

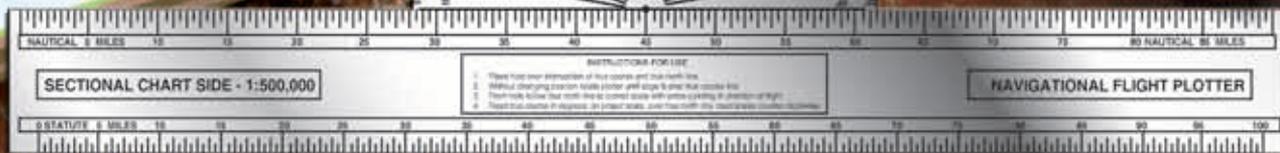
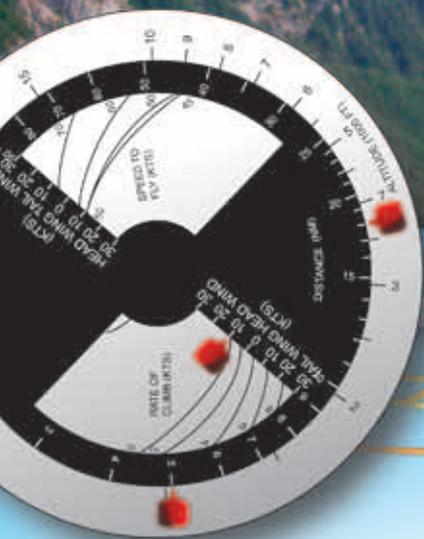
Chapter II

Cross-Country Soaring

Introduction

A cross-country flight is defined as one in which the glider has flown beyond gliding distance from the local soaring site. Cross-country soaring seems simple enough in theory; in reality, it requires a great deal more preparation and decision-making than local soaring flights. Items that must be considered during cross-country flights are how good the thermals ahead are, and if they will remain active, what the landing possibilities are, which airport along the course has a runway that is favorable for the prevailing wind conditions. What effect will the headwind have on the glide? What is the best speed to fly in sink between thermals?

Flying cross-country using thermals is the basis of this chapter. A detailed description of cross-country soaring using ridge or wave lift is beyond the scope of this chapter.



Flight Preparation and Planning

Adequate soaring skills form the basis of the pilot's preparation for cross-country soaring. Until the pilot has flown several flights in excess of 2 hours and can locate and utilize thermals consistently, the pilot should focus on improving those skills before attempting cross-country flights.

Any cross-country flight may end in an off-field landing, so short-field landing skills are essential. These landings should be practiced on local flights by setting up a simulated off-field landing area. Care is needed to avoid interfering with the normal flow of traffic during simulated off-field landings. The first few simulated landings should be done with an instructor, and several should be done without the use of the altimeter.

The landing area can be selected from the ground, but the best training is selecting one from the air. A self-launching glider or other powered aircraft for landing area selection training and simulated approaches to these areas is a good investment, if one is available.

Once soaring skills have been honed, the pilot needs to be able to determine position along a route of flight. A Sectional Aeronautical Chart, or sectional, is a map soaring pilots use during cross-country flights. They are updated every 6 months and contain general information, such as topography, cities, major and minor roads and highways, lakes, and other features that may stand out from the air, such as a ranch in an otherwise featureless prairie. In addition, sectionals show the location of private and public airports, airways, restricted and warning areas, and boundaries and vertical limits of different classes of airspace. Information on airports includes field elevation, orientation and length of all paved runways, runway lighting, and radio frequencies in use. Each sectional features a comprehensive legend. A detailed description of the sectional chart is found in FAA-H-8083-25, the Pilot's Handbook of Aeronautical Knowledge. *Figure 11-1* shows a sample sectional chart.

The best place to become familiar with sectional charts is on the ground. It is instructive to fly some "virtual" cross-country flights in various directions from the local soaring site. In addition to studying the terrain (hills, mountains, large lakes) that may affect the soaring along the route, study the various lines and symbols. What airports are available on course? Do any have a control tower? Can all the numbers and symbols for each airport be identified? If not, find them on the legend. Is there Class B, C, or D airspace en route? Are there any restricted areas? Are there airways along the flightpath? Once comfortable with the sectional from ground study, it can be used on some local flights to practice locating features within a few miles of the soaring site.



Figure 11-1. Excerpt from a Sectional Aeronautical Chart.

Any cross-country flight may end with a landing away from the home soaring site, so pilots and crews should be prepared for the occurrence prior to flight. Sometimes an aerotow retrieve can be made if the flight terminates at an airport; however, trailer retrieval is more typical. Both the trailer and tow vehicle need a preflight before departing on the flight. The trailer should be roadworthy and set up for the specific glider. Stowing and towing a glider in an inappropriate trailer can lead to damage. The driver should be familiar

with procedures for towing and backing a long trailer. The tow vehicle should be strong and stable enough for towing. Both radio and telephone communication options should be discussed with the retrieval crew.

Before any flight, obtain a standard briefing and a soaring forecast from the Automated Flight Service Station (AFSS). As discussed in Chapter 9, Soaring Weather, the briefer supplies general weather information for the planned route, as well as any NOTAMs, AIRMETs, or SIGMETs, winds aloft, an approaching front, or areas of likely thunderstorm activity. Depending on the weather outlook, beginners may find it useful to discuss options with more experienced cross-country pilots at their soaring site.

Many pilots have specific goals in mind for their next cross-country flight. Several options should be planned ahead based on the area and different weather scenarios. For instance, if the goal is a closed-course 300 nautical mile (NM) flight, several likely out-and-return or triangle courses should be laid out ahead of time, so that on the specific day, the best task can be selected based on the weather outlook. There are numerous final details that need attention on the morning of the flight, so special items should be organized and readied the day before the flight.

Lack of preparation can lead to delays, which may mean not enough of the soaring day is left to accomplish the planned flight. Even worse, poor planning leads to hasty last-minute preparation and a rush to launch, making it easy to miss critical safety items.

Inexperienced and experienced pilots alike should use checklists for various phases of the cross-country preparation in order to organize details. When properly used, checklists can help avoid oversights, such as sectionals left at home, barograph not turned on before takeoff, etc. Checklists also aid in making certain that safety of flight items, such as all assembly items, are checked or accomplished, oxygen turned on, drinking water is in the glider, etc. Examples of checklists include the following:

- Items to take to the gliderport (food, water, battery, charts, barograph).
- Assembly must follow the Glider Flight Manual/Pilot's Operating Handbook (GFM/POH) and add items as needed.
- Positive control check.
- Prelaunch (water, food, charts, glide calculator, oxygen on, sunscreen, cell phone).
- Pretakeoff checklist itself.
- Briefing checklist for tow pilot, ground crew, and retrieval crew.

Being better organized before the flight leads to less stress during the flight, enhancing flight safety.

Personal and Special Equipment

Many items not required for local soaring are needed for cross-country flights. Pilot comfort and physiology is even more important on cross-country flights since these flights often last longer than local flights. An adequate supply of drinking water is essential to avoid dehydration. Many pilots use the backpack drinking system with readily accessible hose and bite valve that is often used by bicyclists. This system is easily stowed beside the pilot, allowing frequent sips of water. A relief system also may be needed on longer flights. Cross-country flights can last up to 8 hours or more, so food of some kind is also a good idea.

Several items should be carried in case there is an off-field landing. (For more details, see Chapter 8, Abnormal and Emergency Procedures.) First, a system for securing the glider is necessary, as is a land-out kit for the pilot. The kit varies depending on the population density and climate of the soaring area. For instance, in the Great Basin in the United States, a safe landing site may be many miles from the nearest road or ranch house. Since weather is often hot and dry during the soaring season, extra water and food should be added items. Taking good walking shoes is a good idea as well. A cell phone may prove useful for landouts in areas with some telephone coverage. Some pilots elect to carry an Emergency Position Indicating Radio Beacon (EPIRB) in remote areas in case of mishap during an off-field landing.

Cross-country soaring requires some means of measuring distances to calculate glides to the next source of lift or the next suitable landing area. Distances can be measured using a sectional chart and navigational plotter with the appropriate scale, or by use of Global Positioning System (GPS). If GPS is used, a sectional and plotter should be carried as a backup. A plotter may be made of clear plastic with a straight edge on the bottom marked with nautical or statute miles for a sectional scale on one side and World Aeronautical Chart (WAC) scale on the other. On the top of the plotter is a protractor or semicircle with degrees marked for measuring course angles. A small reference index hole is located in the center of the semicircle. [Figure 11-2] Prior to taking off, it may be handy to prepare a plotter for the specific glider's performance by applying some transparent tape over the plotter marked with altitudes versus range rings in still air. After a little use, the glider pilot should gain a perception of the glide angle most often evident in the conditions of the day.

Glide calculations must take into account any headwind or tailwind, as well as speeds to fly through varying sink rates as discussed in chapter 5. Tools range widely in their level

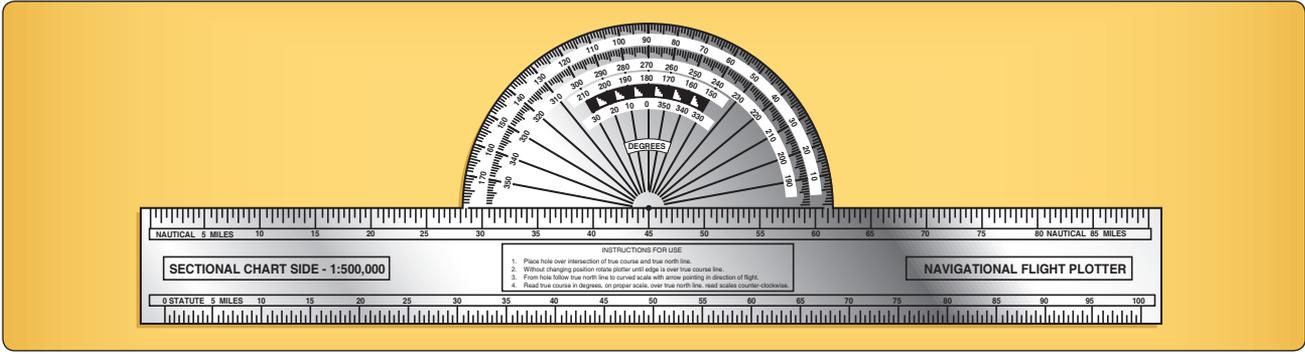


Figure 11-2. Navigational plotter.

of sophistication, but all are based on the performance polar for the particular glider. Most high-performance gliders usually have glide/navigation computers that automatically compute the glide ratio (L/D). The simplest glide aid is a table showing altitudes required for distance versus wind, which can be derived from the polar. To avoid a table with too many numbers, which could be confusing, some interpolation is often needed. Another option is a circular glide calculator as shown in Figure 11-3. This tool allows the pilot to read the altitude needed for any distance and can be set for various estimated headwinds and tailwinds. Circular glide calculators also make it easy to determine whether a pilot is actually achieving the desired glide, since heavy sink or a stronger-than-estimated headwind can cause a loss of more height with distance than was indicated by the calculator. For instance, the settings in Figure 11-3 indicate that for the estimated 10 knot headwind, 3,600 feet is required to glide 18 miles. After gliding 5 miles, there is still 2,600 feet. Note that this only gives the altitude required to make the glide.

