CHAPTER 8

Abnormal and Emergency Procedures

Training for abnormal and emergency procedures is an essential element in becoming a glider pilot. Knowledge of procedures for coping with control problems and instrument or equipment malfunction is especially important in soaring activities. Knowing 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. In most cases, pilots induce these oscillations through over-controlling the glider as they attempt to stop the oscillations from occurring in the first place.

PILOT—INDUCED OSCILLATIONS

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. Alarmed, 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 over-controlling the glider, it is unlikely that the oscillations will cease. More likely, they will increase in intensity until there is a complete loss of control.

Although pilot-induced oscillations can occur at any time, these situations arise most commonly during primary training. They tend 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 in a new type 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 will 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 affect, and the mass of the glider responds to the pilot's control inputs. The second step is to modify control inputs to avoid over-controlling the glider. The correct technique is to pressure the controls until the glider begins to respond in the desired direction, then ease off the pressure. As the glider nears the desired attitude, center the appropriate flight control so that overshooting does not occur.

PILOT-INDUCED PITCH OSCILLATIONS DURING LAUNCH

Pilot-induced oscillations 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. 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 pilot-induced oscillations become much less likely.

FACTORS INFLUENCING PIOS

The pitch effect of the towhook/towline combination characteristic of the glider being flown, which may cause uncommanded pitch excursions, contributes to PIOs 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. To minimize the influence of the towplane's wake, use a towline of adequate length—200 feet is the minimum length for normal 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. Do not try to lift off until confident that flying speed and good aerodynamic control have been achieved. Also, just after the moment of liftoff, 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 the glider smacking back to the ground, but not high enough for you to lose sight of the towplane below the nose of the glider. Although visually attractive to onlookers, the practice of trying to stabilize the glider just a few inches above the ground provides little margin for error if a PIO occurs.

IMPROPER ELEVATOR TRIM SETTING

The elevator trim control position also contributes to PIOs in pitch attitude. The takeoff checklist includes a check to confirm that the flight controls including elevator trim are properly set for takeoff. If the trim is properly set for takeoff, elevator pressure felt through the control stick is normal and the likelihood of PIO is reduced. If the elevator trim is set incorrectly, however, elevator pressure felt through the control stick may contribute to PIOs. If the trim is set excessively nose-down, the pilot needs 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 that is needed, the more likely it is that the pilot will over-control 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 anti-servo 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 pre-takeoff checklist and set the elevator trim in the appropriate position prior to launch to help prevent PIOs attributable to elevator trim miss-use. [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 Handbook (GFM/POH) recommend that flaps be set at zero degrees for takeoff (check the GFM/POH for the manufacturer recommendations). If the flaps are incorrectly set to a positive flap setting, which 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. PIOs are likely to result. If allowed to continue, a hard landing may result, with potential for 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 will lift off and begin to climb out while the glider is still rolling down the runway, unable to get airborne. Powerful back pressure on the stick may eventually assist the glider in leaving the runway, but the relatively high airspeed at liftoff translates into a very effective elevator, and ballooning may occur as a result of the elevator position. The pilot, startled once again by the magnitude of this pitch excursion, tries to correct by

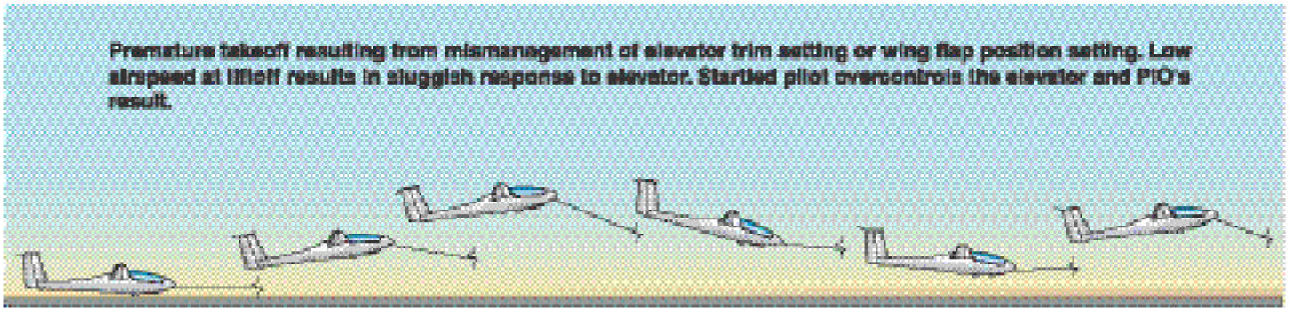

Figure 8-1. Premature takeoffs and PIOs.

applying considerable forward pressure on the control stick. A series of PIOs may result. If the PIOs continue, a hard landing may occur.

