Chapter 11: Cross-Country Soaring

Introduction

A cross-country flight occurs when the pilot flies the glider beyond gliding distance from the local soaring site. Cross-country flying requires more preparation and decision-making than a local flight. The pilot should determine if the glider, equipment, and the pilot can maintain safely given the known and expected environmental conditions along the route of flight.

Flight Preparation & Planning

If planning to use thermals, the pilot should consider the availability and strength of thermals, if they will remain active, landing possibilities, and which airports along the course have a runway compatible with prevailing wind conditions. The pilot should also consider what effect winds will have on gliding distance and the best speed to fly in sink between thermals. While the main part of this chapter describes flying cross-country using thermals, increased preparation for cross-country flights also involves other sources of lift, and this chapter provides a brief description of cross-country soaring using ridge or wave lift.

Getting Ready for Cross-Country Glider Flights

Adequate soaring skills indicate pilot readiness for cross-country soaring. Until the pilot has flown several flights more than 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 could end in an off-field landing, so pilots planning to fly on cross-country flights should also perfect their short-field landing skills. Pilots can practice these landings on local flights by setting up a simulated off-field landing area at an airport or glider port. The first few simulated landings should utilize the services of an instructor, and the pilot should practice several landings without using the altimeter. Pilots should try to avoid interfering with the normal flow of traffic during simulated off-field landings.

In addition, the pilot should know what airspace exits along the planned route including different classes (B, C, D, E, G), restricted areas, prohibited areas, and military operations areas. The pilot should understand implications of any airways along the flightpath. Once comfortable with the sectional during ground study, pilots can locate landmarks and features within a few miles of the soaring site from the air.

While short-field training can use a known area, site selection training involves selecting a landing site from the air. Using a self-launching glider or other powered aircraft to practice landing area selection allows simulated approaches to different selected areas in a condensed time frame.

Glider pilots can use an electronic or paper Sectional Aeronautical Chart to determine position along a route of flight during cross-country flights. These charts publish with updates every 56 days 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 public, and some private, airports, airways, restricted and warning areas, and boundaries and vertical limits of different classes of airspace. Charted 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.

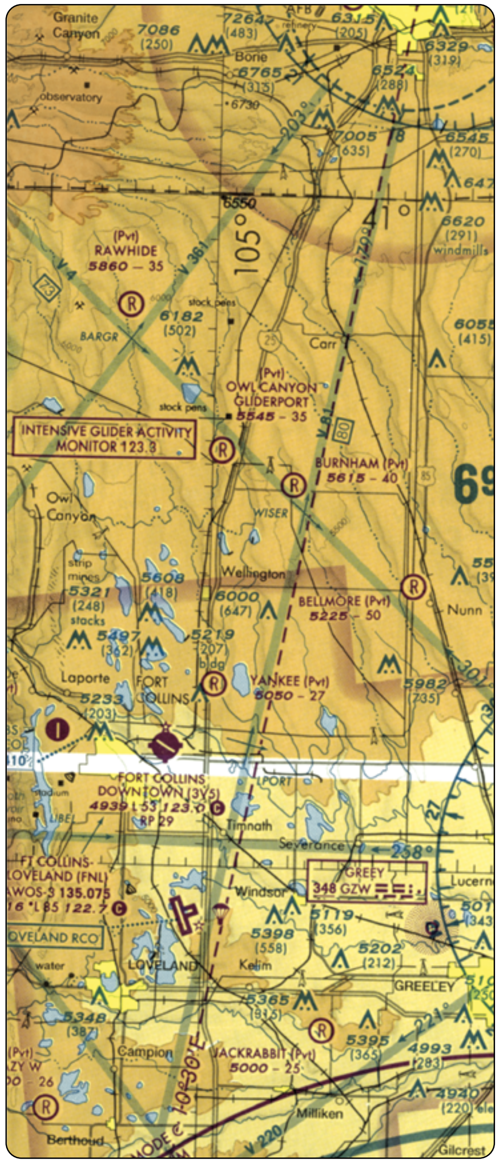

Figure 11-1. *Excerpt from a Sectional Aeronautical Chart.*

Pilots should spend a significant amount of time studying sectional charts on the ground. This includes flying 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, the pilot should study the various lines and symbols and answer the following questions:

- What airports are available on course?
- Do any have a control tower?
- What do all the numbers and symbols for each airport mean?
- What do other chart symbols mean?

GPS navigation and moving map displays enhance awareness of position during flight or after an off-field landing, and pilots should take advantage of this technology. However, pilots should practice verifying position with a sectional chart while in the air in case the GPS fails.

Any cross-country flight may end with a landing away from the home soaring site, so pilots and crews should prepare for that occurrence prior to flight. Sometimes an aerotow retrieval can take place if the flight terminates at an airport; however, trailer retrievals occur more often. Both the trailer and tow vehicle should be in good operating condition before the pilot departs on a cross-country flight, and the pilot and retrieval crew should discuss communication options prior to flight.

The pilot should obtain a standard briefing and a soaring forecast from an approved weather source. The briefing should include general weather information for the planned route, as well as any NOTAMs, AIRMETs, or SIGMETs, winds aloft, approaching front, or areas of likely thunderstorm activity. Depending on the weather outlook, inexperienced pilots may find it useful to discuss options with more experienced pilots at their soaring site.

The pilot should contact a briefer or NWS-derived source for a current soaring forecast. As briefly discussed in Chapter 9, Glider Flight and Weather, certain NWS Weather Forecast Offices (WFO) issue soaring forecasts. These automated forecasts primarily derive from the radiosonde observation or model-generated soundings. The content and format of a soaring forecast vary depending on the NWS WFO providing the forecast and the needs of the local soaring community. A soaring forecast issues once per day without continuous monitoring or updating after initial issuance. The content and format of a soaring forecast as well as the issuance times are subject to change without prior notice. The following sample soaring forecast came from the WFO in Salt Lake City, Utah [*Figure 11-2*]:

Soaring Forecast
National Weather Service Denver/Boulder, Colorado
645 AM MDT Wednesday August 25, 2010

This forecast is for Wednesday August 25, 2010:

If the trigger temperature of 77.3 F/25.2 C is reached...then
Thermal Soaring Index....................... Excellent
Maximum rate of lift........................ 911 ft/min (4.6 m/s)
Maximum height of thermals.................. 16119 ft MSL (10834 ft AGL)

Forecast maximum temperature................... 89.0 F/32.1 C
Time of trigger temperature.................... 1100 MDT
Time of overdevelopment........................ None
Middle/high clouds during soaring window....... None
Surface winds during soaring window............ 20 mph or less
Height of the -3 thermal index................. 10937 ft MSL (5652 ft AGL)
Thermal soaring outlook for Thursday 08/26..... Excellent

Wave Soaring Index............................. Poor
Wave Soaring Index trend (to 1800 MDT)......... No change
Height of stable layer (12-18K ft MSL)......... None
Weak PVA/NVA (through 1800 MDT)................ Neither
Potential height of wave....................... 14392 ft MSL (9107 ft AGL)
Wave soaring outlook for Thursday 08/26........ Poor

Remarks...

Sunrise/Sunset.................... 06:20:55 / 19:42:44 MDT
Total possible sunshine........... 13 hr 21 min 49 sec (801 min 49 sec)
Altitude of sun at 13:01:25 MDT... 60.82 degrees

Upper air data from rawinsonde observation taken on 08/25/2010 at 0600 MDT

Freezing level.................. 15581 ft MSL (10296 ft AGL)
Additional freezing level....... 54494 ft MSL (49209 ft AGL)
Convective condensation level... 13902 ft MSL (8617 ft AGL)
Lifted condensation level....... 14927 ft MSL (9641 ft AGL)
Lifted index.................... -3.4
K index......................... +9.7

* * * * * * Numerical weather prediction model forecast data valid * * * * * *

08/25/2010 at 0900 MDT | 08/25/2010 at 1200 MDT
|
K index... +4.0 | K index... -0.7

This product is issued twice per day, once by approximately 0630 MST/0730 MDT (1330 UTC) and again by approximately 1830 MST/1930 MDT (0130 UTC). It is notcontinuously monitored nor updated after its initial issuance.

The information contained herein is based on rawinsonde observation and/or numerical weather prediction model data taken near the old Stapleton Airport site in Denver, Colorado at

North Latitude: 39 deg 46 min 5.016 sec
West Longitude: 104 deg 52 min 9.984 sec
Elevation: 5285 feet (1611 meters)

and may not be representative of other areas along the Front Range of the Colorado Rocky Mountains. Note that some elevations in numerical weather prediction models differ from actual station elevations, which can lead to data which appear to be below ground. Erroneous data such as these should not be used.