The pilot can also use simple formulas to mentally compute an estimated L/D. One hundred feet per minute (fpm) is approximately 1 knot. To compute your glide ratio, take groundspeed divided by vertical speed as indicated on a vertical speed indicator (VSI) or variometer, then divide by 100 (just drop the zeros). If groundspeed is not available, use indicated airspeed, which will not yield as accurate a result as groundspeed. In this case, groundspeed or indicated airspeed is 60 knots. VSI shows 300 fpm down. Calculate the glide ratio.

$$\frac{\text{VSI}}{100} = \text{vertical speed in knots}$$

$$\frac{300 \text{ fpm}}{100} = 3 \text{ knots}$$

$$\frac{\text{Groundspeed}}{\text{Vertical speed}} = \text{Glide ratio}$$

$$\frac{60 \text{ knots}}{3 \text{ knots}} = 20, \text{ a glide ratio of } 20:1$$

This is a good approximation of the current L/D.

Another method is to basically recompute a new L/D by utilizing this standard formula. Glide ratio, with respect to the air (GRA) or L/D, remains constant at a given airspeed. For example, your glider's glide ratio, lift over drag (L/D) is 30 to 1 expressed as 30:1 at a speed of 50 knots. At 50 knots with an L/D of 30:1, a 10-knot tailwind results in an effective L/D of 36:1. [Figure 11-4]

In addition to a glide calculator, a MacCready ring on the variometer allows the pilot to easily read the speed to fly for different sink rates. MacCready rings are specific to the type of glider and are based on the glider performance polar. (See Chapter 4, Flight Instruments, for a description of the MacCready ring.) Accurately flying the correct speed in sinking air can extend the achieved glide considerably.

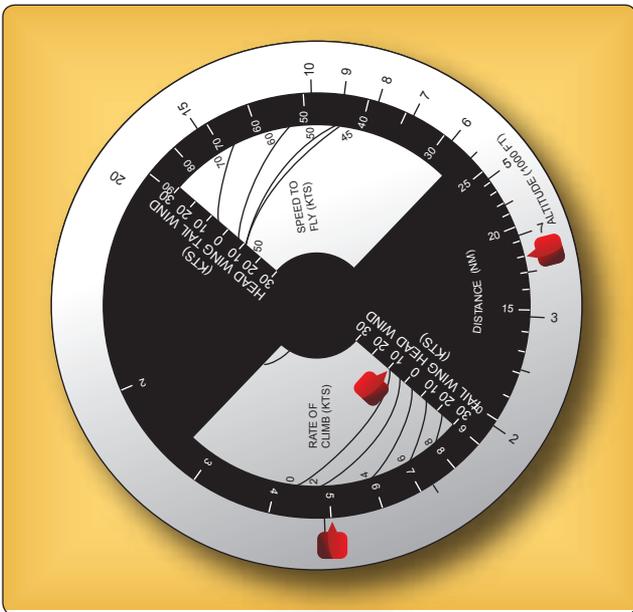


Figure 11-3. Circular glider calculator.

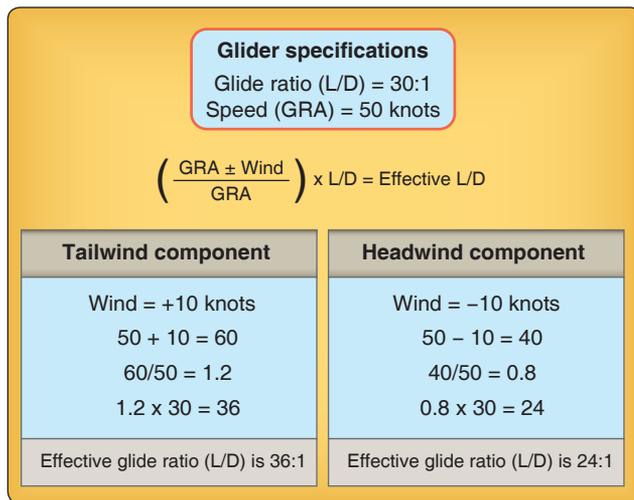


Figure 11-4. Glide calculation example.

Many models of electronic glide calculators now exist. Often coupled with an electronic variometer, they display the altitude necessary for distance and wind as input by the pilot. In addition, many electronic glide calculators feature speed-to-fly functions that indicate whether the pilot should fly faster or slower. Most electronic speed-to-fly directors include audio indications, so the pilot can remain visually focused outside the cockpit. The pilot should have manual backups for electronic glide calculators and speed-to-fly directors in case of a low battery or other electronic system failure.

Other equipment may be needed to verify soaring performance to receive a Federation Aeronautique Internationale (FAI) badge or record flights. These include turn-point cameras, barographs, and GPS flight recorders. For complete descriptions of these items, as well as badge or record rules, check the Soaring Society of America website (www.ssa.org) for details.

Finally, a notepad or small leg-attached clipboard on which to make notes before and during the flight is often handy. Notes prior to flight could include weather information such as winds aloft forecasts or distance between turn points. In flight, noting takeoff and start time, as well as time around any turn points, is useful to gauge average speed around the course.

Navigation

Airplane pilots navigate by pilotage (flying by reference to ground landmarks) or dead reckoning (computing a heading from true airspeed and wind, and then estimating time needed to fly to a destination). Glider pilots use pilotage since they generally cannot remain on a course line over a long distance and do not fly one speed for any length of time. Nonetheless, it is important to be familiar with the concepts of dead reckoning since a combination of the two methods is sometimes needed.

Using the Plotter

Measuring distance with the plotter is accomplished by using the straight edge. Use the Albuquerque sectional chart and measure the distance between Portales Airport (Q34) and Benger Airport (Q54), by setting the plotter with the zero mark on Portales. Read the distance of 47 nautical miles (NM) to Benger. Make sure to set the plotter with the sectional scale if using a sectional chart (as opposed to the WAC scale), otherwise the measurement will be off by a factor of two. [Figure 11-5]

The true heading between Portales and Benger can be determined by setting the top of the straightedge along the course line, then slide it along until the index hole is on a line of longitude intersecting the course line. Read the true heading on the outer scale, in this case, 48°. The outer scale should be used for headings with an easterly component. If the course were reversed, flying from Benger to Portales, use the inner scale, for a westerly component, to find 228°. [Figure 11-6]

A common error when first using the plotter is to read the course heading 180° in error. This error is easy to make by reading the scale marked W 270° instead of the scale marked E 09°. For example, the course from Portales to Benger is towards the northeast, so the heading should be somewhere between 30° and 60°, therefore the true heading of 48° is reasonable.

A Sample Cross-Country Flight

For training purposes, plan a triangle course starting at Portales Airport (PRZ), with turn points at Benger Airport (X54), and the town of Circle Back. As part of the preflight preparation, draw the course lines for the three legs. Using the plotter, determine the true heading for each leg, then correct for variation and make a written note of the magnetic heading on each leg. Use 9° east (E) variation as indicated on the sectional chart (subtract easterly variations, and add westerly variations). The first leg distance is 47 NM with a heading of 48° (48° - 9° E = 39° magnetic); the second leg is 38 NM at 178° true (178° - 9° E = 169° magnetic); the third leg is 38 NM at 282° true (282° - 9° E = 273° magnetic). [Figure 11-7]

Assume the base of the cumulus is forecast to be 11,000 MSL, and the winds aloft indicate 320° at 10 knots at 9,000 MSL and 330° at 20 knots at 12,000 MSL. Make a written note of the winds aloft for reference during the flight. For instance, the first leg has almost a direct crosswind from the left; on the second leg, a weaker crosswind component from the right; while the final leg is almost directly into the wind. Knowing courses and approximate headings aids the navigation and helps avoid getting lost, even though deviations to stay with the best lift are needed. During the flight, if the sky ahead

