

Flight Planning – Part 1 – Pilotage Planning

One of the activities leading to the award of a Private Pilot license is the ability to plan and conduct a cross country flight legally and safely. This part of the flight planning process describes how to determine the True Course (TC), distance, and the selection of visual waypoints. These steps are critical to a method of navigation called pilotage. Pilotage is the ability to fly, along a selected course, from waypoint to waypoint. In the other parts, you will apply wind correction and transfer the cumulative information into useable data so you can safely navigate using the magnetic compass in the airplane.

Your instructor may give you a route or he may ask you to select a route. Typically routes are selected with legs of at least 50nm so as to coincide with the FAA requirement for the long cross country that one leg be at least 50nm [FAR 61.109 (a)(5)(ii)].

For this tutorial the route of flight is KHYI – T85 – KGYB – KHYI. Let's examine the first segment from San Marcos, TX to Yoakum, TX. (See below figure)

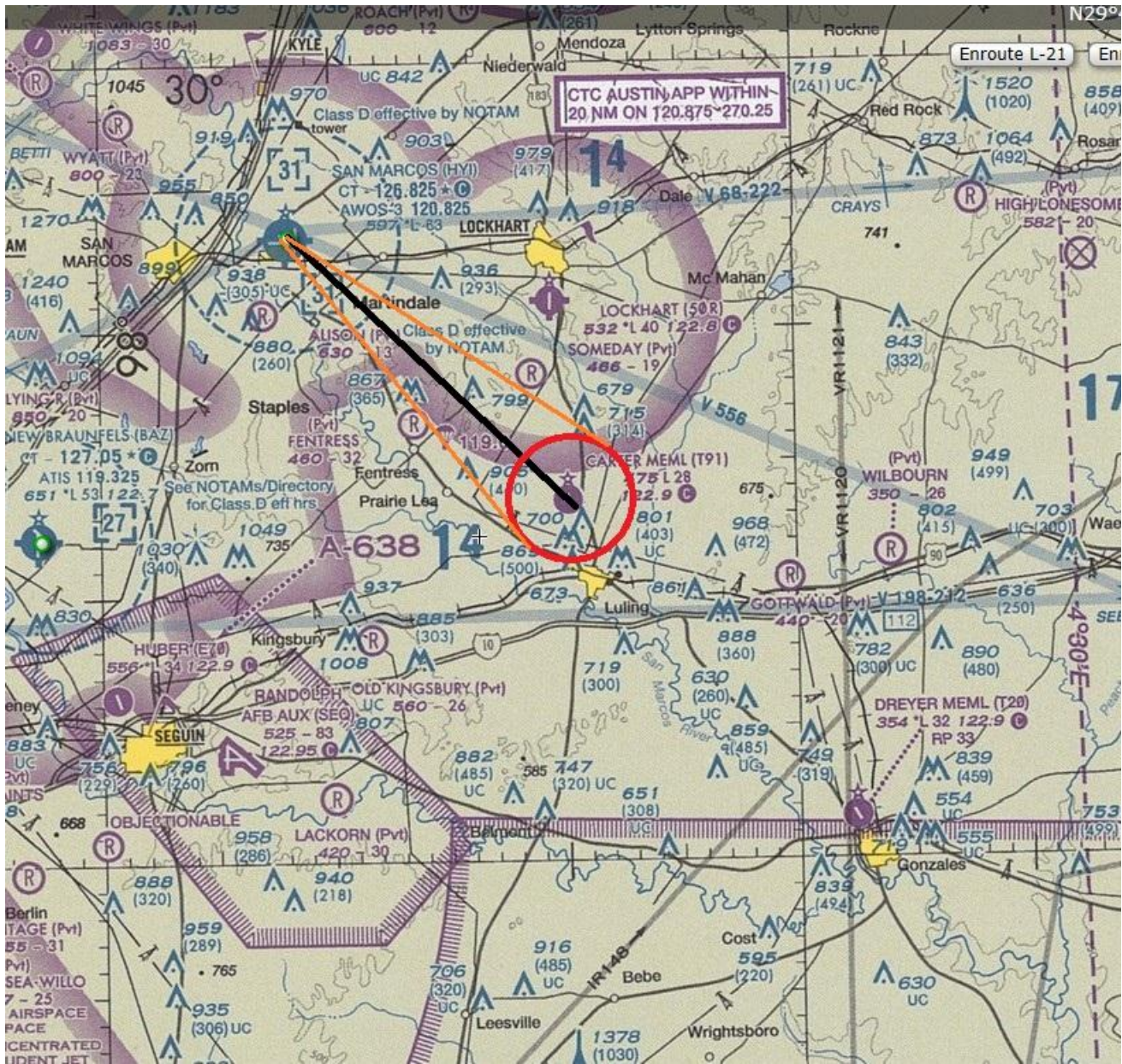


In this example, T85 is 51nm from KHYI on a true course (TC) of 130 degrees. So the length of this leg satisfies the requirements. True course (TC) is obtained by:

1. Drawing a straight line between KHYI and T85
2. Using a plotter, determining a true course (TC), in this case it is 130 degrees
3. While you are at it, use the plotter to verify distance (be sure to use the sectional scale) as 51nm

The next step is to select waypoints along the flight segment. Waypoints must be selected so as to be easily identified and not ambiguous. One common mistake is to try to select a communication tower. In the figure above, there are numerous communication towers along the route of this flight segment. These are usually unsuitable because they are both difficult to see as well as the great difficulty in identifying them from the many other towers that are along the route of flight. Good waypoints might be airports, towns, road intersections or railroad tracks (only when nearly at a 90 degree angle to the route of flight). The other attention that needs to be considered when selecting waypoints is the distance between the two waypoints. Generally, waypoint distances greater than 20nm should be avoided. This can be best explained by the below figure.

In this figure, assuming a no-wind situation, a pilot is holding a heading that coincides with his desired course of +/- 5 degrees. Departing from San Marcos airport and flying direct to the Carter Memorial airport (a distance of slightly more than 14nm), this directional uncertainty will lead to a range uncertainty of about 3nm (the radius of the red circle). It ought to be evident that if you increase the distance between waypoints, this uncertainty circle will get larger. Finally, adding in a wind can make this range uncertainty grow ever larger such that the ability to see and identify the waypoint becomes problematic. Wind correction will be discussed in the next part of this flight planning series.

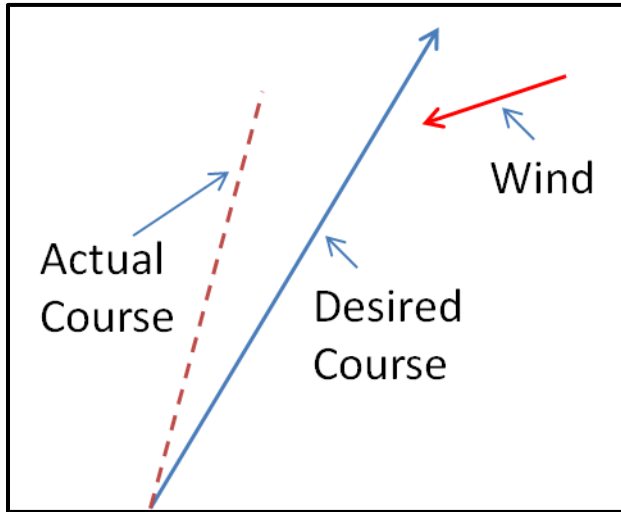


So for this flight segment, what waypoints would you choose? If you selected the airports T91 and T20, congratulations. You might have also selected Highway 10 as an additional waypoint.

Now, as an exercise, repeat this process for the flight segments T85 to KGYB, and KGYB to KHYI. Measure distance, TC, and select waypoints.

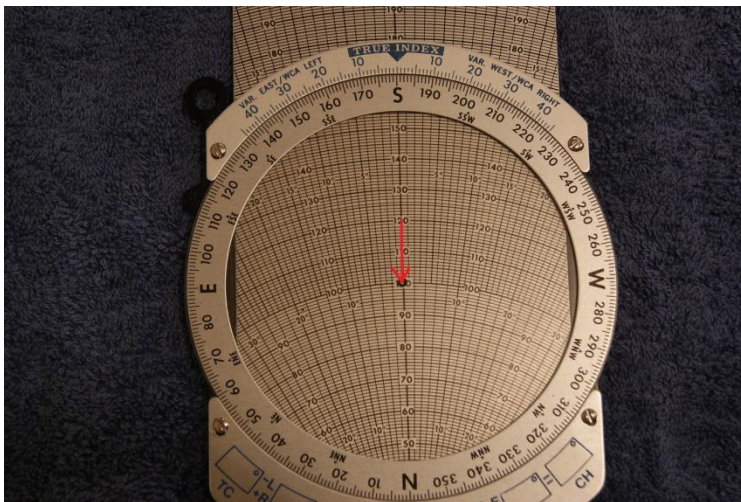
Flight Planning – Part 2 – Applying Wind

During the flight the actual airplane's path will be through a parcel of air that is also moving. Just like a boat that crosses a river current, the airplane must adjust for these wind currents. This is best explained by the following figure:



Without any wind adjustment, the actual course will be different than the desired course. Also, since our airplane's travel is a vector (it has both direction and speed) and since the wind is also a vector, not only will the course direction be affected but also the actual speed of our aircraft over the ground.