The content and format of this report as well as the issuance times are subject to change without prior notice. Comments and suggestions are welcome and should be directed to one of the addresses or phone numbers shown at the bottom of this page. To expedite a response to comments, be sure to mention your interest in the soaring forecast.

DEFINITIONS:

Convective Condensation Level - The height to which an air parcel possessing the average saturation mixing ratio in the lowest 4000 feet of the airmass, if heated sufficiently from below, will rise dry adiabatically until it just becomes saturated. It estimates the base of cumulus clouds that are produced by surface heating only.

Convection Temperature (ConvectionT) - The surface temperature required to make the airmass dry adiabatic up to the given level. It can be considered a "trigger temperature" for that level.

Freezing Level - The height where the temperature is zero degrees Celsius.

Height of Stable Layer - The height (between 12,000 and 18,000 feet above mean sea level) where the smallest lapse rate exists. The location and existence of this feature is important in the generation of mountain waves.

K Index - A measure of stability which combines the temperature difference between approximately 5,000 and 18,000 feet above the surface, the amount of moisture at approximately 5,000 feet above the surface, and a measure of the dryness at approximately 10,000 feet above the surface. Larger positive numbers indicate more instability and a greater likelihood of thunderstorm development. One interpretation of K index values regarding soaring in the western United States is given in WMO Technical Note 158 and is reproduced in the following table:

below -10	no or weak thermals
-10 to 5	dry thermals or 1/8 cumulus with moderate thermals
5 to 15	good soaring conditions
15 to 20	good soaring conditions with occasional showers
20 to 30	excellent soaring conditions, but increasing probability of showers and thunderstorms
above 30	more than 60 percent probability of thunderstorms

Lapse Rate - The change with height of the temperature. Negative values indicate inversions.

Lifted Condensation Level - The height to which an air parcel possessing the average dewpoint in the lowest 4000 feet of the airmass and the forecast maximum temperature must be lifted dry adiabatically to attain saturation.

Lifted Index - The difference between the environmental temperature at a level approximately 18,000 feet above the surface and the temperature of an air parcel lifted dry adiabatically from the surface to its lifted condensation level and then pseudoadiabatically thereafter to this same level. The parcel`s initial temperature is the forecast maximum temperature and its dewpoint is the average dewpoint in the lowest 4000 feet of the airmass. Negative values are indicative of instability with positive values showing stable conditions.

Lift Rate - An experimental estimate of the strength of thermals. It is computed the same way as the maximum rate of lift but uses the actual level rather than the maximum height of thermals in the calculation. Also, none of the empirical adjustments based on cloudiness and K-index are applied to these calculations.

Maximum Height of Thermals - The height where the dry adiabat through the forecast maximum temperature intersects the environmental temperature.

Figure 11-2. *Sample Soaring Forecast.*

In the sample soaring forecast depicted above, the line for Height of the -3 Thermal Index represents the difference between the environmental temperature and the temperature at a particular level determined by following the dry adiabat through the forecast maximum temperature up to that level. Increasing magnitude of a negative value indicates stronger thermal lift. A value of -3 or below generally indicates thermal activity favorable for cross-country soaring. Soaring pilots should consult with the NWS WFO in their soaring area for more information about the soaring forecast.

Finalizing plans

Pilots may have specific goals for their upcoming cross-country flight and should plan based on the area and different weather scenarios. If planning for a closed-course 300 nautical mile (NM) flight, the pilot should consider several possible out-and-return or triangle courses ahead of time. On the day of departure, the pilot can select the best pre-planned option based on the weather outlook. Since numerous final details need attention on the morning of the flight, accounting for the items used during flight should take place the day before.

Lack of preparation can lead to delays, which may not leave enough of the soaring day 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 to organize the details. When properly used, checklists can help avoid oversights, such as missed assembly items, sectionals left at home, barograph not turned on before takeoff, oxygen status, drinking water in the glider, etc. Checklists can cover the following:

- Items to take to the gliderport (food, water, battery, charts, barograph).
- Assembly in accordance with the Glider Flight Manual/Pilot's Operating Handbook (GFM/POH), including assembly check and any other items as needed.
- Positive control check.
- Prelaunch (charts, barograph, glide calculator, oxygen on).
- Briefings for tow pilot, ground crew, and retrieval crew.
- Pre-takeoff.

Being better organized before the flight leads to less stress during the flight and enhances flight safety.

Personal & Special Equipment

Many items not required for local soaring ensure pilot comfort on long cross-country flights. An adequate supply of drinking water prevents dehydration. Some pilots use a backpack drinking system with a readily accessible hose and bite valve. This system stows easily beside the pilot and allows frequent sips of water. Pilots should also have food onboard since cross-country flights can last up to 8 hours or more. Pilots should also have a relief system on longer flights.

Several items carried onboard can assist in case of an off-field landing. (For more details, see Chapter 8, Abnormal and Emergency Procedures.) For example, the land-out kit should include a system for securing the glider. The remaining contents of a land-out kit depend on the population density and climate of the soaring area. A safe landing site may occur many miles from the nearest road, and the land-out kit should include extra water and food for this contingency. Walking shoes could prove valuable should the pilot need to hike to a structure some distance away. A mobile phone proves useful for landings in areas with cell coverage. Some pilots elect to carry an Emergency Position Indicating Radio Beacon (EPIRB) in case of mishap during a remote off-field landing.

Cross-country soaring requires some means of measuring distances to the next source of lift or the next suitable landing area. Pilots can use a GPS system for measuring distances or a mechanical system such as a plotter and paper chart. [*Figure 11-3*]

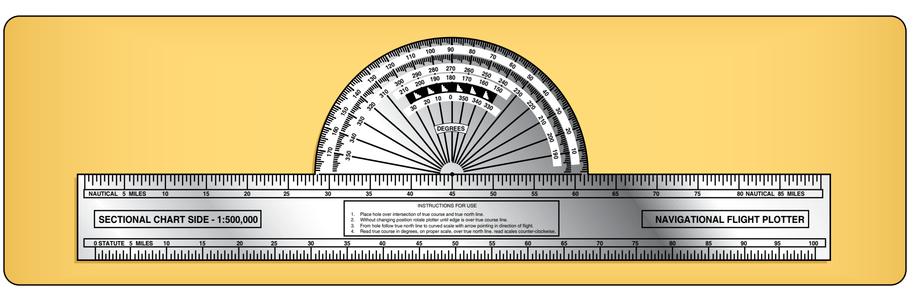

Figure 11-3. *Navigational plotter.*

Glide calculations take headwinds or tailwinds into account, as well as speeds to fly through varying sink rates as discussed in chapter 5, Glider Performance. Tools range widely in their level of sophistication, but all account for the performance polar for the glider. The simplest glide aid derived from the polar consists of a table showing altitudes required for distance versus wind. Another option consists of a circular glide calculator as shown in *Figure 11-4*. The settings in *Figure 11-4* indicate that a glide of 18 miles in an estimated 10 knot headwind takes 3,600 feet. Note that this only gives the altitude required to make the glide. High-performance gliders often have glide/navigation computers that automatically compute the glide ratio (L/D).

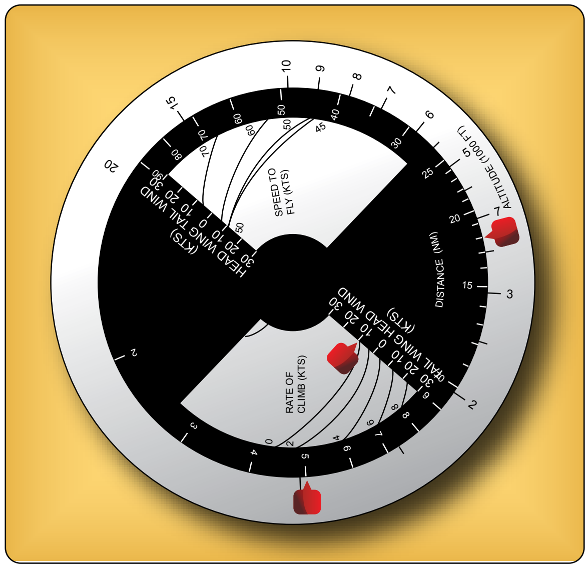

Figure 11-4. *Circular glider calculator.*

Another method allows a pilot to compute effective L/D by utilizing a standard formula. Glide ratio, with respect to the air (GRA) or L/D, remains constant at a given airspeed. For example, the pilot might know the glide ratio, and lift over drag (L/D) being 30 to 1 (expressed as 30:1) for a speed of 50 knots in a specific glider. At 50 knots airspeed with an L/D of 30:1, a 10-knot tailwind results in an effective L/D of 36:1. [*Figure 11-5*]

Glider specifications

Glide ratio (L/D) = 30:1

Speed (GRA) = 50 knots

$$\left(\frac{\text{GRA} \pm \text{Wind}}{\text{GRA}}\right) \times \text{L/D} = \text{Effective L/D}$$

Tailwind component	Headwind component
Wind = +10 knots	Wind = −10 knots
50 + 10 = 60	50 − 10 = 40
60/50 = 1.2	40/50 = 0.8
1.2 x 30 = 36	0.8 x 30 = 24
Effective glide ratio (L/D) is 36:1	Effective glide ratio (L/D) is 24:1

Figure 11-5. *Glide calculation examples for a headwind and a tailwind.*

In addition to a glide calculator, a flight computer or MacCready ring on the variometer gives the pilot the appropriate speed to fly for different sink rates. Data such as windspeed and direction may be manually or automatically input depending on the age and capability of the flight computer. Accurately flying the correct speed in sinking air can extend the achieved glide considerably.