PILOT-INDUCED ROLL OSCILLATIONS DURING LAUNCH

Pilot-induced roll oscillations occur primarily during launch, particularly via aerotow. As the towpilot applies full throttle, the glider moves forward, balanced laterally on its main wheel. 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. 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 quickening response of the glider to avoid over-controlling the glider. [Figure 8-2]

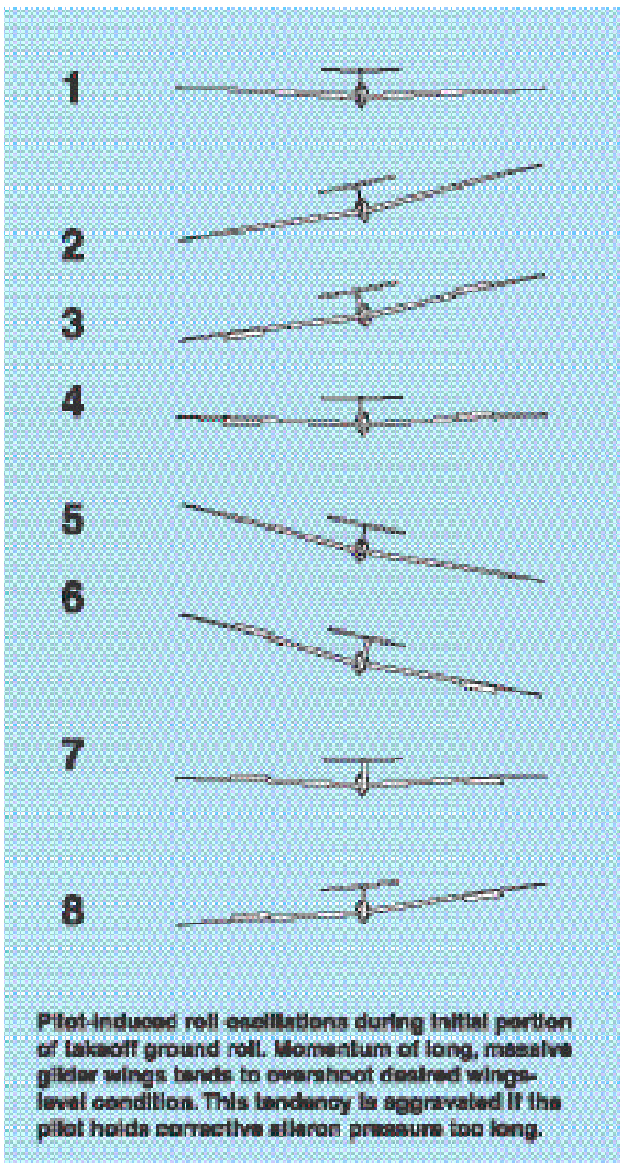

Figure 8-2. Pilot-induced roll oscillations during takeoff roll.

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 thanks to the rapid acceleration. Since control improves as acceleration increases, operations that use a powerful winch or launch vehicle are less likely to be hampered by oscillations.

Wing mass also affects roll oscillations. 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, then release the 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 groundloop 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 is veering 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. The alarmed pilot now applies considerable rudder pressure in the direction opposite from 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 to anticipate 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 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