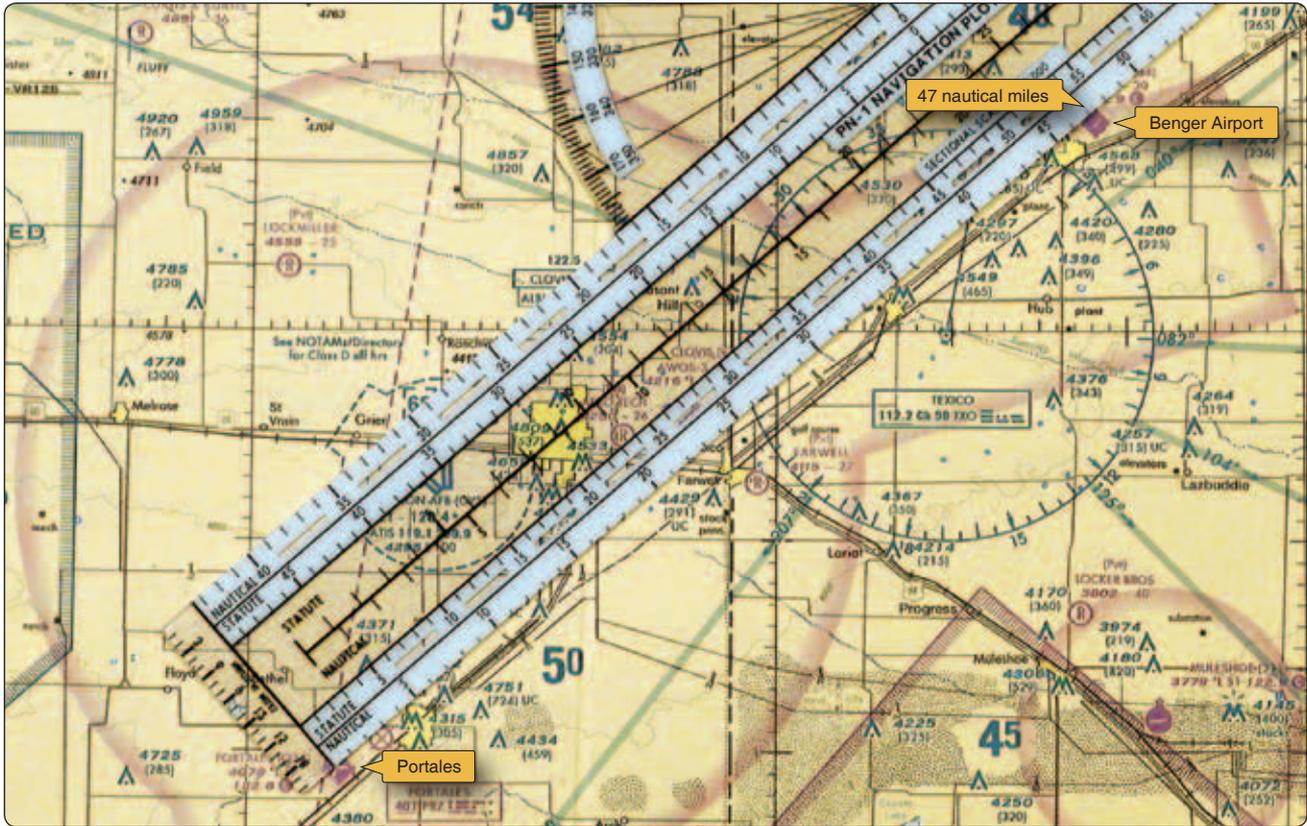


Figure 11-5. Measuring distance using the navigation plotter.

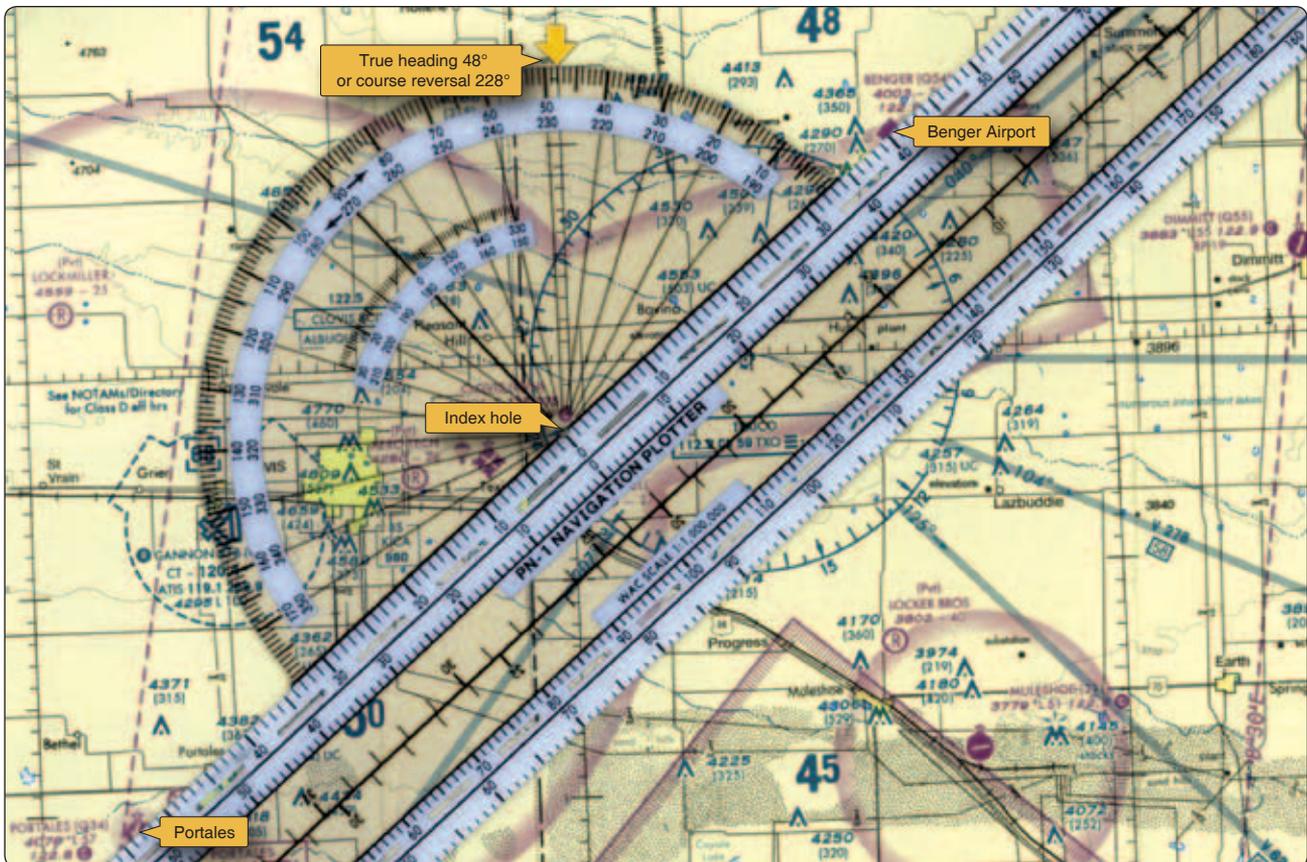


Figure 11-6. Using the outer and inner scales of the navigation plotter.

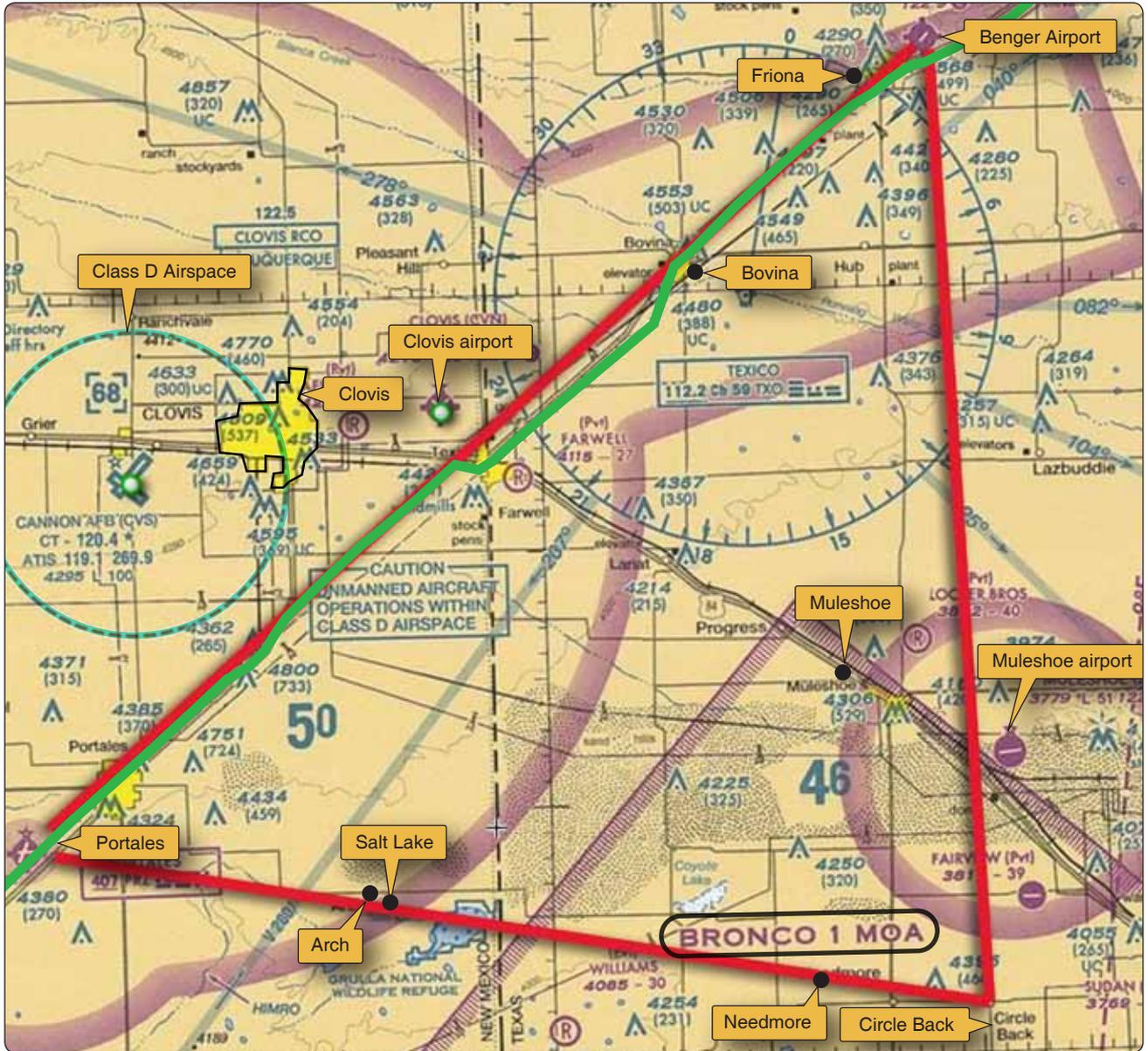


Figure 11-7. Cross-country triangle.

shows several equally promising cumulus clouds, choosing the one closest to the course line makes the most sense.