Many models of electronic glide calculators 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 verify soaring performance that allows a pilot to receive a Federation Aeronautique Internationale (FAI) badge or to 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 for details.

Finally, pilots should consider using a notepad or kneeboard on which to make notes before and during the flight. 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 and time around any turn points helps 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 generally use pilotage since they often deviate from a course line over a long distance and do not fly one speed for any length of time. At times, glider pilots might use a combination of the two methods.

A Sample Cross-Country Flight

For training purposes, a pilot could plan a triangle course starting at Portales Airport (PRZ), with turn points at Benger Airport (X54), and the town of Circle Back. The preflight preparation includes drawing the course lines for the three legs using an electronic system or chart. [*Figure 11-6*]

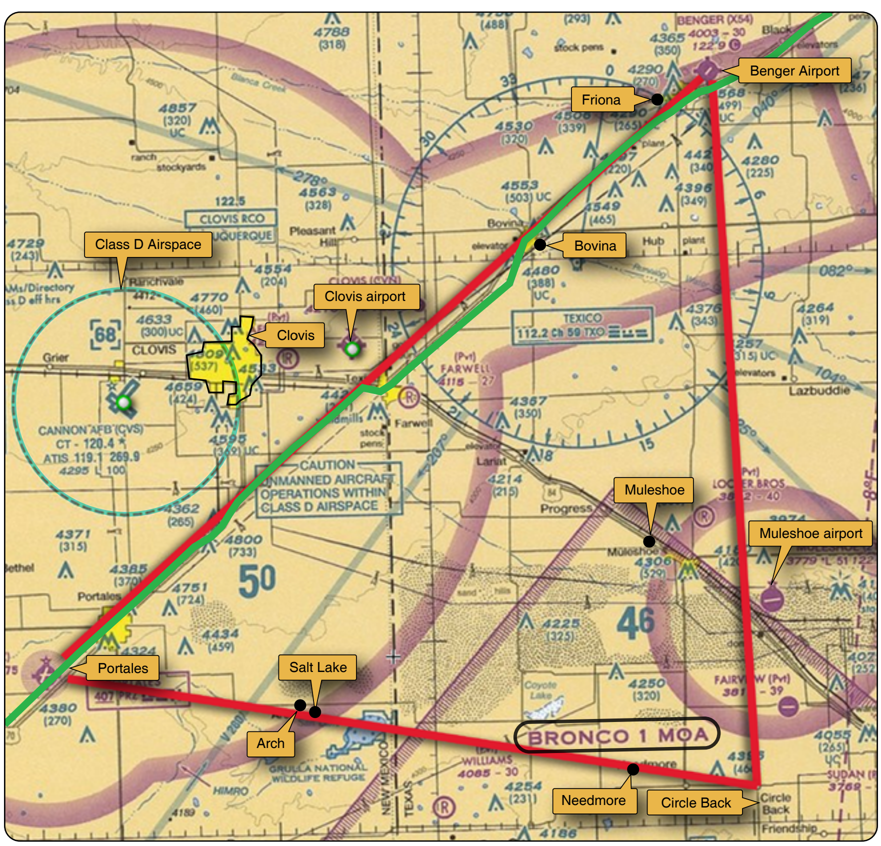

Figure 11-6. *Cross-country triangle drawn on the Albuquerque Sectional Chart.*

The forecast shows the expected base of the cumulus at 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 during the flight. The pilot should take note of the winds aloft for reference during the flight. For instance, the first leg has an almost direct crosswind from the left; the second leg has a weaker crosswind component from the right; the final leg has an almost direct headwind. For this reason, the glider pilot may decide to fly the course in the opposite direction. In this example however, the pilot accepts a headwind on the final leg. The forecast shows the expected base of the cumulus at 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 during the flight. The pilot should take note of the winds aloft for reference during the flight. For instance, the first leg has an almost direct crosswind from the left; the second leg has a weaker crosswind component from the right; the final leg has an almost direct headwind. For this reason, the glider pilot may decide to fly the course in the opposite direction. In this example however, the pilot accepts a headwind on the final leg.

During preflight preparation, the pilot should study the course line along each leg for expected landmarks and possible alternate landing sites. For instance, the first leg follows highway and parallels railroad tracks for several miles before the highway turns north just due south of Clovis. 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. If better soaring conditions exist north of course track and with the northwesterly wind, the glider might cross the path of aircraft on a long final approach to the northwest-southeast runway at the air base. Knowing the courses and the approximate heading for each leg helps keep the pilot from getting lost even when making deviations toward the best lift. During the flight, if the sky ahead shows several equally promising cumulus clouds, choosing the one closest to the course line keeps the flight distance to a minimum and makes the most sense.

The pilot should see the Clovis airport (CVN) next and check for traffic operating in and out of the airport. After Clovis, the towns of Bovina and Friona can serve as landmarks for the flight. The Texico (TXO) VOR, a VHF Omnidirectional Range station near Bovina serves as approach aid to the Clovis airport, and the pilot should remain alert for more powered aircraft traffic as a result.

The pilot can locate the first turn point easily because of good landmarks, including Benger Airport (X54). [*Figure 11-7*] The second leg has fewer landmarks. After about 25 miles, the town of Muleshoe and the Muleshoe airport (2T1) should appear. (See *Figure 11-6*). The town should appear on the right and the airport on the left of the intended course.

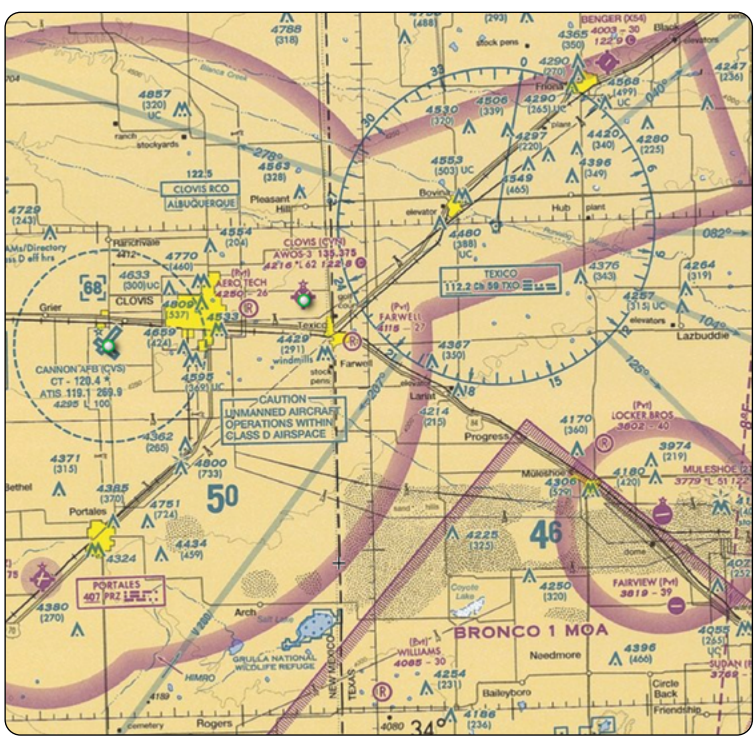

Figure 11-7. *TEXICO VOR and Benger Airport (X54).*

Next, the course enters the Bronco 1 Military Operations Area (MOA). The dimensions of the MOA appear on the sectional chart, and the pilot should determine the active times of this airspace. Approaching the second turn point, the pilot could confuse the towns of Circle Back and Needmore. [*Figure 11-6*] The relative position of an obstruction 466 feet above ground level (AGL) and a road that heads north out of Needmore provide clues for identification. Landmarks on the third leg [*Figure 11-8*] include power transmission lines, Salt Lake (possibly dry), the small town of Arch, and a major road coming south out of Portales.