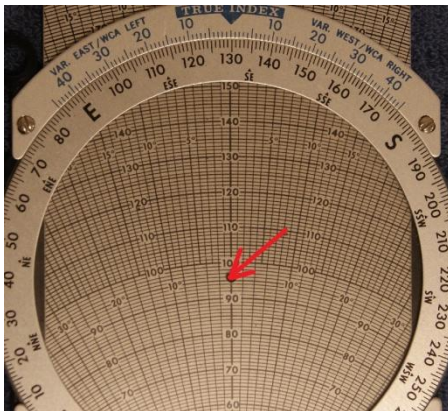
Fortunately we will not have to solve vector math as a very nifty device called an E6B flight computer will easily solve the entire vector math for us. For this exercise, assume we have a 20 knot wind from 180 degrees and we are flying the 130 degree True Course from KHYI to T85. (Note: upper air winds are given in true degrees)



In the above figure, the wind direction is set to 180 degrees under the true index and the wind speed is drawn between two convenient speed scales on the 'trombone' slide so as to depict a wind speed of 20

knots. In this example, I have drawn the wind with an arrow at the ‘grommet’ (center of the circular transparent scale usually marked with a small donut shaped circle) so as to remind myself of its direction in the following steps. *The tail of the wind arrow we will call the ‘wind dot’.*

Let’s assume we have determined our true air speed (TAS) at our cruising altitude will be 110 knots. Then all we need to do to solve for our ground speed (GS) is to rotate the circular dial to place the desired course under the index and place the wind dot over 110 knots by sliding the trombone scale up and down. See the following figure:



This tells us our ground speed is 96 knots.

But wait, there is more. Examining the fan shaped lines that expand upward, we see that the wind dot is on an 8 degree line to the right of the centerline. This is a very special reading called a Wind Correction Angle (WCA). A right WCA means, in order to correct for the wind, we must add 8 degrees to our True Course (TC) of 130 degrees to obtain a True Heading (TH) of 138 degrees.

If the wind dot were to the left, then we would subtract it. To summarize all of our equations so far:

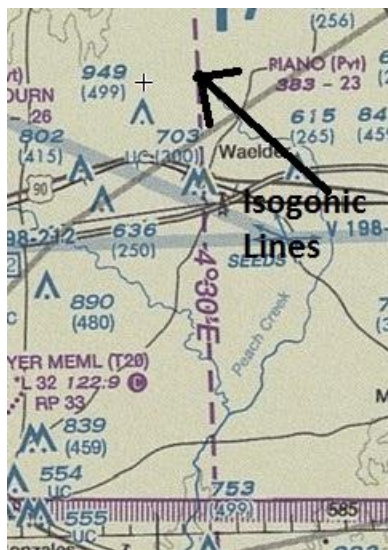
$$TC \pm WCA = TH$$

Flight Planning – Part 3 – Converting A True Heading to a Magnetic Heading

In the previous part of this tutorial we converted the True Course to a True Heading by finding the WCA and applying it. Our airplane instruments are magnetic reading devices (magnetic compass) or are referenced to the magnetic compass via a gyro heading indicator called a directional gyro (DG).

In order to use our True Heading, it must be converted to a Magnetic Heading. The lines of magnetic force are rarely in alignment with the lines of longitude that pass thru the rotational poles of the earth. Fortunately, on our sectional chart, these differences are plotted. In the below figure, a line of Easterly Variation exists between True and Magnetic north.

This line of magnetic variation is called an isogonic line. Iso is derived from Greek and it means equal, while gonic means angles of the same measure, hence anywhere along this line, the magnetic variation is such that Magnetic north is 4 degrees and 30 minutes to the East of true North. Therefore, if one is wishing to find Magnetic course of exactly North, they would need to be on a True Course of 355 degrees and 30 minutes.



Our True Heading (TH) is thus easily converted to a Magnetic Heading by.

$$\text{MH} = \text{TH} \pm \text{W/E Variation}$$

If the variation is easterly, then it is subtracted from the TH, but if it is westerly, it is added.

Continuing from the previous part, since our TH was 138 degrees, we now have our MH of 133 degrees (rounding 4.5 degrees to 5 degrees of easterly variation).

There is one final step and that is determining the actual compass heading (CH) from our magnetic heading. Just above (or below) the magnetic compass is a card with the deviations between magnetic headings and what the compass indicates. This card is included to remove the errors associated with the

electrical system in the airplane. The difference between these heading is called deviation. For example, your card may say for MH=120 steer 124. This is a positive deviation that needs to be added to headings close to 120 degrees. So finally, our CH = $133 + 4 = 137$ degrees.

Wrapping up. While these steps seem involved, with a little bit of practice it is very easy to make these computations in just a few minutes.

Of course they need to be entered into a navigation log. A good log format can be downloaded from this web site: <http://www.dauntless-soft.com/downloads/vfrfp22a.pdf>