During preflight preparation, study the course line along each leg for expected landmarks. For instance, the first leg follows highway and parallel railroad tracks for several miles before the highway turns north. The town of Clovis should become obvious on the left. Note the Class D airspace around Cannon Air Force Base (CVS) just west of Clovis—this could be an issue if there is better soaring north of course track because of military traffic operating into Cannon. With the northwesterly wind, it is possible to be crossing the path of aircraft on a long final approach to the northwest-southeast runway at the air base.

Next is the Clovis airport (CVN) with traffic to check operating in and out of the airport. Following Clovis are Bovina and Friona; these towns can serve as landmarks for the flight. The proximity of the Texico (TXO) VOR, a VHF Omnidirectional Range station near Bovina, indicates the need for alertness for power traffic in the vicinity. The VOR serves as an approach aid to the Clovis airport.

The first turn point is easy to locate because of good landmarks, including Bengier Airport (X54). [Figure 11-8] The second leg has fewer landmarks. After about 25 miles, the town of Muleshoe and the Muleshoe airport (2T1) should appear. The town should be on the right and the airport on the left of the intended course. Next, the course enters the Bronco 1 Military Operations Area (MOA). The dimensions of the



Figure 11-8. Benger Airport (X54).

MOA can be found on the sectional chart, and the automated flight service station (AFSS) should be consulted concerning the active times of this airspace. Approaching the second turn point, it is easy to confuse the towns of Circle Back and Needmore. [Figure 11-9] The clues are the position of Circle Back relative to an obstruction 466 feet above ground level (AGL) and a road that heads north out of Needmore. Landmarks on the third leg include power transmission lines, Salt Lake (possibly dry), the small town of Arch, and a major road coming south out of Portales. About eight miles from Portales a VOR V-280 airway is crossed.



Figure 11-9. Circle Back and Needmore.

After a thorough preflight of the glider and all the appropriate equipment is stowed or in position for use in flight, it is time to go fly. Once in the air and on course, try to verify the winds aloft. Use pilotage to remain as close to the course line as soaring conditions permit. If course deviations become necessary, stay aware of the location of the course line to the next turn point. For instance, the Cu directly ahead indicates lift, but the one 30° off course indicates possibly even more lift,

it may be better not to deviate. If the Cu left of course indicates a possible area of lift compared to the clouds ahead and only requires a 10° off course deviation, proceed towards the lift. Knowing the present location of the glider and where the course line is located is important for keeping situational awareness.

Sometimes it is necessary to determine an approximate course once already in the air. Assume a few miles before reaching the town of Muleshoe, on the second leg, the weather ahead is not as forecast and has deteriorated—there is now a shower at the third turn point (Circle Back). Rather than continuing on to a certain landing in the rain, the decision is made to cut the triangle short and try to return directly to Portales. Measure and find that Portales is about 37 miles away, and the estimated heading is about 240°. Correct for variation (9°) for a compass heading of about 231° ($240^\circ - 9^\circ = 231^\circ$). The northwesterly wind is almost 90° to the new course and requires a 10° or 20° crab to the right, so a heading between 250° and 270° should work, allowing for some drift in thermal climbs. With practice, the entire thought process should take little time.

The sky towards Portales indicates favorable lift conditions. However, the area along the new course includes sand hills, an area that may not have good choices for off-field landings. It may be a good idea to fly more conservatively until beyond this area and then back to where there are suitable fields for landing. Navigation, evaluation of conditions ahead, and decision-making are required until arrival back at Portales or until a safe off-field landing is completed.

Navigation Using GPS

The GPS navigation systems are available as small hand-held units. (See Chapter 4, Flight Instruments, for information on GPS and electronic flight computers.) Some pilots prefer to use existing flight computers for final glide and speed-to-fly information and add a hand-held GPS for navigation. A GPS system makes navigation easier. A GPS unit displays distance and heading to a specified point, usually found by scrolling through an internal database of waypoints. Many GPS units also continuously calculate and display ground speed. If TAS is also known, the headwind component can be calculated from the GPS by subtracting ground speed from TAS. Many GPS units also feature a moving map display that shows past and present positions in relation to various prominent landmarks like airports. These displays can often zoom in and out to various map scales. Other GPS units allow marking a spot for future reference. This feature can be used to mark the location of a thermal before going into a turn point, with the hopes that the area will still be active after rounding the turn point.

One drawback to GPS units is their attractiveness—it is easy to be distracted by the unit at the expense of flying the glider

and finding lift. This can lead to a dangerous habit of focusing too much time inside the cockpit rather than scanning outside for traffic. Like any electronic instrument, GPS units can fail, so it is important to have a backup for navigation, such as a sectional and plotter.

Cross-Country Techniques

The number one rule of safe cross-country soaring is always stay within glide range of a suitable landing area. The alternate landing area may be an airport or a farmer's field. If thermaling is required just to make it to a suitable landing area, safe cross-country procedures are not being practiced. Sailplane pilots should always plan for high sink rates between thermals as there are always areas of sink around a lifting thermal to fill in the void vacated by the lifting air.

Before venturing beyond gliding distance from the home airport, thermaling and cross-country techniques can be practiced using small triangles or other short courses. Three examples are shown in *Figure 11-10*. The length of each leg depends on the performance of the glider, but they are typically small, around 5 or 10 miles each. Soaring conditions do not need to be excellent for these practice tasks but should not be so weak that it is difficult just to stay aloft. On a good day, the triangle may be flown more than once. If other airports are nearby, practice finding and switching to their

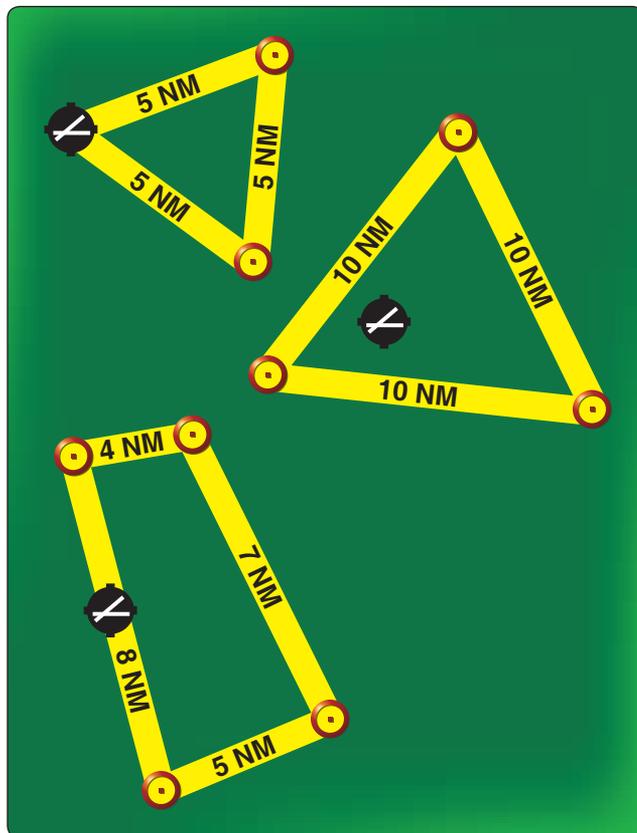


Figure 11-10. Examples of practice cross-country courses.

communication frequency and listening to traffic in the traffic pattern. As progress is made along each leg of the triangle, frequently cross check the altitude needed to return to the home airport and abandon the course if needed. Setting a minimum altitude of 1,500 feet or 2,000 feet AGL to arrive back at the home site adds a margin of safety. Every landing after a soaring flight should be an accuracy landing.

Determining winds aloft while en route can be difficult. Often an estimate is the best that can be achieved. A first estimate is obtained from winds aloft forecasts provided by the AFSS. Once aloft, estimate windspeed and direction from the track of cumulus shadows over the ground, keeping in mind that the winds at cloud level are often different than those at lower levels. On cloudless days, obtain an estimate of wind by noting drift while thermaling. If the estimate was for a headwind of 10 knots but more height is lost on glides than the glide calculator indicates, the headwind estimate may be too low and will need to be adjusted. When flying with GPS, determine windspeed from TAS by simple subtraction. Some flight computers automatically calculate the winds aloft while other GPS systems estimate winds by calculating the drift after several thermal turns.

It is important to develop skill in quickly determining altitude needed for a measured distance using one of the glide calculator tools. For instance, while on a cross-country flight and over a good landing spot with the next good landing site a distance of 12 miles into a 10-knot headwind. [*Figure 11-11*] The glide calculator shows that 3,200 feet is needed to accomplish the glide. Add 1,500 feet above ground to allow time to set up for an off-field landing if necessary, to make the total needed 4,700 feet. The present height is only 3,800 feet, not high enough to accomplish the 12-mile glide, but still high enough to start along course. Head out adjusting the speed based on the MacCready ring or other speed director. After two miles with no lift, altitude is almost 3,300 feet, still not high enough to glide the remaining 10 miles, but high enough to turn back to the last landing site. After almost 4 miles, a 4-knot thermal is encountered at about 2,700 feet and provides for a climb to 4,300 feet.

When using the glide calculator tool, keep in mind that these calculations account for only the glider's calm air rate of descent. Any sink can drastically affect these calculations and make them worthless. In times of good lift, there will also be areas of strong sink. A sailplane pilot must learn to read the sky to find the lift and avoid or pass through the sink as quickly as possible. Time in lift is good and time in sink is bad. A good sailplane pilot will be thoroughly aware of that particular sailplane's polar curves and the effects from different conditions of lift, sink, and winds.