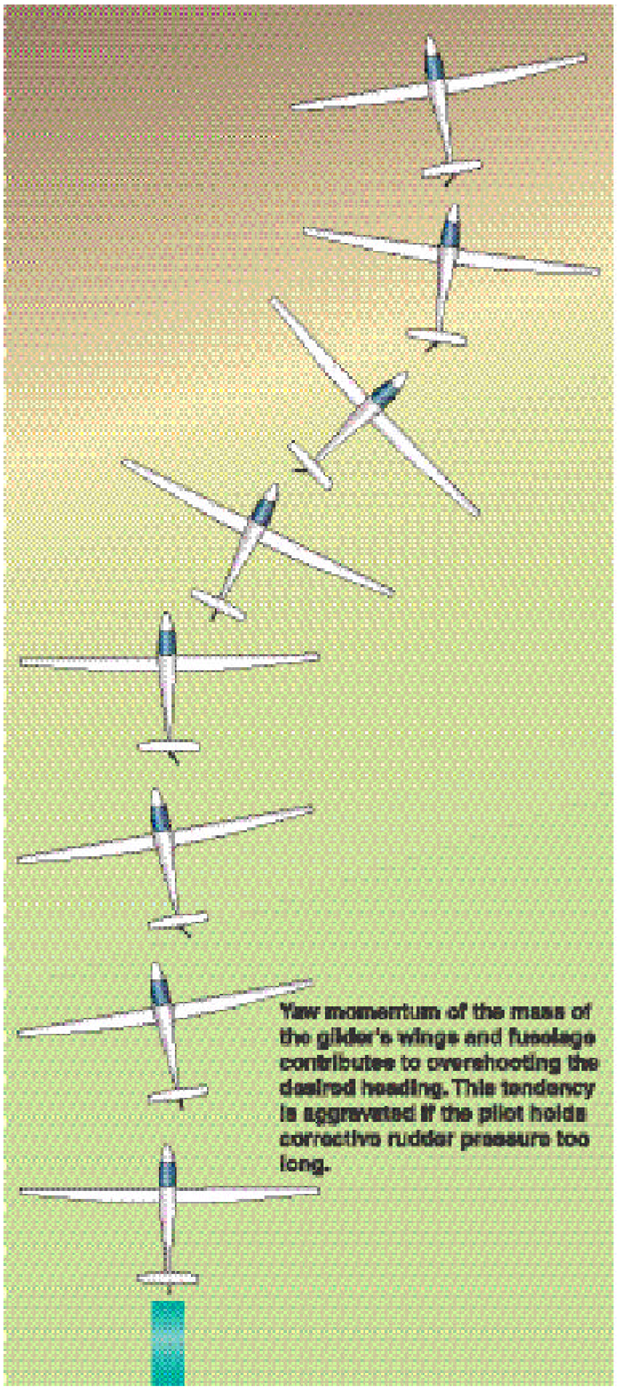

Figure 8-3. Pilot-induced yaw oscillations during

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 mass of the wings and the longer the wingspan, the more momentum the glider will exhibit whenever roll or yaw oscillations arise. Some very high performance gliders feature remarkably long and heavy wings, meaning 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 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.

If there is an opportunity to fly such a glider, study the GFM/POH thoroughly prior to flight. It is also a good idea to seek out instruction from an experienced pilot/flight instructor in what to expect during takeoff roll and landing rollout in gliders with long/heavy wings.

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. A crosswind from the right, for instance, tends to weathervane the glider into the wind, causing an uncommanded yaw to the right. Right crosswind also tends to lift the upwind wing of the glider. When crosswinds are gusty, these effects vary rapidly as the speed of the crosswind varies.

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 three hundred feet or more. If flight in these conditions cannot be avoided, then the general rule during takeoff is to achieve a faster than normal speed prior to liftoff. 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 will have a considerable effect on indicated airspeed.

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 main 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 now 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 now experiences reduced G, accompanied perhaps by a head bang against the top of the canopy. 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. With positive G the increased apparent weight of the pilot's arm tends to move the control stick aft, further increasing the angle of attack of the main wing and increasing the positive G factor as a result, in a type of vicious circle. During negative G 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 factor still further; once again, in a sort of vicious circle. In short, the effect of rapid alternations in load factor is to increase the intensity of load factor variations. One protection against this is to slow down 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 PIOs 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 over-controlling 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 soon be diving 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 is not likely to be sufficient 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 slow and the ballooning takes the glider higher than a normal flare altitude, it may be necessary to reduce the extension of the spoilers/dive breaks in order to moderate the descent rate of the glider. Care must be taken to avoid abrupt changes. Partial retraction of the spoilers/dive breaks allows the wing to provide a bit more lift despite decaying airspeed.

