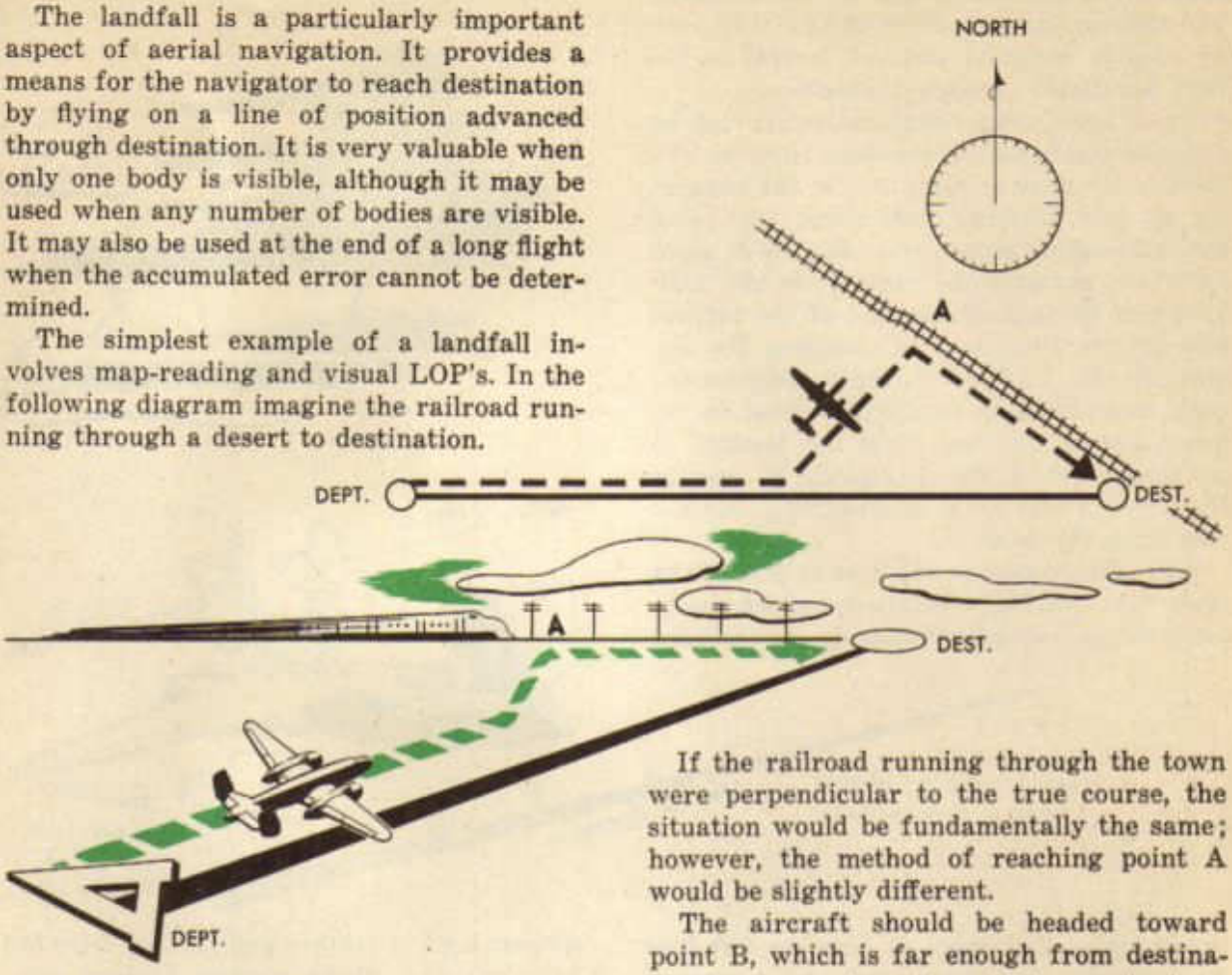
The Landfall

The landfall is a particularly important aspect of aerial navigation. It provides a means for the navigator to reach destination by flying on a line of position advanced through destination. It is very valuable when only one body is visible, although it may be used when any number of bodies are visible. It may also be used at the end of a long flight when the accumulated error cannot be determined.

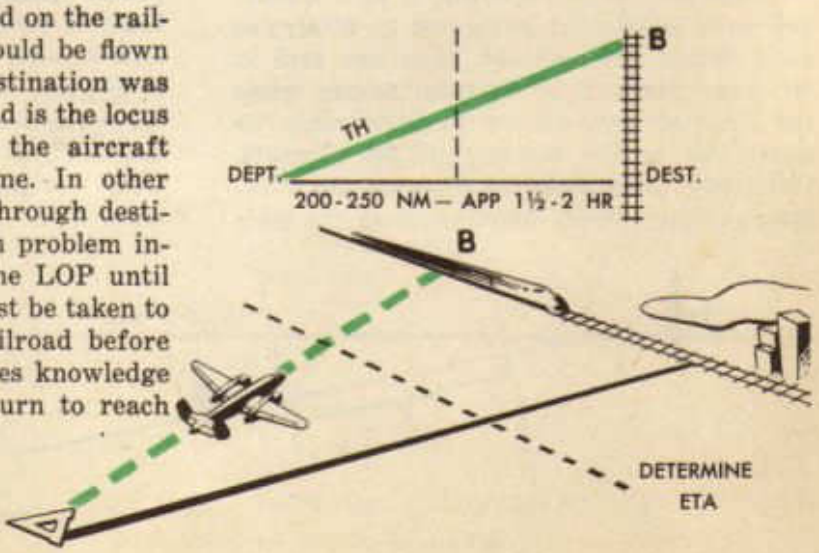
The simplest example of a landfall involves map-reading and visual LOP's. In the following diagram imagine the railroad running through a desert to destination.