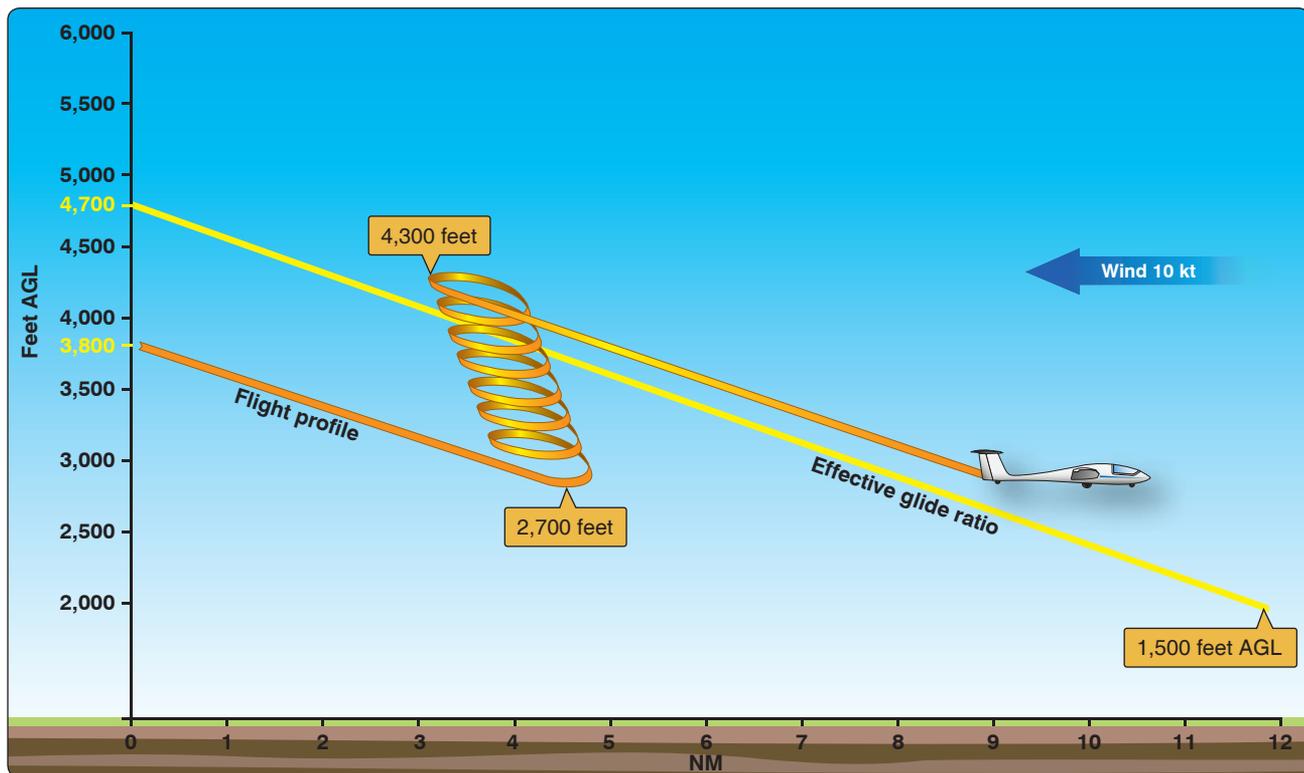


Figure 11-11. Example of a flight profile during a cross-country course.

During the climb, the downwind drift of the thermal moves the glider back on course approximately a half mile. Now, there is almost 9 miles to glide to the next landing spot, and a check of the glide calculator indicates 2,400 feet are needed for the glide into the 10-knot headwind, plus 1,500 feet at the destination, for a total of 3,900 feet. Now, there is 400 feet above the minimum glide with a margin to plan the landing. In the previous example, had the thermal topped at 3,600 feet (instead of 4,300 feet) there would not be enough altitude to glide the 9 miles into the 10-knot headwind. However, there would be enough height to continue further on course in hopes of finding more lift before needing to turn downwind back to the previous landing spot. Any cross-country soaring flight involves dozens of decisions and calculations such as this. In addition, safety margins may need to be more conservative if there is reason to believe the glide may not work as planned, for example, other pilots reporting heavy sink along the intended course.

On any soaring flight, there is an altitude when a decision must be made to cease attempts to work thermals and commit to a landing. This is especially true of cross-country flights in which landings are often in unfamiliar places and feature additional pressures like those discussed in Chapter 8, Abnormal and Emergency Procedures. It is even more difficult on cross-country flights to switch the mental process from soaring to committing to a landing. For beginners, an altitude of 1,000 feet AGL is a recommended minimum to

commit to landing. A better choice is to pick a landing site by 1,500 feet AGL, which still allows time to be ready for a thermal while further inspecting the intended landing area. The exact altitude where the thought processes should shift from soaring to landing preparation depends on the terrain. In areas of the Midwest in the United States, landable fields may be present every few miles, allowing a delay in field selection to a lower altitude. In areas of the desert southwest or the Great Basin, landing sites may be 30 or more miles apart, so focusing on a landing spot must begin at much higher altitudes above the ground.

Once committed in the pattern, do not try to thermal away again. Accidents occur due to stalls or spins from thermalizing attempts in the pattern. Damage to the glider's airframe can and has occurred after a pilot drifted away from a safe landing spot while trying to thermal from low altitudes. When the thermal dissipates, the pilot is too far beyond the site to return for a safe landing and is left with a less suitable landing choice. It is easy to fall into this trap. In the excitement of preparing for an off-field landing, do not forget a prelanding checklist.

A common first cross-country flight is a 50-kilometer (32 statute miles) straight distance flight with a landing at another field. The distance is short enough that it can be flown at a leisurely pace on an average soaring day and also qualifies for part of the FAI Silver Badge. Prepare the course well and find out about all available landing areas along the way. Get

to the soaring site early so there is no rush in the preflight preparations. Once airborne, take time to get a feel for the day's thermals. If the day looks good enough and height is adequate to set off on course, commit to the task! Landing away from the home field for the first time requires skill, planning, and knowledge but is a confidence builder whether the task was accomplished or not.

Soaring Faster and Farther

Early cross-country flights, including small practice triangles within gliding range of the home field, are excellent preparation and training for longer cross-country flights. The FAI Gold Badge requires a 300-kilometer (187 statute miles) cross-country flight, which can be straight out distance or a declared triangle or out-and-return flight. An average cross-country speed of 20 or 30 miles per hour (mph) may have been adequate for a 32-mile flight, but that average speed is too low on most days for longer flights. Flying at higher average cross-country speeds also allows for farther soaring flights.

Improvement of cross-country skills comes primarily from practice, but reviewing theory as experience is gained is also important. A theory or technique that initially made little sense to the beginner has real meaning and significance after several cross-country flights. Postflight self-critique is a useful tool to improve skills.

In the context of cross-country soaring, flying faster means achieving a faster average groundspeed. The secret to faster cross-country flight lies in spending less time climbing and more time gliding. This is achieved by using only the better thermals and spending more time in lifting air and less time in sinking air. Optimum speeds between thermals are given by MacCready ring theory and/or speed-to-fly theory, and can be determined through proper use of the MacCready speed ring or equivalent electronic speed director.

Height Bands

On most soaring days there is an altitude range, called a height band, in which the thermal strength is at a maximum. Height bands can be defined as the optimum altitude range in which to climb and glide on a given day. For instance, a thermal in the 3,000 feet AGL range may have 200 to 300 fpm thermals, increasing to 500 fpm at 5,000 feet AGL range then weaken before topping out at 6,000 feet AGL. In this case, the height band would be 2,000 feet deep between 3,000 feet and 5,000 feet AGL. Staying within the height band gives the best (fastest) climbs. Avoid stopping for weaker thermals while within the height band unless there is a good reason.

On another day, thermals may be strong from 1,000 feet to 6,000 feet AGL before weakening, which would suggest a

height band 5,000 feet deep. In this case, however, depending on thermal spacing, terrain, pilot experience level, and other factors, the height band would be 2,000 feet or 3,000 feet up to 6,000 feet AGL. Avoid continuing to the lower bounds of strong thermals (1,000 feet AGL) since failure to find a thermal there gives no extra time before committing to a landing. [Figure 11-12]

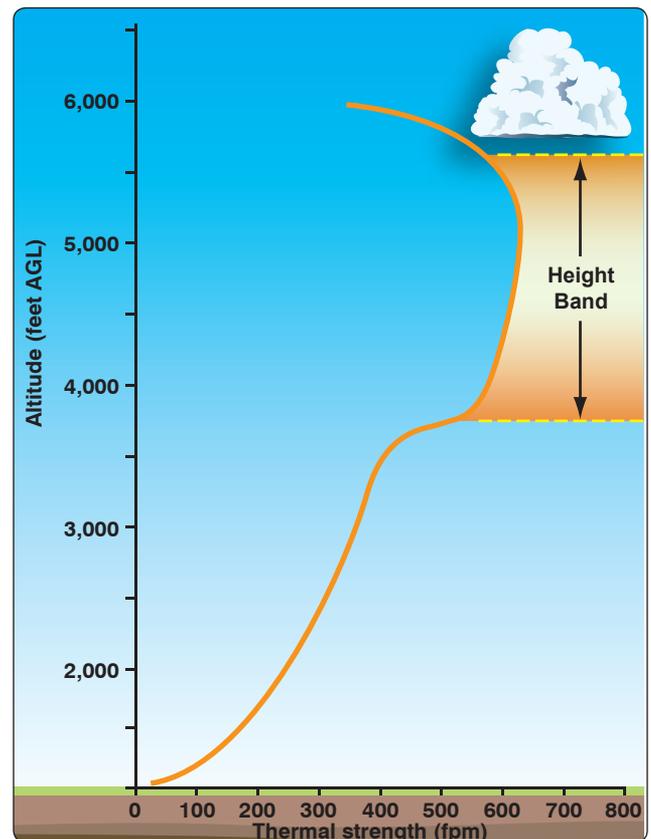


Figure 11-12. Example of the height band.

NOTE: Automated Flight Service Stations (AFSS) report cloud levels as AGL in METARS, and PIREPS are reported as MSL. Area forecasts gives clouds as MSL if above 1,000' AGL. Pilots must be careful to determine which value is being presented. This is very important when glider pilots travel to higher elevation airports and must subtract field elevation from MSL reports to ensure cloud clearances.