Another source of PIOs during the approach to landing is a too abrupt adjustment of the spoilers/dive breaks setting. The spoilers/dive breaks on most modern gliders provide a very large amount of drag when fully deployed, and they reduce the lift of the wing considerably. Over-controlling the spoilers/dive breaks during the approach to land can easily lead to oscillations in pitch attitude and airspeed. The easiest way to guard against these oscillations is to make smooth adjustments in the spoilers/dive breaks setting whenever spoilers/dive breaks adjustment is necessary. This becomes particularly important during the landing flare just prior to touchdown. If the spoilers/dive breaks are extended further with anything less than a very smooth and sure hand, the resultant increase in sink rate may cause the glider to contact the runway suddenly. 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 breaks are retracted abruptly during the flare, the glider will likely balloon into the air. Pilot reaction may result in over-controlling and PIOs may result. During the flare, it is best to leave the spoilers/dive breaks extension alone unless the glider balloons excessively. If you must adjust the spoilers/dive breaks, do so with 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. This is the case when the towhook is located in the most forward part of the gliders nose, such as in the air vent intake hole. This is the ideal location for the aerotow hook for most gliders.

The towhook on many gliders is located below or aft of this ideal location. In particular, many European gliders have the towhook located on the belly of the glider, just forward of the main landing gear, far below the longitudinal axis of the glider. The glider's center of mass is well 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 bellyhook-equipped gliders, 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 will be conducted in turbulent air. The potential for inducing pitch 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 in a bellyhook-equipped glider, the pilot must be alert to variations in towline tension and adjust pressure on the control stick to counteract the pitch effect of variations in towline tension.

SELF-LAUNCH GLIDER OSCILLATIONS DURING POWERED FLIGHT

Gliders equipped with an extended pod engine and propeller located high above the glider's longitudinal axis exhibit a complex relationship between power setting and pitch attitude. When power changes are made, the location of the thrust line of the propeller in this location has a noticeable effect on pitch attitude. The changing speed of the propwash over the elevator causes considerable variation in elevator effectiveness, modifying pitch attitude still further. 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. This gives the pilot time to recognize and counteract the effect the power setting change has on pitch attitude. In most self-launched gliders, the effect is greatest when flying at or near minimum controllable airspeed (MCA). Self-launch glider pilots avoid slow flight when flying at low altitude under power. [Figure 8-5]

Self-launch gliders may also be susceptible to PIOs during takeoff roll, particularly those with a pylon engine mounted high above the longitudinal axis. The high thrust line and the propeller wash influence on the air flow over the self-launch 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 as well, 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 taxi operations, if the pneumatic nosewheel remains in contact with the ground, any bump will compress 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 will contact the runway, compress, and rebound. 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.

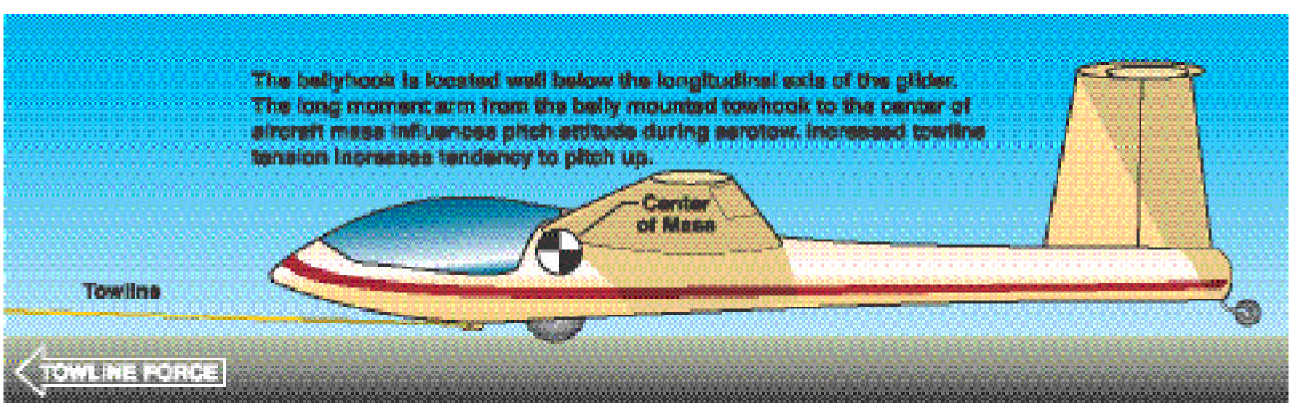

Figure 8-4. Effect of increased towline on pitch altitude of bellyhook-equipped glider during aerotow.