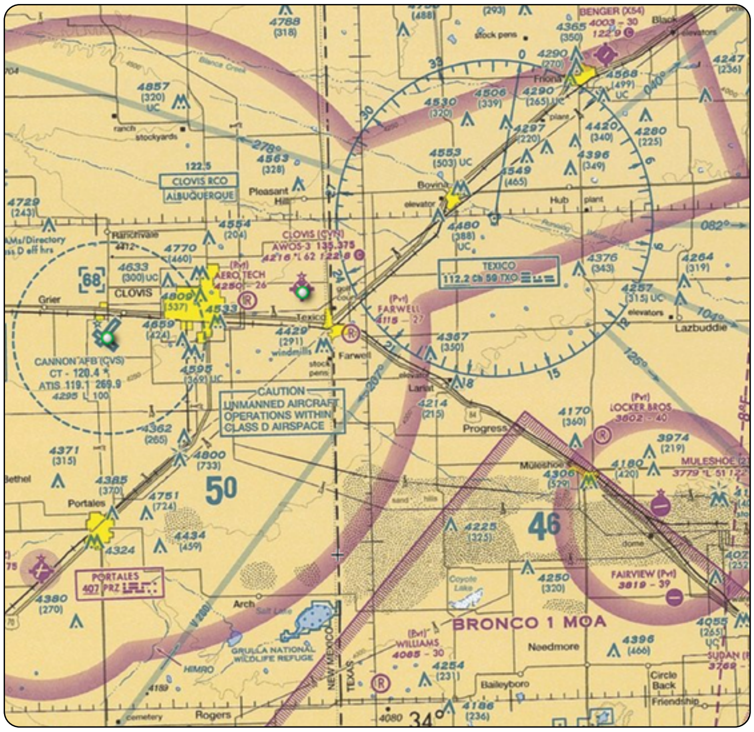

Figure 11-8. *Circle Back and Needmore.*

The flight can begin after a final check of the weather, a thorough preflight of the glider, and after stowing all the appropriate equipment. Once in the air and on course, the pilot can try to verify the winds aloft while using pilotage to remain as close to the course line as soaring conditions permit. If making course deviations, the pilot should remain aware of the location of the course line to the next turning point. For example, a Cu directly ahead may indicate lift, but one 30° off course indicates possibly even more lift. The pilot chooses whether to proceed toward the larger lift while accepting a longer distance to fly, or to accept lesser lift with a smaller off-course deviation.

Sometimes a pilot determines an approximate course while in the air. Assume a few miles before reaching the town of Muleshoe, on the second leg, the weather ahead has deteriorated—a shower developed at the final turn point (Circle Back). Rather than continuing, the pilot can cut the triangle short and return directly to Portales. The pilot determines that Portales is about 37 miles away on an estimated heading of about 240° true or about 231° magnetic after accounting for magnetic variation. The pilot adjusts for the northwesterly wind at almost 90° across the new course and uses a 10° or 20° crab to the right, allowing for some drift in thermal climbs. With practice, a pilot can manage an inflight course change with relative ease.

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. The pilot decides to take time to gain altitude in thermals until beyond this point and until within gliding distance of suitable landing sites.

Navigation Using GPS

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. Given TAS information, the GPS can calculate the headwind component.

When using a GPS unit, the pilot should continue focusing on flying the glider, finding lift, and scanning for traffic. Like any electronic instrument, a GPS unit can fail, and the pilot should have a backup system.

Cross-Country Techniques

For safe cross-country soaring, the pilot should always stay within glide range of a suitable landing area. The landing area may be an airport or other suitable spot to land out. If following this practice, even with high sink rates between thermals, the pilot should never need a thermal to obtain the range to a suitable landing area.

Before venturing beyond gliding distance from the home airport, the pilot can practice thermalling and cross- country techniques using small triangles or other short courses. *Figure 11-9* shows three examples. The length of each leg, typically between 5 and 10 miles, depends on the performance of the glider. The pilot does not need excellent soaring conditions to fly these short courses, but conditions should not make it difficult to stay aloft. On a good day, the pilot can fly the short-course pattern more than once and can also practice switching communication frequencies and listening to transmissions from aircraft or controllers at nearby airports. While progressing along each leg of the triangle, the pilot should frequently cross check the altitude needed to return to the home airport and abandon the course if needed. Setting a minimum altitude for arrival at the home site of 1,500 or 2,000 feet AGL adds a margin of safety. The pilot should make every landing at the conclusion of a soaring flight an accuracy landing to keep the pilot's attention focused until the conclusion of the flight.

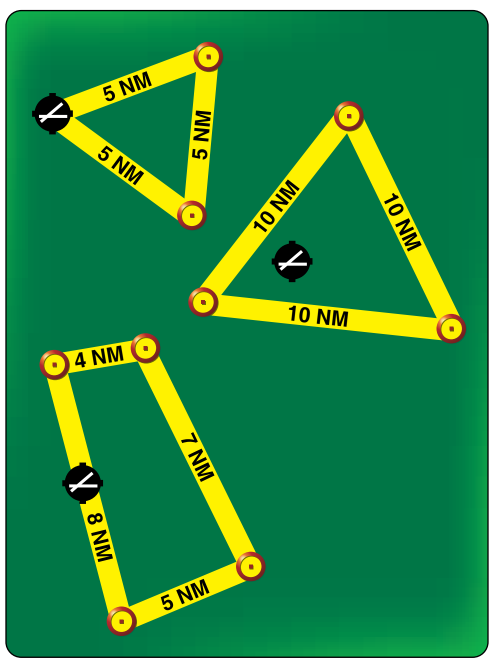

Figure 11-9. *Examples of practice cross-country courses.*

Some flight computers automatically calculate the winds aloft while other GPS systems estimate winds by calculating the drift after several thermal turns. When flying with GPS, the pilot can determine a headwind component from TAS by simple subtraction of groundspeed while maintaining a particular heading. Determining winds aloft without either system can prove difficult. A first estimate comes from winds aloft forecasts. Once aloft, the pilot can estimate windspeed at cloud level from the track of cumulus shadows over the ground. However, the winds at lower levels can differ from those at cloud level. On cloudless days, the pilot can estimate wind by noting drift while thermalling. If losing more height on glides than expected, the pilot should increase the headwind estimate.

A common flight planning technique involves drawing 5 and 10 nautical mile radius circles around alternate landing sites along the planned route. This helps the pilot visualize the altitude needed to safely reach an alternate site should thermal activity be insufficient to continue the cross-country. Alternatively, a pilot using a glide calculator or computerized tool can quickly determine the altitude needed to glide a specific distance. For instance, while on a cross-country flight and over a good landing spot, the next good landing site appears 12 miles distant into a 10-knot headwind. [*Figure 11-10*] A glide calculation shows that the glider will lose 3,200 feet during the glide, and the pilot should add at least 1,500 feet to allow for setting up for a landing, which makes the total altitude needed to make the glide as 4,700 feet. While not high enough to accomplish the 12-mile glide, the 3,800 current foot altitude allows the pilot to start along the course provided the pilot remains within gliding distance of the landing spot where the glide began. After two miles with no lift, the glider has descended to an altitude of almost 3,300 feet. While not high enough to glide the remaining 10 miles, the pilot can still glide back to the landing site two miles behind. After almost 4 miles, the pilot encounters a 4-knot thermal at about 2,700 feet and climbs to 4,300 feet.