Determining the top of the height band is a matter of personal preference and experience, but a rule of thumb puts the top at an altitude where thermals drop off to 75 percent of the best achieved climb. If maximum thermal strength in the height band is 400 fpm, leave when thermals decrease to 300 fpm for more than a turn or two. The thermal strength used to determine the height band should be an average achieved climb. Many electronic variometers have an average function that displays average climb over specific time intervals.

Another technique involves simply timing the altitude gained over 30 seconds or 1 minute.

Theoretically, the optimum average speed is attained if the MacCready ring is set for the achieved rate of climb within the height band. To do this, rotate the ring so that the index mark is at the achieved rate of climb (for instance, 400 fpm) rather than at zero (the setting used for maximum distance). A series of climbs and glides gives the optimum balance between spending time climbing and gliding. The logic is that, on stronger days, the extra altitude lost by flying faster between thermals is more than made up in the strong lift during climbs. Flying slower than the MacCready setting does not make the best use of available climbs. Flying faster than the MacCready setting uses too much altitude between thermals; it then takes more than the optimum amount of time to regain the altitude.

Strict use of the MacCready ring assumes that the next thermal is at least as strong as that set on the ring and can be reached with the available altitude. Efforts to fly faster must be tempered with judgment when conditions are not ideal. Factors that may require departure from the MacCready ring theory include terrain (extra height needed ahead to clear a ridge), distance to the next landable spot, or deteriorating soaring conditions ahead. If the next thermal appears to be out of reach before dropping below the height band, either climb higher, glide more slowly, or both.

To illustrate the use of speed-to-fly theory, assume there are four gliders at the same height. Ahead are three weak cumulus

clouds, each produced by 200-fpm thermals, then a larger cumulus with 600 fpm thermals under it, as in *Figure 11-13*.

- Pilot 1 sets the ring to 6 knots for the anticipated strong climb under the large cumulus, but the aggressive approach has the glider on the ground before reaching the cloud.
- Pilot 2 sets the ring for 2 knots and climbs under each cloud until resetting the ring to 6 knots after climbing under the third weak cumulus, in accordance with strict speed-to-fly theory.
- Pilot 3 is conservative and sets the ring to zero for the maximum glide.
- Pilot 4 calculates the altitude needed to glide to the large cumulus using an intermediate setting of 3 knots, and finds the glider can glide to the cloud and still be within the height band.

By the time pilot 4 has climbed under the large cumulus, the pilot is well ahead of the other two pilots and is relaying retrieve instructions for pilot 1. This example illustrates the science and art of faster cross-country soaring. The science is provided by speed-to-fly theory, while the art involves interpreting and modifying the theory for the actual conditions. Knowledge of speed-to-fly theory is important as a foundation. How to apply the art of cross-country soaring stems from practice and experience.

Tips and Techniques

The height band changes during the day. On a typical soaring day, thermal height and strength often increases rapidly

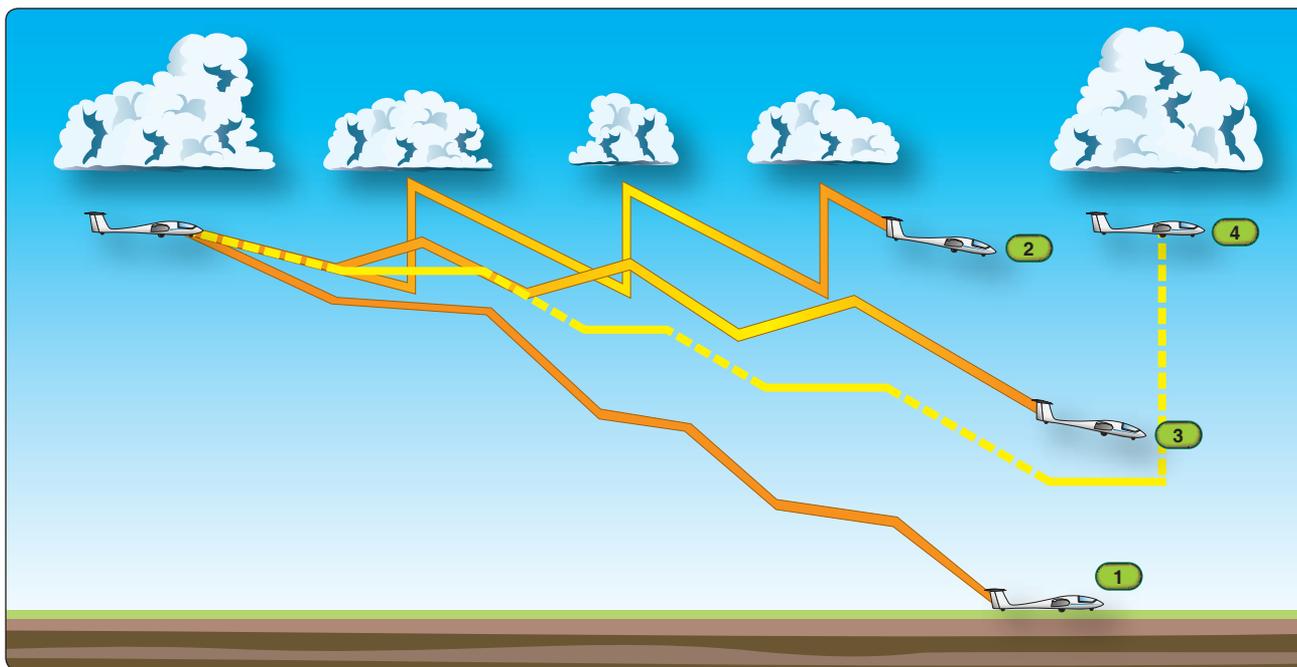


Figure 11-13. Example of glides achieved for different MacCready ring settings.

during late morning, and then both remain somewhat steady for several hours during the afternoon. The height band rises and broadens with thermal height. Sometimes the top of the height band is limited by the base of cumulus clouds. Cloud base may slowly increase by thousands of feet over several hours, during which the height band also increases. Thermals often “shut off” rapidly late in the day, so a good rule of thumb is to stay higher late in the day. [Figure 11-14]

It is a good idea to stop and thermal when at or near the bottom of the height band. Pushing too hard can lead to an early off-field landing. Pushing too hard leads to loss of time at lower altitudes because the pilot is trying to climb in weak lift conditions.

Another way to increase cross-country speed is to avoid turning at all. A technique known as dolphin flight can be used to cover surprising distances on thermal days with little or no circling. The idea is to speed up in sink and slow down in lift while only stopping to circle in the best thermals. The speed to fly between lift areas is based on the appropriate MacCready setting. This technique is effective when thermals are spaced relatively close together, as occurs along a cloud street.

As an example, assume two gliders are starting at the same point and flying under a cloud street with frequent thermals and only weak sink between thermals. Glider 1 uses the conditions more efficiently by flying faster in the sink and slower in lift. In a short time, glider 1 has gained distance on glider 2. Glider 2 conserves altitude and stays close to cloud base by flying best L/D through weak sink. To stay under the clouds, he is forced to fly faster in areas of lift, exactly opposite of flying fast in sink, slow in lift. At the end of the cloud street, one good climb quickly puts glider 1 near cloud base and well ahead of glider 2. [Figure 11-15] The best speed to fly decreases time in sink and therefore

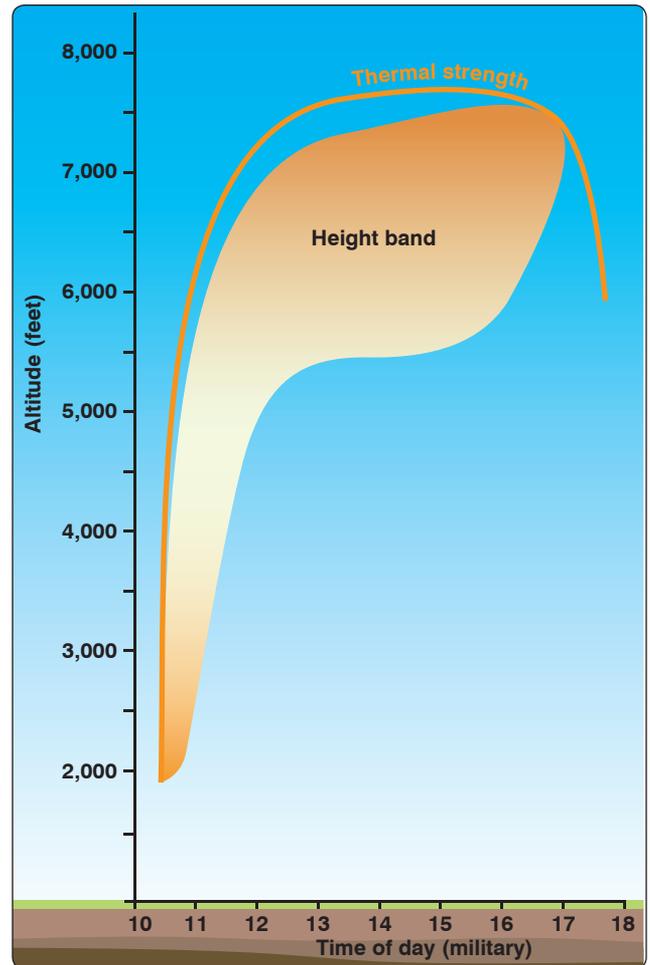


Figure 11-14. Thermal height and height band versus time of day.

decreases the overall amount of descent but produces the best forward progress. Being slower in sink increases time descending and slows forward progress, while being fast in lift decreases time in lift and altitude gained.