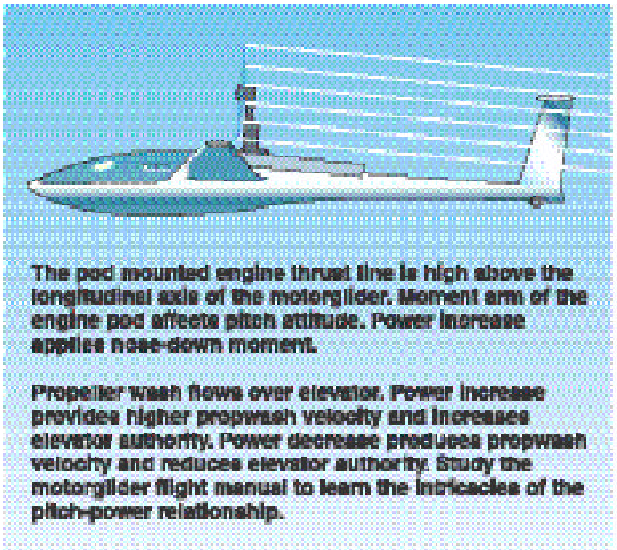

Figure 8-5. Pitch attitude power setting relationships for self-launch glider with engine pod.

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 mainwheel and tailwheel touch simultaneously. During rollout, use the elevator to keep the nosewheel off the ground for as long as possible.

TAILWHEEL/TAILSKID EQUIPPED GLIDER OSCILLATIONS DURING LAUNCHES AND LANDINGS

Some two-seat gliders, self-launch gliders, and single-seat gliders have a tailwheel. When loaded and ready for flight, these gliders have the mainwheel 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 tail wheel 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 will leave 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 will result 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 will provide significant upward thrust. The glider nose may pitch up, the angle of attack will increase, and the glider will become 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 off a few inches above the ground with gentle backpressure on the control stick as necessary. The speed will decay and the pitch attitude will gradually change 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 is very acceptable and desirable for almost all 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.

OFF-FIELD LANDING PROCEDURES

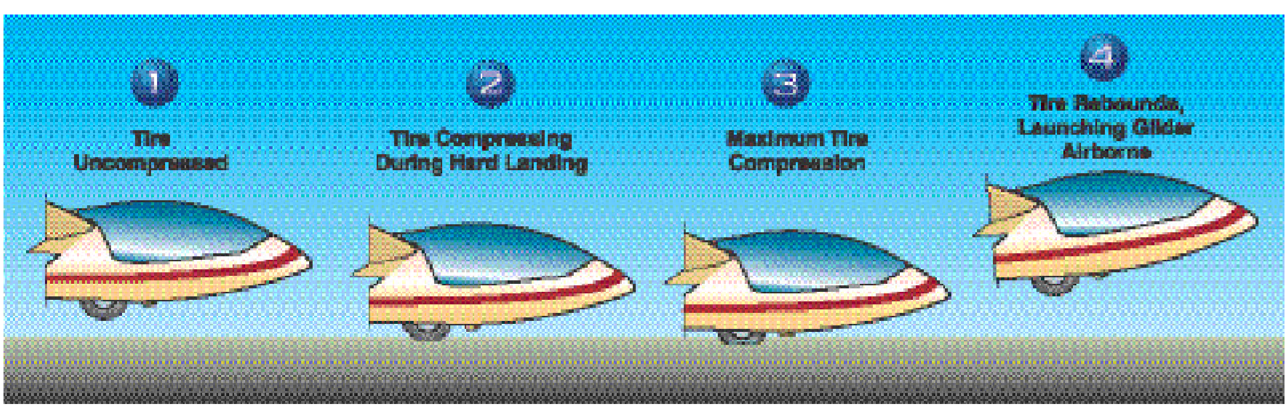

Figure 8-6. Pneumatic tire rebound during hard landing.

The possibility of an off-field landing is present on virtually every cross-country soaring flight, even when flying in a self-launch glider. If the engine or power system fails and there is no airport within gliding range, then an off-field landing may be inevitable. It should be noted that many glider pilots who were not flying cross-country have faced the necessity of performing an off-field landing. Root causes of off-field landings while engaged in soaring in the vicinity of the launching airport include rapid weather deterioration, a significant change in wind direction, unanticipated amounts of sinking air, disorientation, or lack of situational awareness. 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 consistently make accurate landings in the glider type being flown. These ingredients can be summarized as follows:

- Recognize the possibility of imminent off-field landing.
- Select a suitable area, then a suitable landing field within that area.
- Plan your approach with wind, obstacles, and local terrain in mind.
- Execute the approach, land, and then stop the glider as soon as possible.