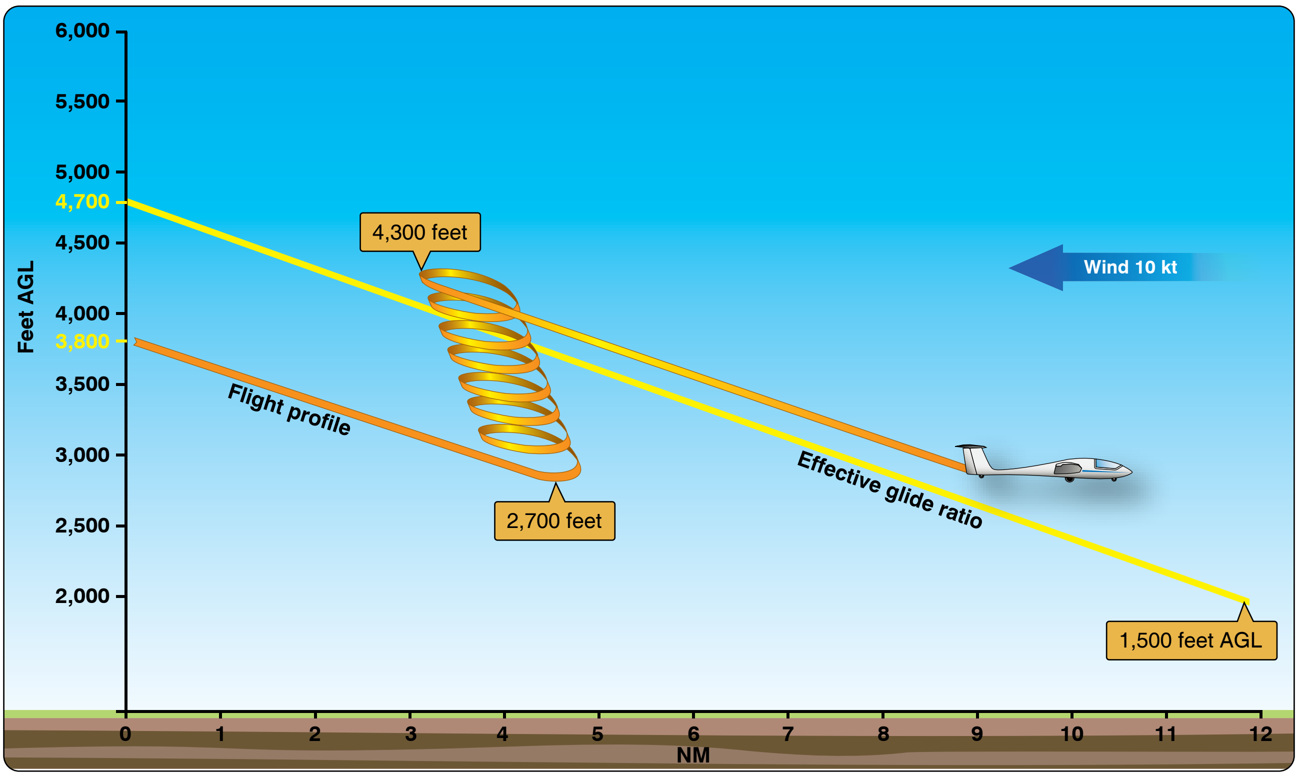

Figure 11-10. *Example of a flight profile during a cross-country course.*

The glide calculator or computer accounts for the glider's calm air rate of descent, which the pilot can adjust for headwinds and tailwinds. However, any vertical currents (sink) can drastically affect these calculations and distort the results. Areas of good thermal lift exist with areas of strong sink, and a glider pilot should read the sky to find the lift and avoid or pass through the sink as quickly as possible. A competent glider pilot understands the polar curves of the glider and the effects of different conditions of lift, sink, and winds.

During the climb in the example above, the downwind drift of the thermal moves the glider back approximately a half mile. The pilot would like to glide almost 9 miles to the next landing spot, and a check of the glide calculator indicates 2,400 feet needed plus 1,500 feet at the destination, for a total of 3,900 feet. The pilot has 400 feet above the altitude needed for the 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) the pilot could continue on course in hopes of finding more lift before needing to turn downwind and back to the previous landing spot. Any cross-country soaring flight involves dozens of decisions and calculations such as this. In addition, a pilot should plan for increasing the altitude safety margin if conditions might cause a lower effective glide ratio. For example, other pilots reporting heavy sink along the intended course would alert a pilot to increase the safety margin.

On any soaring flight, a critical altitude exists where a decision must be made to cease attempts to work thermals and commit to a landing. Cross-country flights can have landings in unfamiliar places and feature additional pressures like those discussed in Chapter 8, Abnormal and Emergency Procedures. In the event not reaching a planned landing site, a reasonable procedure involves choosing a general area by 2,000 feet AGL, picking a landing site by 1,500 feet AGL, and committing to landing by 1,000 feet AGL. The exact altitude where the thought processes should shift from soaring to landing preparation depends on the terrain. In areas where numerous fields suitable for landing may exist, the pilot can delay field selection to a lower altitude. In areas with landing sites spaced by 30 miles or more apart, the pilot's focus on committing to a landing spot should begin at much higher altitudes above the ground.

Attempts to thermal in the pattern may lead to a stall or spin accident. Therefore, once committed in the pattern, the pilot should not try thermalling. When over a safe landing spot, the pilot should perform the prelanding checklist.

A common first cross-country flight consists of a 50-kilometer (32 statute miles) straight distance flight with a landing at another field. The pilot can fly this distance at a leisurely pace on an average soaring day. The pilot should review the planned course carefully, research all available landing areas along the way, arrive early, and complete all preflight preparations. Once airborne, the pilot should take time to get a feel for the day's thermals. If the day looks good enough and the glider gains adequate altitude, the pilot can set off on course.

Pilots gain cross-country skills through practice but should also continue to review theory while gaining that experience. A theory or technique that initially made little sense takes on a lot more significance after several cross-country flights. Postflight self-critique, which can occur at any time before the next flight, also improves pilot skills.

Soaring Faster & Farther

An average cross-country speed of 20 or 30 miles per hour (mph) seems adequate for a 32-mile flight, but that average speed does not accommodate longer flights. Flying at higher average cross-country speeds allows for increased soaring flight distance.

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 occurs when using better thermals and spending more time in lifting air and less time in sinking air. MacCready ring theory and/or speed-to-fly theory determines the optimum speeds between thermals. Proper use of the MacCready speed ring or equivalent electronic speed director displays the appropriate speed.

Height Bands

On most soaring days an altitude range called a height band describes where maximum thermal strength exists. Height bands give the optimum altitude range in which to climb and glide on a given day. For instance, a thermal may have 200 to 300 fpm lift between 3,000 and 5,000 feet AGL which then weakens before topping out at 6,000 feet AGL. In this case, a 2,000-foot height band exists between 3,000 feet and 5,000 feet AGL. Staying within the height band gives the best (fastest) climbs. On a long cross-country flight, the pilot should thermal while within the height band and avoid stopping for weak thermals unless needing additional altitude at that moment.

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 the thermal spacing, terrain, pilot experience level, and other factors, a height band would run from 2,000 feet or 3,000 feet up to 6,000 feet AGL. Pilots should avoid gliding to the lower bounds of strong thermals (1,000 feet AGL) since the thermal could dissipate and commit the pilot to a poorly planned landing. [*Figure 11-10*]

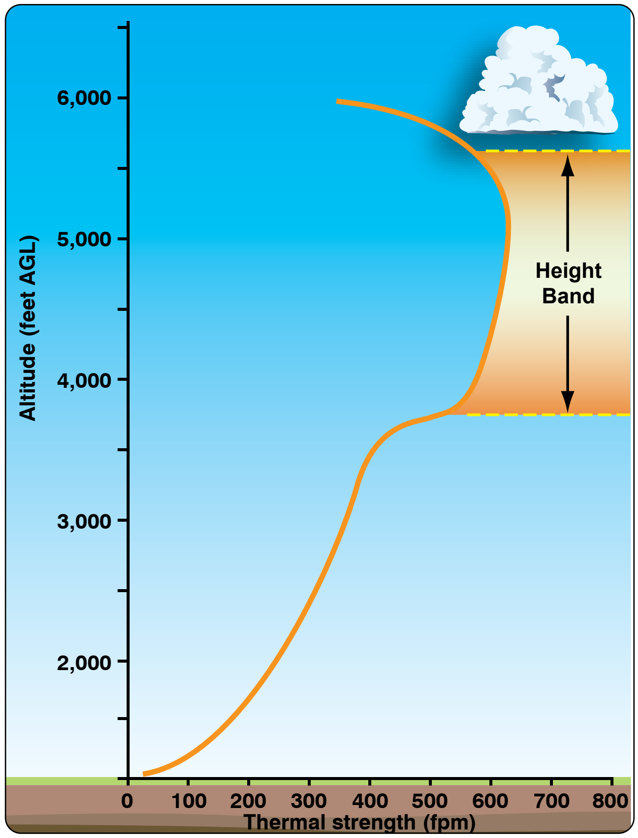

Figure 11-11. *Example of the height band.*

Note: METARs give cloud levels as AGL, while PIREPS report clouds using MSL. Graphical Area Forecasts (GFA) give clouds as MSL. Pilots should interpret the reported cloud heights with care. This interpretation takes on added significance when glider pilots travel to higher elevation airports and subtract field elevation from MSL reports to ensure cloud clearances.

