information. This can speed the search effort and can be the difference between life and death.

The parachute canopy and case can be employed to lay out a prominent marker to aid recognition from the air by other aircraft. Matches and a combustible material can provide flame for visibility by night and provide smoke that may be seen during daylight hours.

Navigation Equipment

Aviation charts help to navigate during flight and help pinpoint the location when an off-airport landing is made. Sectional charts have the most useful scale for cross-country soaring flights. Local road maps (with labeled roads) should be carried in the glider during all cross-country flights. Local road maps make it much easier to give directions to the ground crew, allowing them to arrive as promptly as possible. GPS coordinates also help the ground crew if they are equipped with a GPS receiver and appropriate charts and maps. Detailed GPS maps are commercially available and make GPS navigation by land easier for the ground crew.

Medical Equipment

Compact, commercially made medical or first aid kits are widely available. These kits routinely include bandages, medical tape, disinfectants, a tourniquet, matches, a knife or scissors, bug and snake repellent, and other useful items. Ensure that the kit contains medical items suitable to the environment in which the glider is operating. Stow the kit so it is secure from inflight turbulence but would be accessible to injured occupant(s)after an emergency landing, even if injured.

Stowage

Stowing equipment properly means securing all equipment to protect occupants and ensuring integrity of all flight controls and glider system controls. Items carried on board must be secured even in the event that severe inflight turbulence is encountered. Items must also remain secured in the event of a hard or off-field landing. No item carried in the glider should have any chance of becoming loose in flight to interfere with the flight controls. Stowed objects should be adequately secured to prevent movement during a hard landing.

Parachute

The parachute should be clean, dry, and stored in a cool place when not in use. It is imperative to keep the parachute free of contaminants to ensure the integrity the parachutes material. The parachute must have been inspected and repacked within the allowable time frame. The pilot is responsible for ensuring that the parachute meets with the required FAA inspection criteria.

Oxygen System Malfunctions

Oxygen is essential for flight safety at high altitude. If there is a suspected or detected failure in any component of the oxygen system, descend immediately to an altitude where supplemental oxygen is not essential for continued safe flight. Remember, the first sign of oxygen deprivation (hypoxia) is a sensation of apparent well-being. Problem-solving capability is diminished. If the pilot has been deprived of sufficient oxygen, even for a short interval, critical thinking capability has been compromised. Do not be lulled into thinking that the flight can safely continue at high altitude. Descend immediately and breathe normally at these lower altitudes for a time to restore critical oxygen to the bloodstream. Try to avoid hyperventilation, which prolongs diminished critical thinking capability. Give enough time to recover critical thinking capability before attempting an approach and landing.

For high altitude flights, such as a wave flight, the oxygen bailout bottle becomes a necessity. It should be in good condition and be within easy reach if a high altitude escape becomes necessary from the glider. Pilots need to be properly trained for an event requiring abandonment of a glider at a very high altitude, the use of oxygen, and proper use of a parachute at high altitudes.

Accident Prevention

The National Transportation Safety Board (NTSB) generates accident reports anytime a reportable soaring accident occurs. Any interested person can visit the website directly at www.ntsb.gov and look at the NTSB query database page to view summaries of both glider and towplane accidents. It is very important for all pilots to educate themselves on past accidents. In particular, they should look at the cause of the accident and how it could have been prevented. All too often accidents are caused from pilot error or equipment failure that, if trained and educated properly, the pilot could have reacted differently and saved a life, usually their own. The Soaring Safety Foundation is an excellent resource for pilots to educate themselves on glider safety and the website provides pilots with lessons learned information, as well as on-line safety learning. The Soaring Safety Foundation website is www.soaringsafety.org.