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 to do so, in the pilot's mind, will probably result in such a landing. 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 will be little or no time to plan an off-field landing if the attempt to climb away does not succeed. It is much better and safer to thoroughly understand the techniques for 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. Heading downwind offers a greater geographical area to search than flying upwind. A tailwind during downwind cruise results in a greater range, 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 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 foremost in mind. During an off-field landing approach, the precise elevation of the landing site normally will not be available 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 strong headwind, the approach angle is steep. If headwind is light or non-existent, 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 will be shallower. Remember to clear each visible obstacle with safe altitude, clearing any wires by a safe margin.

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 there. 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 harder to see from pattern altitude. Take a careful look around to find them. Power lines and wires are nearly impossible to see from pattern altitude; 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 your approach to over fly the wires that may be present, even if you cannot see them. The more you see of the landing area 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 8-7]

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, you must consider how the obstacle effects the length of landing area that is actually going to be available for touchdown, rollout, and stopping the glider. If an obstacle is 50 feet high, the first 500 feet or so of the landing area will be over flown as you descend to flare and land. If the field selected has obstacles on the final approach path, remember that the field will have to be long enough to accommodate the descent to flare altitude after clearing the obstacle.

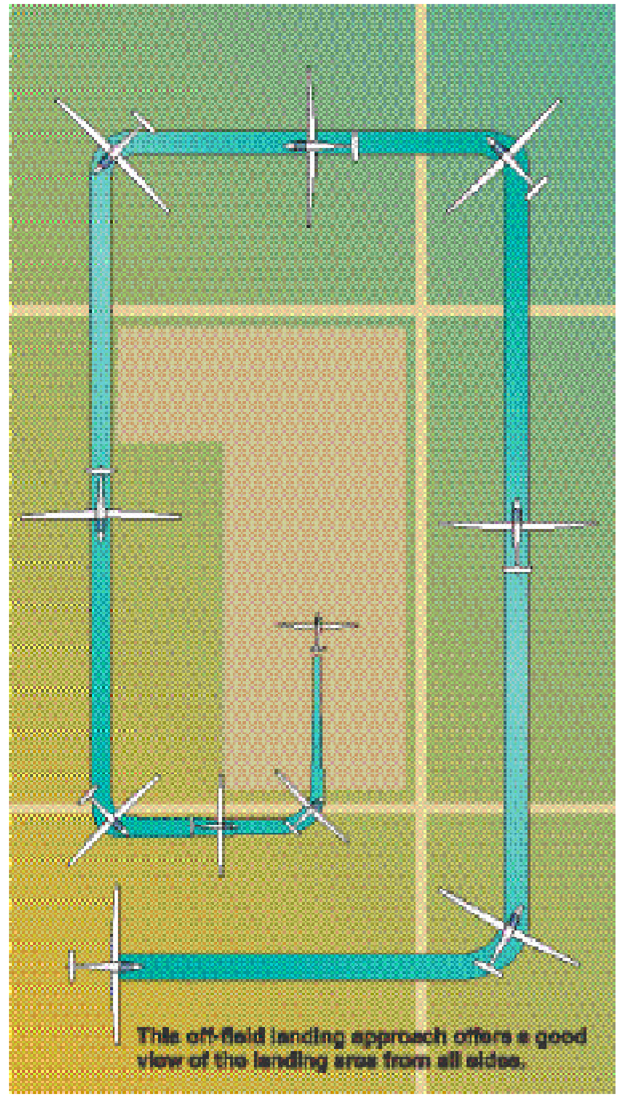

Figure 8-7. Off-field landing approach.

Hold the glider off during the flare and touch down at the lowest safe speed manageable. After touchdown, use the wheelbrake 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.

AFTER LANDING OFF-FIELD

OFF-FIELD LANDING WITHOUT INJURY

If uninjured, tend to personal needs 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. Use a cell phone to call 911 if nervous about personal safety. To help identify your 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 your 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. Once contact has been made with outsiders to arrange for retrieval, take care of minor items such as collecting any special tools that are needed for glider de-rigging 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 assistance you can identify. Use the glider radio, if operable, to broadcast a Mayday distress call on the emergency frequency 121.5 MHz. Many in-flight aircraft routinely monitor this frequency. 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 home in on this signal, reducing the time spent searching for your exact location. If the two-way radio is operable and you want to transmit a voice message on 121.5 MHz, turn the ELT switch to OFF in order for the voice message to be heard. If cell phone coverage is available, dial 911 to contact emergency personnel. If possible, include a clear description of your 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 not safe 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, if at all possible, to stay with the glider. The glider bulk is likely to be much easier to locate from the air than is an individual person. The pilot may be able to obtain a measure of protection from the elements by crawling into the fuselage, 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.