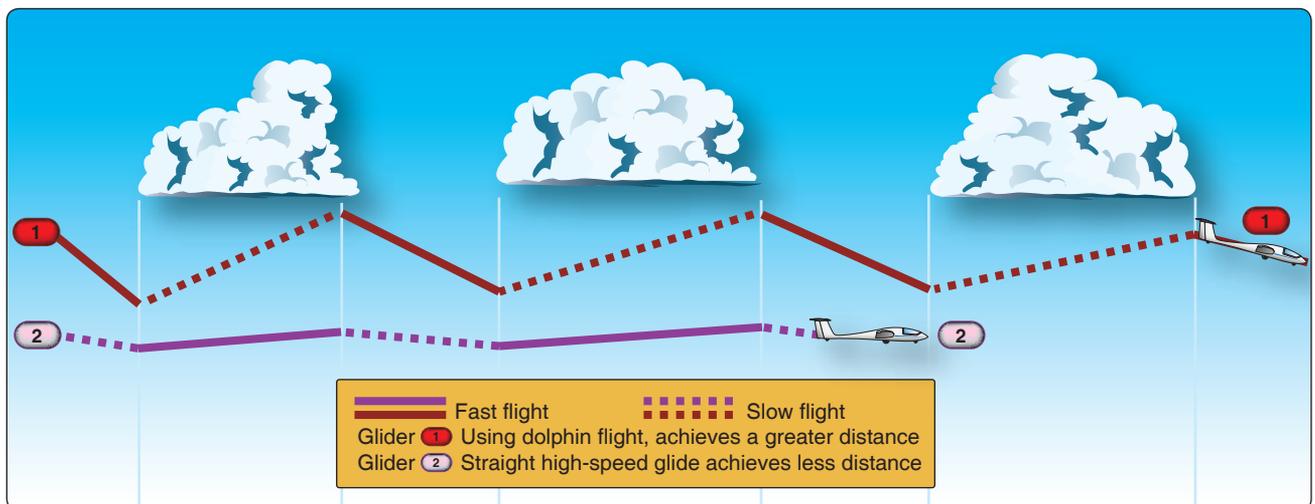


Figure 11-15. Advantage of proper speed to fly under a cloud street.

On an actual cross-country flight, a combination of dolphin flight and classic climb and glide is frequently needed. In a previous example, the two pilots who decided not to stop and circle in the weaker thermals would still benefit from dolphin flight techniques in the lift and sink until stopping to climb in the strong lift.

Special Situations

Course Deviations

Diversion on a soaring cross-country flight is the norm rather than the exception. Some soaring days supply fair weather cumulus evenly spaced across all quadrants, and it is still beneficial to deviate toward stronger lift. Deviations of 10° or less add little to the total distance and should be used without hesitation to fly toward better lift. Even deviations up to 30° are well worthwhile if they lead toward better lift and/or avoid suspected sink ahead. The sooner the deviation is started, the less total distance is covered during the deviation. [Figure 11-16]

Deviations of 45° or even 90° may be needed to avoid poor conditions ahead. An example might be a large cloudless area or a shaded area where cumulus have spread out into stratus clouds. Sometimes deviations in excess of 90° are needed to return to active thermals after venturing into potentially stable air.

Deviations due to poor weather ahead should be undertaken before the flight becomes unsafe. For instance, if cloud bases are lowering and showers developing, always have the option for a safe, clear landing area before conditions deteriorate too much. Generally, glider pilots will encounter stable air or sinking air which will put them on the ground before VFR conditions disappear. If the sky becomes cloudy, thermaling will cease. Ridge lift might remain but will be in the clouds so either way the glider pilot must get on the ground. It is better to land on your terms rather than be forced down by total lack of lift. Thunderstorms along the course are a special hazard, since storm outflow can affect surface winds for many miles surrounding the storm. Do not count on landing at a site within 10 miles of a strong thunderstorm—sites farther removed are safer. Thunderstorms ahead often warrant large course deviations of up to 180° (i.e., retreat to safety).

NOTE: Cloud development can and does shade the earth, decreasing the heating, and hence decreasing lift. Be aware of cloud shadowing.

Lost Procedures

Navigation has become far easier with the advent of GPS. Since GPS systems are not 100 percent free from failure, pilots must still be able use the sectional chart and compass for navigation. It is important to have an alternate plan in the event of becoming lost. As discussed earlier, preflight

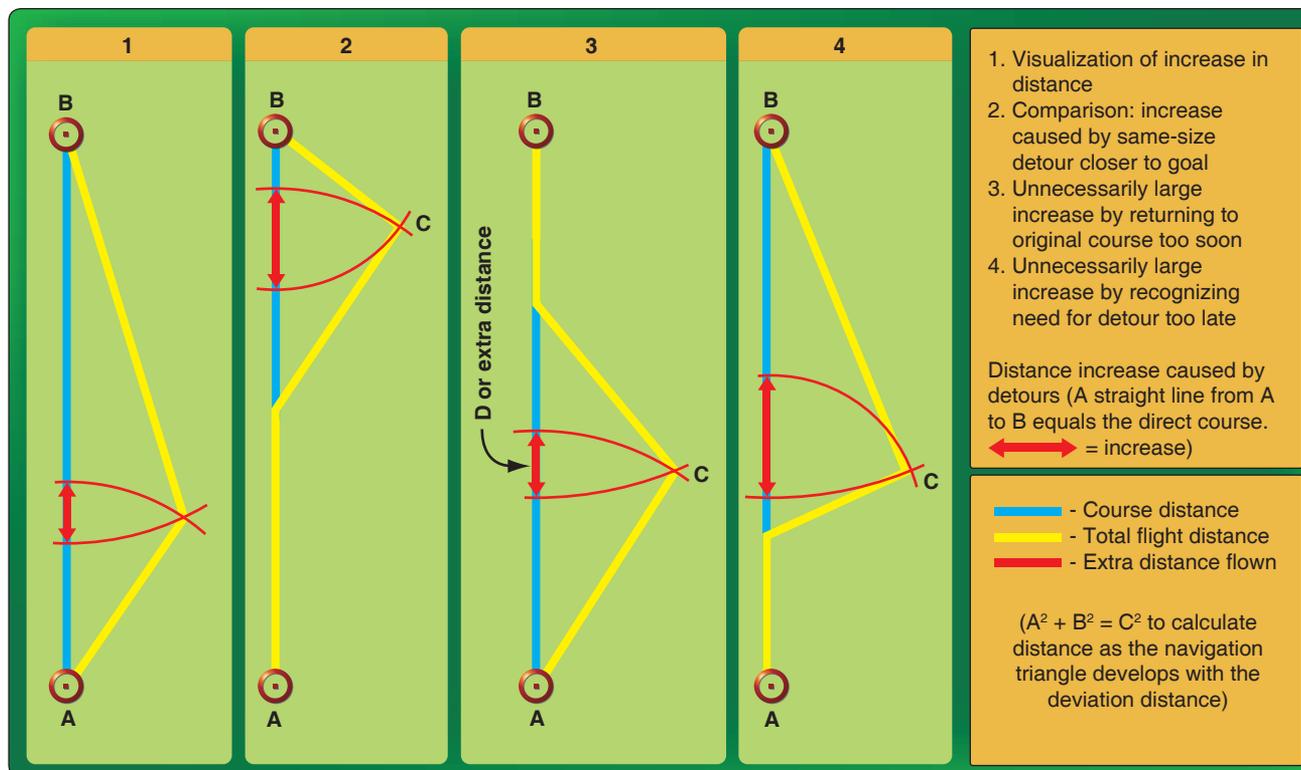


Figure 11-16. Effects of starting course deviations at different times. Red arrows show extra course distance and indicate the benefit of early course deviations.

preparation can help avoid becoming lost. Spend some time studying the sectional chart for airports or other notable landmarks along the route.

If you are still lost after some initial searching, try to remain calm. The first priority is to make sure there is a suitable landing area within gliding distance. Then, if possible, try to find lift, even if it is weak, and climb. This buys time and gives a wider view of the area. Next, try to estimate the last known position, the course flown, and any possible differences in wind at altitude. For instance, maybe the headwind is stronger than anticipated and not as far along the course as expected. Try to pinpoint the present position from an estimate of the distance traveled for a given period of time and confirm it with visible landmarks by reference to the sectional chart. For instance, if at point X, averaging about 50 knots, heading north for about 30 minutes should put the glider at point Y. Look again at the sectional chart for landmarks that should be nearby point Y, then search the ground for these landmarks. Thermaling while searching has the added advantage of allowing a wider area of scan while circling.

Once a landmark is located on the sectional and on the ground, confirm the location by finding a few other nearby landmarks. For instance, if that is a town below, then the highway should curve like the one shown on the chart. Does it? If you are lost and near a suitable landing area, stay in the area until certain of location. Airports and airport runways provide valuable clues, like runway orientation and markings or the location of town or a city relative to the airport.

If all efforts fail, attempt a radio call to other soaring pilots in the area. A description of what is below and nearby may bring help from a fellow pilot more familiar with the area.

Cross-Country Flight in a Self-Launching Glider

A self-launching glider can give the pilot much more freedom in exchange for a more complex and expensive aircraft. First, a self-launching glider allows the pilot to fly from airports without a towplane or tow pilot. Second, the engine can be used to avoid off-field landings and extend the flight. In theory, when low in a self-launching glider, simply start the engine and climb to the next source of lift. This second advantage has pitfalls and dangers of its own and has led to many accidents due to engine failure and/or improper starting procedures. Engines on self-launching gliders generally are less reliable than those on airplanes and are susceptible to special problems. For instance, in the western United States, summer thermals often extend to altitudes where the air is cold. The self-launching engine can become cold soaked after several hours of flight, and may take more time to start or may fail to start.