Determining the top of the height band depends upon 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. A pilot who finds 400 fpm as the maximum thermal strength in the height band might leave when thermals decrease to 300 fpm for more than a turn or two. Pilots can also compare the current climb with average climb achieved to determine the height band top. If the climb falls to 75 percent or less of the average climb, the pilot should consider leaving the thermal. 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 pilot can achieve the highest average speed on a cross-country flight when setting the MacCready ring, if available, for the rate of climb within the height band. To do this, the pilot rotates the ring so that the index mark lines up with the rate of climb (for instance, 400 fpm) rather than at zero (the setting used for maximum distance). [*Figure 11-12*] This setting optimizes the time distribution between climbing and gliding. If flying slower than the MacCready setting, the pilot consumes more time between thermals than can be saved during shorter time in strong thermals. If flying faster than the MacCready setting, the pilot loses too much altitude between thermals and uses more than the optimum amount of time to regain the altitude.

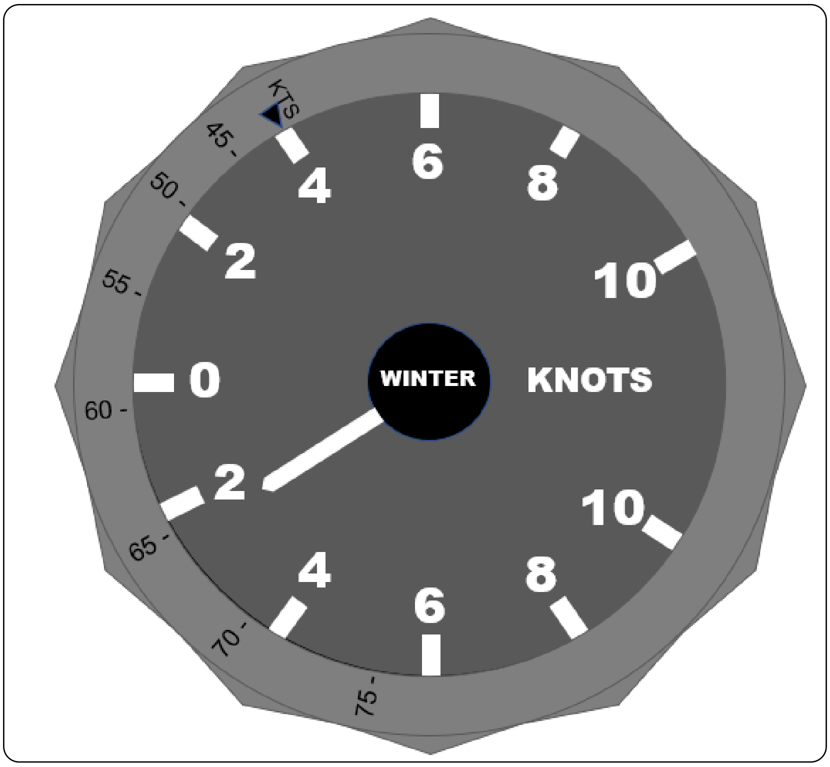

Figure 11-12. *A MacCready Ring set for an expected 4 knot climb in the next thermal. With current sink of a little over 2 knots, the MacCready ring suggests 65 knots as the speed to the next thermal.*

MacCready ring theory assumes that the next thermal has at least the same strength as that set on the ring, and the glider can reach the next thermal with sufficient altitude. The pilot should judge whether actual conditions support adherence to the numbers. Factors that may require departure from the MacCready ring theory include terrain (extra height needed to clear a ridge), distance to the next suitable landing spot, or deteriorating soaring conditions ahead. If the next thermal appears to be out of reach before dropping below the height band, the pilot should 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. The scenario includes three weak cumulus clouds each produced by 200-fpm thermals followed by a larger cumulus with 600 fpm thermals under it, illustrated in Figure 11-13.

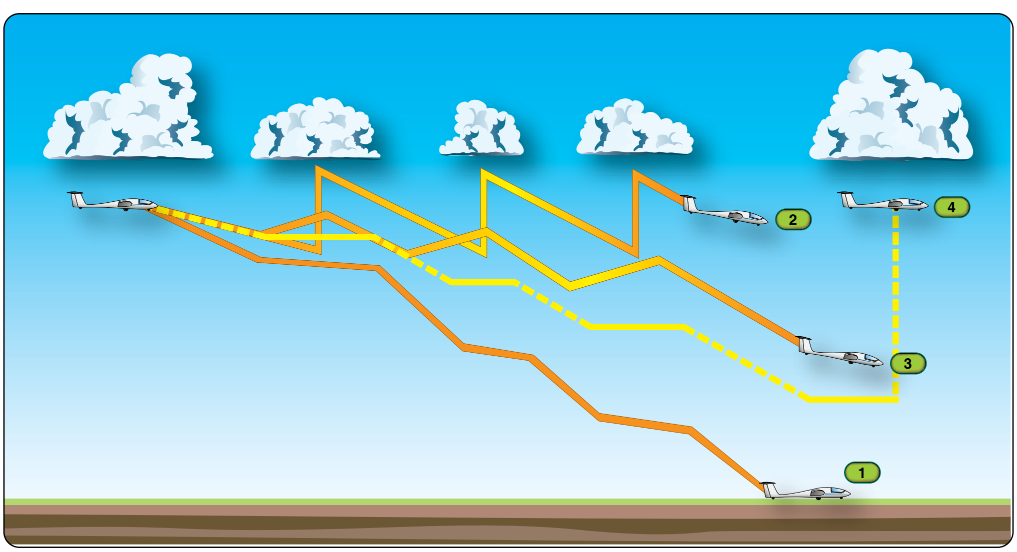

Figure 11-13. *Example of glides achieved for different MacCready ring settings.*

- 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 climbs under the large cumulus, the pilot sits well ahead of pilots 2 and 3 and can relay retrieval instructions for pilot 1. This example illustrates the science and art of faster cross-country soaring. The science comes from speed-to-fly theory, while the art involves interpreting and modifying the theory for the actual conditions.

Tips & Techniques

The height band changes during the day. On a typical soaring day, thermal height and strength often increase rapidly during late morning, and then both the strength and height remain somewhat steady for several hours during the afternoon. The height band rises and broadens with overall thermal height. Sometimes a base of cumulus clouds limits the top of the height band. The cloud base may slowly increase by thousands of feet over several hours, during which time the height band also increases. Pilots should stop traveling and thermal when at or near the bottom of the height band. Pushing too hard for distance can lead to an early off-field landing or lead to lost time spent climbing inefficiently at lower altitudes. Thermals often "shut off" rapidly late in the day, and pilots should consider staying higher late in the day. [*Figure 11-14*]

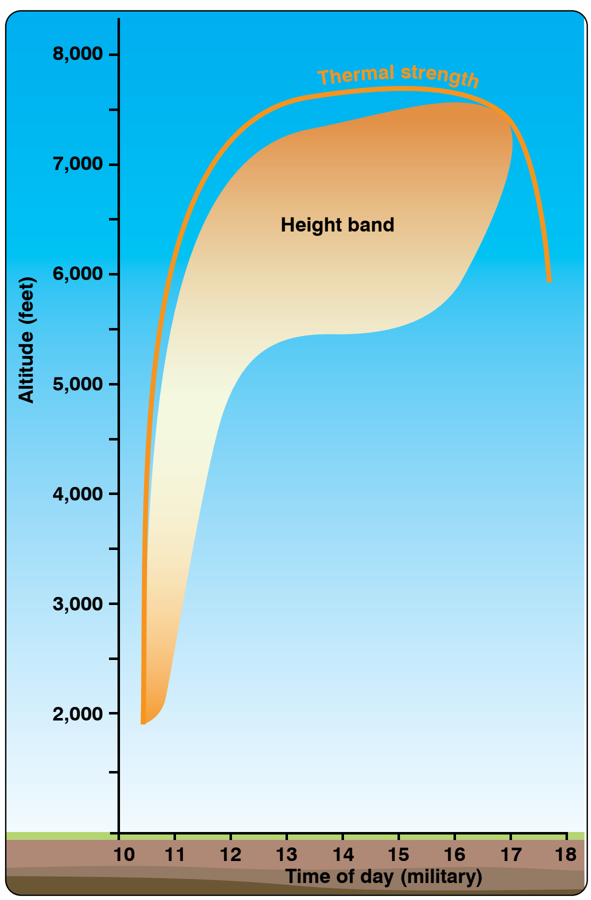

Figure 11-14. *Thermal height and height band versus time of day.*

Another way to increase cross-country speed involves a technique known as "dolphin flight," which covers surprising distances with little to no turning or circling. The idea involves diving to speed up while in sink and slowing down and climbing in lift while maintaining a straight course line. This technique utilizes closely spaced thermals, as occur along a cloud street. The speed to fly between lift areas depends on the appropriate MacCready setting.