SYSTEMS AND EQUIPMENT MALFUNCTIONS

FLIGHT INSTRUMENT MALFUNCTIONS

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

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 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 full spoilers/dive breaks 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 breaks 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 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. An excellent opportunity to review these procedures is when accompanied by a glider flight instructor during the flight review.

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 cues to sources of lift. Some cues 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 your 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 in orientation also. Section lines and major roads often provide helpful cues to orientation as well.

GLIDER CANOPY MALFUNCTIONS

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.

GLIDER CANOPY OPENS UNEXPECTEDLY

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 tow-plane 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 companion aboard, concentrate on flying 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 will be higher than normal, so when flying the approach it is best to plan a steeper-than-normal descent path. The best prevention against unexpected opening of the canopy is proper use of the pre-takeoff checklist.

BROKEN GLIDER CANOPY

If the canopy plexiglas is damaged or breaks during flight the best response is to land as soon as practicable. Drag will be increased 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 out 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, then abandoning the glider may be the safest choice. The best prevention for water ballast problems are 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 break than normal during the approach. Try to land on the smoothest surface available. Allow the glider to touch down at a slightly faster airspeed than would be used if the landing gear were extended. This helps avoid a tailwheel-first landing, and a hard thump of the glider onto the runway. Avoiding the hard thump will help to avoid back injury. The glider will make considerable noise as the glider slides along the runway, and wingtip clearance above the ground will be much reduced. Keep the wings level for as long as possible. Try to keep the glider going as straight as possible using the rudder to yaw the glider. The primary goal is to avoid collision with objects on the ground or along the runway border. Accept the fact that minor 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 failures 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, that all safety pins have been installed and latched properly. Ensure that a positive control check against resistance applied 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 towpilot. 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. If wearing a parachute, high altitude gives more time to abandon the glider and deploy the parachute.

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 breaks, elevator trim system, and raising or lowering the landing gear. If flying a self-launch 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 will provide, in effect, a small spoiler that disturbs the airflow over the elevator just aft of the lifted seal. Elevator blanking occurring 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 will be 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 failures include the following.

- An improper connection of the aileron control circuit during assembly.
- An aileron control lock that was not removed before flight.
- A separation of the aileron gap seal tape.
- An interference of a foreign object with free and full travel of the control stick or aileron circuit.
- A seat 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 and/or aileron flutter.

These failures can sometimes be counteracted successfully. Part of the reason for this is that 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 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 bank effect is a secondary effect of the rudder. If the pilot must resort to using the rudder to bank the glider wings, keep all banks shallow. 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 will be 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 most likely occur due to 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 groundloop 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 soaring 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 be careful 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 can not be retrieved and stowed, a precautionary landing may be required.

SECONDARY FLIGHT CONTROL 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 are connected, then one or both of the spoilers/dive brakes may deploy at any time and retraction will be 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. Another reason is that the spoilers/dive brakes might deploy asymmetrically: one spoiler/dive brake retracted, the other spoiler/dive brake extended. This results in a yaw tendency and a roll tendency that does not arise when the spoilers/dive brakes deploy symmetrically. The final reason is that it will not be 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, relieving the asymmetry. 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 cold or icing during long, high altitude flights, such as might occur during a mountain wave flight. The cold 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 heat, 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. If a decision is made to fly with one spoiler/dive brake extended and the other retracted, the wing with the extended spoiler/dive brake creates less lift and more drag than the other wing. 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 will be much easier but gliding range will be 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 just like 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 towrope 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 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 that 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 will prolong 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 the spoilers/dive breaks provide. The drogue chute is packed and stowed in the aft tip 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 takeoff roll or during climb, the rate of climb will be seriously degraded 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 fan the rudder several times to yaw the tail of the glider back and forth in rapid alternation. Make certain to have safe flying speed before attempting the slip or fanning the rudder. Either technique increases the drag on the tailcone 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 will result 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 when the drogue chute evacuates the chute compartment, but fails to inflate fully. If this happens, the canopy will "stream" 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 will increase substantially. If in doubt regarding the degree of deployment of the drogue chute, the safest option may be to jettison the drogue.