Overreliance on the engine may result in a false sense of security. This can lead pilots to glide over unlandable terrain, something they might not normally do. If the engine then fails when needed most, the pilot has no safe place to land. Some accidents have occurred in which the engine starting system was actually fully functional, but in the rush to start the engine to avoid landing, the pilot did not perform a critical task, such as switching the ignition on. Other accidents have occurred in which the engine did not start immediately, and while trying to solve the starting problem, the pilot flew too far from a suitable landing area. For a self-launching glider with an engine that stows in the fuselage behind the cockpit, the added drag of an extended engine can reduce the glide ratio by 50 to 75 percent. [Figure 11-17]

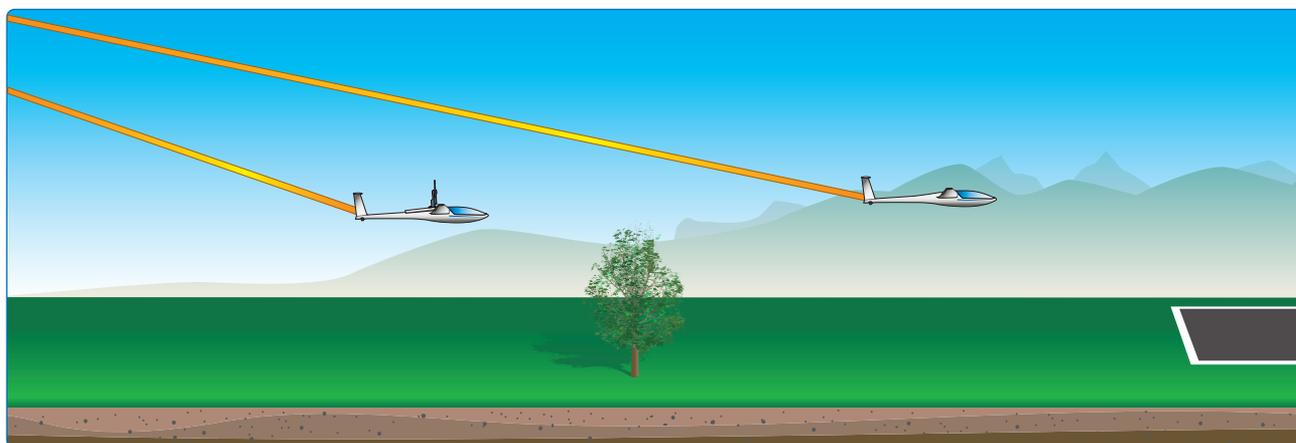


Figure 11-17. Effects on the glide ratio of the engine being extended but not running.

The critical decision height to commit to an engine start on a self-launching glider is typically higher than the critical decision height for a nonpowered glider. This is due to a combination of the time needed to start the engine and extra drag during the starting process. It may take anywhere from 200 feet to 500 feet of altitude to extend and then start the engine. Whereas a pure glider may commit to landing at 1,000 feet AGL, the pilot of a self-launching glider probably opts for 1,500 feet AGL, depending on the glider and landing options should the engine fail. In this sense, the self-launching glider becomes more restrictive.

Cross-country flight can also be done under power with a self-launching glider, or a combination of powered and soaring flight. For some self-launching gliders, the most efficient distance per gallon of fuel is achieved by a maximum climb under power followed by a power-off glide. Check the GFM/POH for recommendations.

Another type of glider features a sustainer engine. These engines are not powerful enough to self-launch but are able to keep the glider airborne if lift fails. Sustainers can only produce enough power to overcome the glider's sink rate, and the higher sink rates can easily overwhelm the climb rate capability of many sustainer powerplants. The sustainer engine is typically less complex to operate than their self-launching counterparts, and can eliminate the need for a time-consuming retrieval. Pilots flying with a sustainer are susceptible to the same pitfalls as their self-launching counterparts.

High-Performance Glider Operations and Considerations

Extended cross-country flights have been made in relatively low-performance gliders. However, on any given soaring day, a glider with a 40:1 glide ratio is able to fly farther and faster than one with 20:1, assuming the pilots in both have similar skill levels. Often, a glider pilot looks for more performance in a glider to achieve longer and faster cross-country flights.

Glider Complexity

Most high-performance gliders have a single seat. If a two-seat, high-performance glider is available, the pilot should obtain some instruction from an authorized flight instructor before attempting to fly a single seat high-performance glider for the first time. Before flying any single-seat glider, pilots should thoroughly familiarize themselves with the GFM/POH, including important speeds, weight and balance issues, and all operating systems in the glider GFM/POH, such as landing gear, flaps, and wheel brake location.

High-performance gliders are usually more complex and somewhat more difficult to fly, but they vary considerably.

Current Standard Class gliders (15 meter wingspan and no flaps) are easy to assemble, and newer types are comparatively easier to fly. On the other end of the spectrum, Open Class gliders (unlimited wingspan with flaps) can feature wingspans of 24 meters or more with wings in four sections. The experience required to fly a high-performance glider cannot be quantified simply in terms of a pilot's total glider hours. Types of gliders flown (low and high performance) must be considered.

Almost all high-performance gliders have retractable landing gear, so pilots must make certain that "landing gear down" is on their prelanding checklist. Most landing gear handles are on the right side of the cockpit, but a few are on the left side, so caution is required when reaching for a handle to make sure it is not flaps or airbrakes. A common error is to neglect to retract the landing gear and then mistakenly retract it as part of the prelanding checklist. A gear-up landing in a glider usually causes only embarrassment and minor damage. The distance between the pilot and the runway with the landing gear up is minimal, providing no real "cushioning" protection for the pilot during a hard landing.

Many high-performance gliders have flaps. A few degrees of positive flap can be used when thermaling, and some gliders have 30° or more positive flap settings for lower landing speeds. Flaps can be set to 0° for relatively low-speed glides, while negative flap settings are available for glides at higher speeds. The GFM/POH and glider polar provide recommended flap settings for different speeds, as well as maximum speeds allowed for different flap settings. A few high-performance gliders have no air brakes and use only large positive flap settings for landing. This system allows steep approaches but can be uncomfortable for a pilot who has only used spoilers or dive brakes for landing. A thorough ground briefing is required.

Many high-performance gliders have greater wingspans that require special care to avoid ground loops on takeoff or landing. Runway lights and other obstructions near the runway can become a problem. If a wingtip strikes the ground before the glider has touched down, a cartwheel is a possibility, leading to extensive damage and serious injury. Gliders with long wings often have speed restrictions for dive brake use to avoid severe bending loads at the wingtips.

The feel of the controls on high-performance gliders is light, and pilot-induced oscillations (PIOs) occur easily with the sensitive elevator. Elevator movements using the wrist only, while the forearm rests on the thigh, can aid in avoiding PIOs.

Some high-performance gliders have only one center of gravity (CG) towhook either ahead of the landing gear or in

the landing gear well. If the CG hook is within the landing gear well, retracting the gear on tow interferes with the towline. Even if the glider has a nose hook, retracting the gear on tow is not recommended, since the handle is usually on the right cockpit side and switching hands to raise the gear can lead to loss of control on tow. A CG hook, as compared to a nose hook, makes a crosswind takeoff more difficult since the glider can weathervane into the wind more easily. In addition, a CG hook makes the glider more susceptible to “kiting” on takeoff, especially if the flying CG is near the aft limit. This can present a serious danger to the tow pilot.

Water Ballast

To maximize average cross-country speed on a day with strong thermals, water ballast can be used. The gain in speed between thermals outweighs the lost time due to slightly slower climbs with water ballast. If thermals are weak, ballast should not be used. If strong thermals become weak, the water ballast can be dumped. In any case, water ballast should be dumped before landing because heavy wings are more difficult to keep level on the ground roll, and a hard landing is more likely to lead to damage with a heavier glider. Water dumping times vary but are typically between 2 and 5 minutes.

Water ballast is carried in the wings in built-in tanks or water bags. The latter works well but has been known to have problems with leaks. Filling and dumping systems vary from glider to glider, and it is vital to be familiar with the ballast system as described in the GFM/POH. Filling without proper venting can lead to structural damage. Care must be taken to ensure that both wings are filled with the same amount of water. If one wing has a few extra gallons, it can lead to ground loops and loss of control on takeoff, especially in the presence of a crosswind.

Water expands when going from the liquid state to the solid state. The force of the water ballast freezing can be enough to split composite wing skins. If anticipating flying at levels where the temperature might be below 0 °C, follow the GFM/POH recommended additive to avoid freezing.

Some gliders have a small ballast tank in the tail, as well as ballast in the wings. Tail ballast is an effective means to adjust for a CG that is too far forward. It should be used with caution, however, since the position of the tail ballast tank gives it a long arm aft of the empty CG. A careless calculation can lead to too much water in the tail tank and a flying CG that is aft of the limit.

Cross-Country Flight Using Other Lift Sources

Many world distance and speed records have been broken using ridge or wave lift. Under the right conditions, these lift sources can extend for hundreds of miles from sunrise to sunset. Ridge or wave lift is often more consistent than thermals, allowing long, straight stretches at high speed.

Cross-country flight on ridge lift poses some special problems and considerations. Often, the best lift is very close to the ridge crest where the air can be quite turbulent. Great pilot concentration is needed over several hours close to terrain in rough conditions for longer flights. On relatively low ridges, (e.g., in the eastern United States) ridge lift may not extend very high, so the pilot is never too far from a potential off-field landing. These are not conditions for the beginning cross-country pilot. In milder conditions, gaps in the ridge may require thermaling to gain enough height to cross the gap. Ridge lift can provide a place to temporarily wait for thermals to generate. For instance, if cumulus have spread out to form a stratus layer shading the ground and eliminating thermals, a wind facing slope can be used to maintain soaring flight until the sun returns to regenerate thermals.

Wave lift can also provide opportunities for long and/or fast cross-country flights. Most record flights have been along mountain ranges; flights in excess of 2,000 kilometers having been flown in New Zealand and along the Andes. In the United States, speed records have been set using the wave in the lee of the Sierra Nevada Mountains. In theory, long-distance flights could also be made by climbing high in wave, then gliding with a strong tailwind to the next range downwind for another climb. Special consideration for pilot physiology (cold, oxygen, etc.) and airspace restrictions are needed when considering a cross-country flight using wave lift.

Convergence zones can also be used to enhance cross-country speed. Even if the convergence is not a consistent line but merely acts as a focus for thermals, dolphin flight is often possible, making glides over long distances possible without thermaling. When flying low, awareness of local, small-scale convergence can help the pilot find thermal triggers, enabling climb back to a comfortable cruising height.

It is possible to find ridge, thermal, wave, and even convergence lift during one cross-country flight. Optimum use of the various lift sources requires mental agility but makes for an exciting and rewarding flight.