As an example, assume two gliders start at the same point and fly under a cloud street with frequent thermals with weak sink between the thermals. Glider 1 uses "dolphin flight" by flying faster in the sink and slower in lift. Glider 2 conserves altitude and stays close to the cloud base by flying best L/D through weak sink. To get to the next cloud, the pilot of glider 2 flies faster in areas of lift. At the end of the cloud street, one good climb quickly puts glider 1 near the cloud base and well ahead of glider 2. [*Figure 11-15*] The best-speed-to-fly decreases time in sink and therefore decreases the overall amount of descent but produces the best forward progress. Being slower in sink increases time descending and slows forward progress. Being fast in lift decreases time in lift and altitude gained.

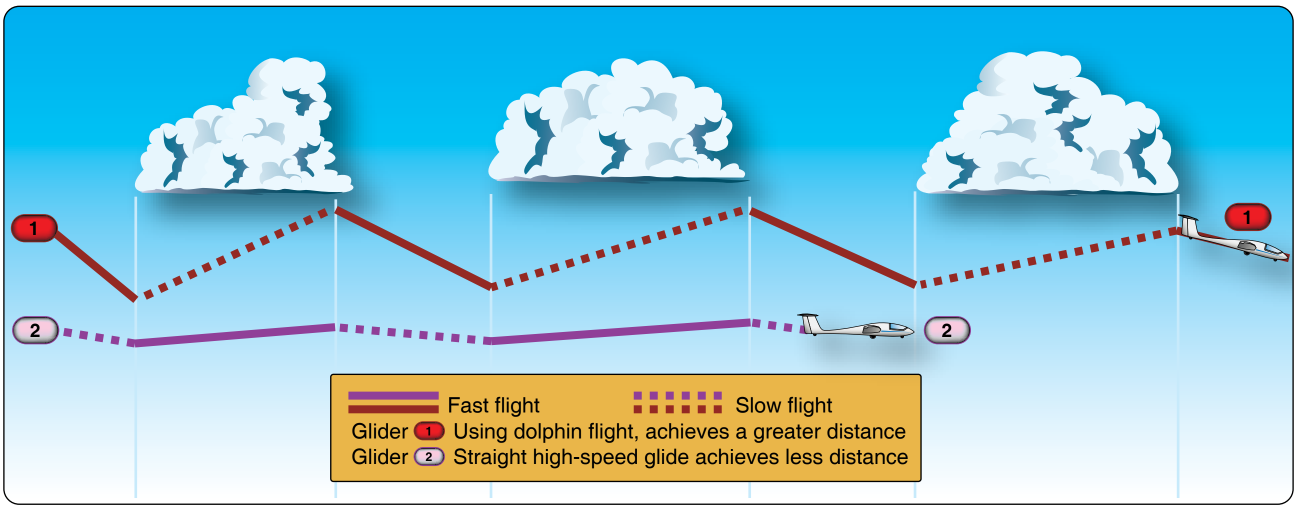

Figure 11-15. *Advantage of proper speed to fly under a cloud street.*

On an actual cross-country flight, the pilot can use a combination of dolphin flight and classic climb and glide. In the example above the pilots decided not to stop and circle in the weak closely spaced thermals, but they could stop and circle if finding areas of strong lift.

Special Situations

Course Deviations

Pilots might consider deviation on a soaring cross-country flight as the norm rather than the exception. Even with fair weather cumulus evenly spaced across all quadrants, the pilot might decide to deviate toward stronger lift. Deviations of 10° or less add little to the total distance and pilots should not hesitate to fly toward such better lift. Even deviations up to 30° may work well if they lead toward better lift or avoid suspected sink ahead. The sooner the deviation starts, the less extra distance the glider will cover during the deviation. [*Figure 11-16*]

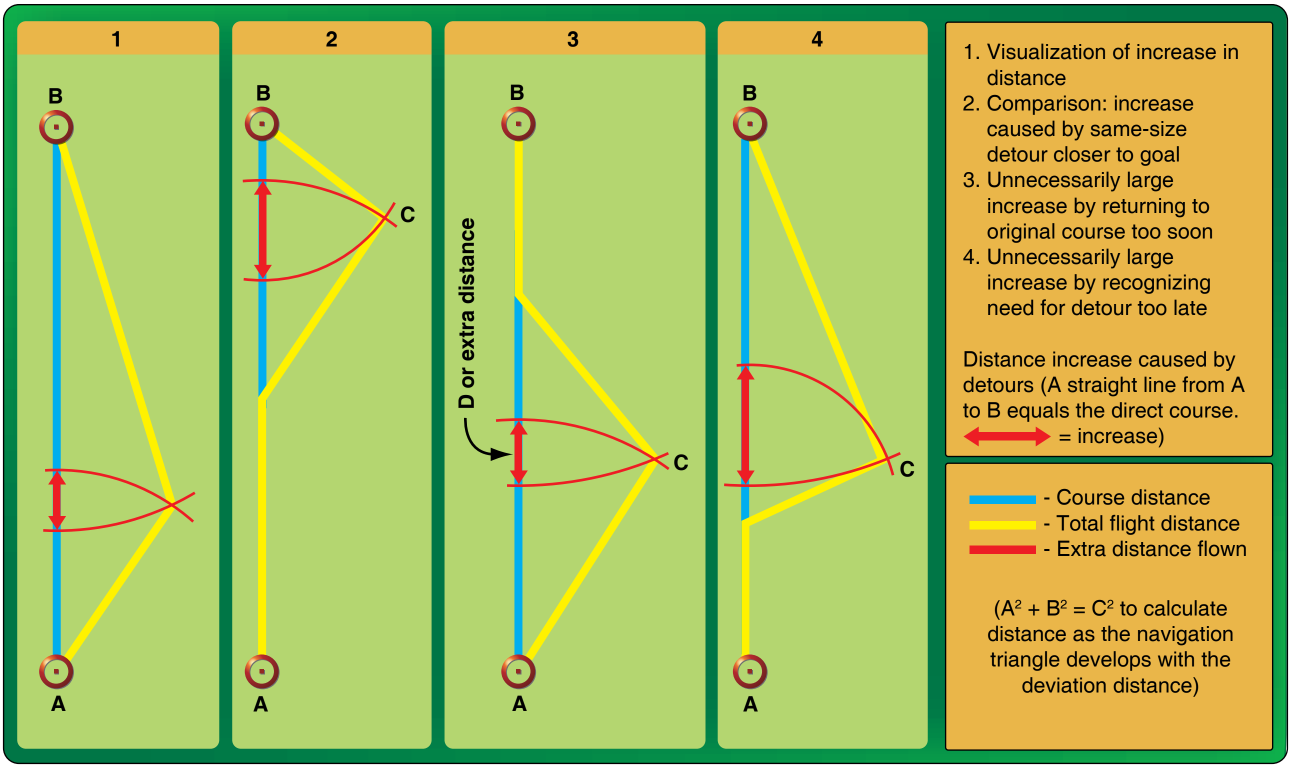

Figure 11-16. *Effects of starting course deviations at different times. Red arrows show extra course distance and indicate the benefit of early course deviations.*

The pilot might use deviations of 45° or even 90° to avoid poor conditions ahead. Areas to avoid could include a large cloudless area or a shaded area where cumulus have spread out into stratus clouds. Cloud development can shade the earth, decrease surface heating, and decrease lift. A pilot could deviate more than 90° to return to active thermals after venturing into stable air.

Generally, glider pilots encountering a large area of stable air or sinking air will end up landing before VFR conditions disappear. Thermalling ceases as the sky becomes cloudy and shades the earth's surface. However, pilots should deviate or have an option for landing rather than fly into lowering ceilings or rain showers ahead. Ridge lift might remain, but cloud bases can obscure that source of lift as well. Thunderstorms along the course can generate outflows and affect surface winds for many miles surrounding the storm. The pilot should avoid landing anywhere near a thunderstorm. Thunderstorms ahead often warrant large course deviations of up to 180° (i.e., retreat to safety).

Lost Procedures

A working GPS system makes it almost impossible to get lost. However, GPS systems can fail, and pilots should have a backup plan if that should occur. The following actions increase the likelihood of reorientation without using GPS.