SELF-LAUNCH GLIDERS

In addition to the standard flight control systems found on all gliders, self-launch 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-launch glider being flown. Any malfunction of these systems can make it impossible to resume powered flight.

SELF-LAUNCH GLIDER ENGINE FAILURE DURING TAKEOFF OR CLIMB

Engine failures are the most obvious source of equipment malfunction in self-launch 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 or 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 are not satisfied. Monitor the engine temperature, oil pressure, fuel pressure, and RPM carefully to ensure engine performance is not compromised. Warning signs of impending difficulty include excess engine temperatures, excess engine oil temperatures, low oil pressure, low RPM despite high throttle settings, low fuel pressure, and engine missing or backfiring. 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 and discover the source of the trouble after safely on the ground.

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-launch 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 will be 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-launch 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 you can. 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 you could manage to restore power in the engine system, chances are that full power will not be 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 RE-START A SELF-LAUNCH 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 self-launch glider pilot. 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-launch glider is the option to terminate a soaring flight by starting the engine and flying to an airport/gliderport for landing. Nearly all self-launch 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 so that if a malfunction occurs there will be 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 will result in an emergency off-field landing in unsuitable terrain. Glider damage and personal injury may result. To avoid these dangers, self-launch 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 always keep a landable field within easy gliding range. There are many reasons that a self-launch 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-LAUNCH 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-launch gliders require that the propeller blades be placed in a particular blade pitch position. If the propeller blades can not be properly adjusted, then the propeller will not deliver enough torque to turn the engine over. The result is a failure to obtain an air-driven engine start.

SELF-LAUNCH GLIDER ELECTRICAL SYSTEM MALFUNCTIONS

An electrical system failure in a self-launch 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 re-start attempt. Self-launch gliders that require a functioning electric starter for an air re-start will be 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-launch gliders are occasionally used for night flight, cruising under power and operating the necessary aeronautical lighting. If an electrical system failure occurs during night operations, pilots of nearby aircraft are not able to see the self-launch glider due to the extinguished position lights. Inside the cockpit, it is difficult or impossible to see the flight instruments or electrical circuit breakers. Carry a flashlight for such an emergency. Check the circuit breakers and reset any breaker that has overloaded unless the smell of smoke is present or any other indication of an overheating circuit. [Figure 8-8] Head directly for the nearest airport and prepare for a precautionary landing there. 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 aboard for use in such an emergency.

Figure 8-8. Self-launch glider circuit breakers.

IN-FLIGHT FIRE

In-flight fires are the most serious emergencies 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-launch 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-launch glider immediately.

After landing, get far away from the glider. Keep onlookers away from the glider as well. The principal danger after evacuating the glider is that the fuel will ignite and explode, with the potential to injure personnel at considerable distance from the glider.

EMERGENCY EQUIPMENT AND SURVIVAL GEAR

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

SURVIVAL GEAR ITEM CHECKLISTS

Checklists help 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 (high-energy foods such as energy bars, granolas, and dried fruits are usually best) 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 reachable during the entire flight. Pilot relief for urination should also be easy to access and use.

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, 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 are 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.

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 will elicit a response. The ELT can be used to provide a continuous signal on 121.5 MHz. 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 recognition 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, painkillers and other medicines, 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 you are operating. Stow the kit so it is secure from in-flight turbulence but is accessible after an emergency landing, even if injured.

STOWAGE

Stowing equipment properly means securing all equipment to protect occupants and ensure integrity of all flight controls and glider system controls. Items carried aboard must be secure even in the event that severe in-flight 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 coming loose in flight to interfere with the flight controls. Stowed objects should be adequately secured to prevent movement during a hard landing.

OXYGEN SYSTEM

The oxygen system is a life support system during flights at high altitude. Ensure that all components of the system are in working condition and that the bottle has a sufficient charge of aviators' breathing oxygen. The oxygen bailout bottle should be in good condition and in an easy-to-reach position should the need to abandon the glider at very high altitude arise. The bailout bottle is most commonly stowed aboard the glider when embarking on high-altitude flights in mountain wave conditions.

PARACHUTE

The parachute should be clean, dry, and be stored in a cool place when not in use. The parachute must have been inspected and repacked within the allowable time frame. For synthetic canopy parachutes this interval is 120 days.