If lost after some initial searching, the pilot should remain calm and make certain a suitable landing area exists within gliding distance. The pilot should then try to find a source of lift and climb. Even weak lift can provide more time to look for landmarks. Thermalling and climbing while searching has the added advantage of allowing a wider area to scan while circling. The pilot should estimate the last known position, the course flown, and any possible differences in wind at altitude. Maybe the headwind was stronger than anticipated, and the flight did not progress as far along the course as expected. The pilot can try to pinpoint the present position from an estimate of the distance traveled for a given time from a known point and confirm it with visible landmarks on an electronic or paper chart.

Once locating a known landmark on the chart and on the ground, the pilot can confirm the location by finding a few other nearby landmarks. For instance, if seeing a specific town below, an adjacent highway should curve like the one shown on the chart. Airports and airport runways provide valuable clues if sighting an airport, which include runway orientation and markings or the location of a town or a city relative to the airport. If still lost and near a suitable landing area, the pilot should stay in that area until certain of the location. If previous efforts fail, a radio call to other soaring pilots in the area with a description of what lies below and nearby may bring help from another pilot. Finally, a safe landing provides the opportunity to figure out the location on the ground.

Cross-Country Flight in a Self-Launching Glider

Although more complex and expensive, a self-launching glider can give the pilot additional freedom. First, a self- launching glider allows the pilot to fly from airports without a towplane or tow pilot. Second, the pilot can use the engine to avoid off-field landings and extend the flight. In theory, when low in a self-launching glider, the pilot simply starts the engine and climbs to the next source of lift. However, this practice has risks of its own and has led to many accidents due to engine failure or improper starting procedures.

Overreliance on the engine can lead pilots to glide over terrain unsuitable for landing. If the engine fails, the pilot has no safe place to land. Some accidents have occurred when the pilot rushed to avoid a landing and forgot a critical task, such as switching the ignition on. Other accidents have occurred in which the engine did not start immediately, and the pilot flew too far from a suitable landing area while trying to troubleshoot. For a self- launching glider with an engine that stows in the fuselage behind the pilot, the added drag of an extended engine can reduce the glide ratio by 50 to 75 percent. [*Figure 11-17*]

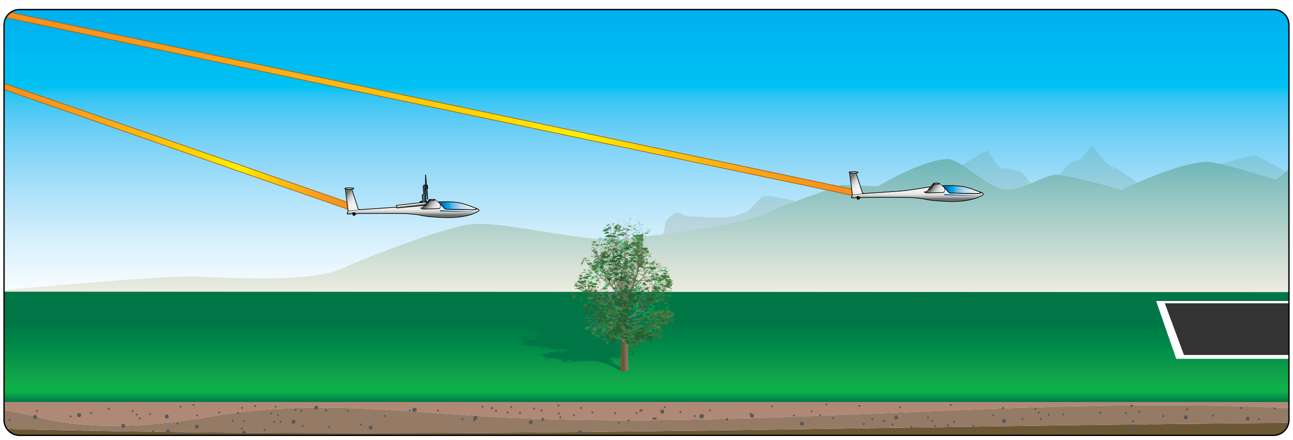

Figure 11-17. *Effects on the glide ratio of the engine being extended but not running.*

The engine starting procedure in a self-launching glider increases the critical decision height to commit to an off- field landing. The time needed to start the engine and extra drag during the starting process can add anywhere from 200 feet to 500 feet of altitude lost to extend and 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 to start. In this sense, the self-launching glider becomes more restrictive during cross-country flying.

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 uses a maximum climb under power followed by a power-off glide. Pilot should check the GFM/POH for recommendations.

Another type of glider features a sustainer engine. Although this type of engine does not have enough power for self-launching, it can keep the glider airborne if lift fails. However, sustainer engines can only produce enough power to overcome the glider's sink rate. Higher sink rates can overwhelm the capability of many sustainer powerplants. Sustainer engines typically eliminate the need for a time-consuming retrieval at the end of a cross country, and they operate with less complexity than their self-launching counterparts. Pilots flying a glider with a sustainer engine have similar concerns as pilots flying self-launching gliders regarding unsuitable terrain and altitude decision heights.

High-Performance Glider Operations & Considerations

Extended cross-country flights have been made in relatively low-performance gliders. However, on any given soaring day, the same pilot can fly a glider with a 40:1 glide ratio farther and faster than one with 20:1 ratio.

Glider Complexity

The experience required to fly a high-performance glider does not necessarily depend on a pilot's total glider hours. Pilots should consider the types of gliders flown (low and high performance). Most high-performance gliders have a single seat. The pilot should obtain some instruction from an authorized flight instructor in a two-seat high performance glider, if available, 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 systems in the glider.

Many high-performance gliders have flaps. Pilots can use a few degrees of positive flap when thermalling, 0° for relatively low-speed glides, and negative flap settings 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 large positive flap settings for landing.

Water Ballast

Water ballast can maximize average cross-country speed on a day with strong thermals. The gain in speed between thermals outweighs the lost time due to slightly slower climbs with water ballast. Pilots should not plan to use ballast on a day with weak thermals. If strong thermals become weak, the pilot can dump the water ballast.

Water expands when going from the liquid state to the solid state. The force of the water ballast freezing can split composite wing skins. If anticipating flying on a cross-country flight and spending time at levels with temperatures below 0 °C, the pilot should add the GFM/POH recommended antifreeze to the ballast before departure.

Cross-Country Flight Using Other Lift Sources

Ridge or wave lift provides more consistent lift than thermals, allowing long, straight stretches of hundreds of miles at high speed.

Pilots with little experience using ridge lift on a cross-country flight should plan for a day with ideal wind and weather. On relatively low ridges, (e.g., in the eastern United States), ridge lift may not extend very high. The best lift often sits very close to the ridge crest in turbulent air, and pilots might end up flying close to terrain in rough conditions for hours at a time. If the pilot loses lift, maneuvering for an off-field landing might occur with little notice. In milder conditions, the cross country might require thermalling to gain enough height to cross any ridge gap. If cumulus spread out to form a stratus layer shading the ground and eliminate thermals, the pilot might need to use a wind facing slope to maintain soaring flight while waiting for the shade to dissipate. Unless the sun returns and generates the thermal needed to gain sufficient altitude, the pilot would need an alternate plan.

Wave lift can also provide opportunities for long or fast cross-country flights. Most record flights have been along mountain ranges; flights more than 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 occur by climbing high in a wave, then gliding with a strong tailwind to the next range downwind for another climb. The pilot needs to consider physiology (cold, oxygen, etc.) and airspace restrictions for cross-country flights using wave lift.

Convergence zones can also enhance cross-country speed. Even if the convergence does not form a consistent line and acts only as a focus for thermals, dolphin flight could occur. When flying low, awareness of local, small-scale convergence can help the pilot find thermal triggers and enable a climb back to a comfortable cruising height.

A pilot might find a combination of ridge, thermal, wave, and even convergence lift during one cross-country flight. Optimum use of the various lift sources requires mental agility and makes for an exciting and rewarding flight.

Chapter Summary

Pilots should begin planning cross-country flights carefully and within their capability and that of the glider. Planning includes a consideration of weather forecasts, possible routes, what to carry, airspace, and potential landing sites. On the day of a planned flight, the pilot can choose from plans and routes considering the existing environmental conditions. The pilot should brief any ground crew and complete all preflight checks without rushing. Pilots who make cross-country flights know how to maximize the available lift to increase the average speed of the flight. They also understand and follow sensible height restrictions to stay safe. They can divert when necessary and know when to commit to an off-airport landing if lift becomes less than needed to continue. Pilots who fly powered gliders know that they commit to landing procedures at safe altitudes and that they could encounter a situation where their engine does not start.