Without worrying about groundspeed and ETA, what would be the best method which could assure arrival at destination? Obviously, if the aircraft were placed on the railroad at or about point A, it could be flown along the "iron beam" until destination was reached. In this case the railroad is the locus for all possible points where the aircraft could be at the particular time. In other words, it is a line of position through destination, and the only navigation problem involved is that of staying on the LOP until destination is reached. Care must be taken to place the aircraft over the railroad before passing destination. This assures knowledge of the direction in which to turn to reach destination.

If the railroad running through the town were perpendicular to the true course, the situation would be fundamentally the same; however, the method of reaching point A would be slightly different.

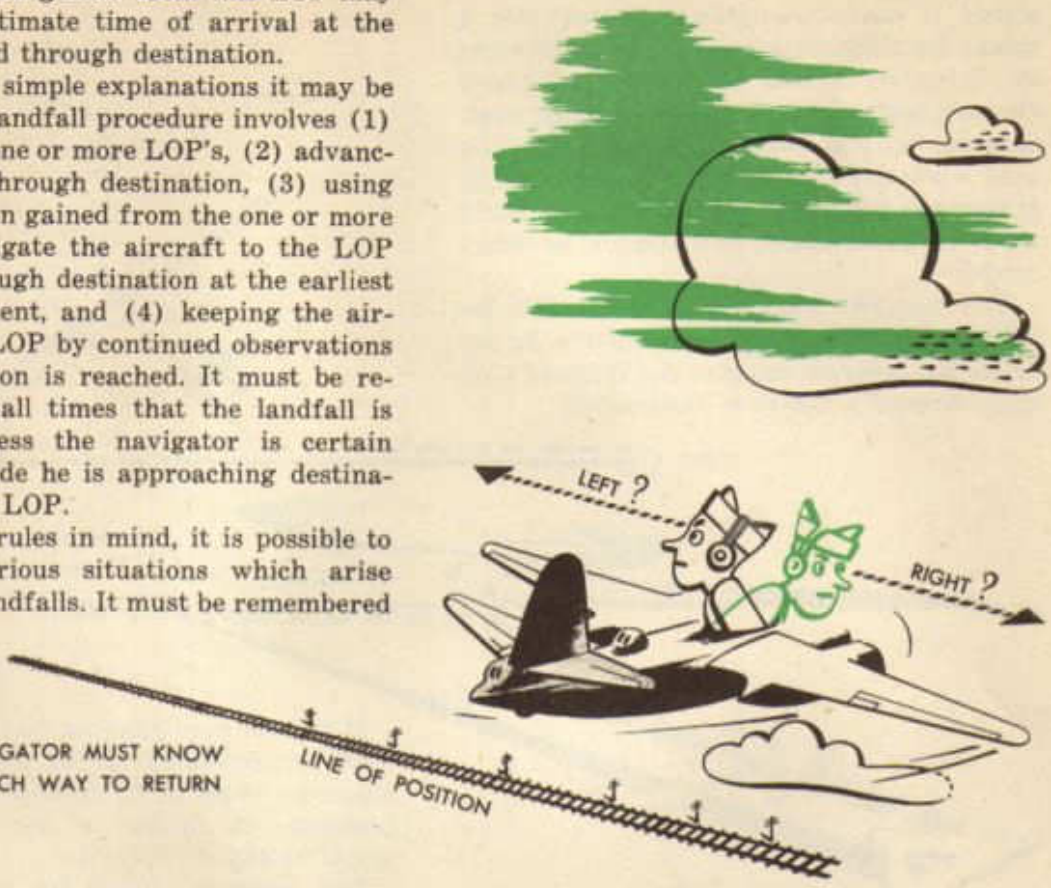
The aircraft should be headed toward point B, which is far enough from destination to assure knowing which way to turn upon arriving at the railroad. Any means may be used to determine an ETA at the



railroad, but, for simplicity, assume another railroad at the dotted line in the diagram. The information gained from this LOP may be used to estimate time of arrival at the LOP paralleled through destination.

From these simple explanations it may be deduced that landfall procedure involves (1) the taking of one or more LOP's, (2) advancing an LOP through destination, (3) using the information gained from the one or more LOP's to navigate the aircraft to the LOP advanced through destination at the earliest practical moment, and (4) keeping the aircraft on this LOP by continued observations until destination is reached. It must be remembered at all times that the landfall is worthless unless the navigator is certain from which side he is approaching destination along the LOP.

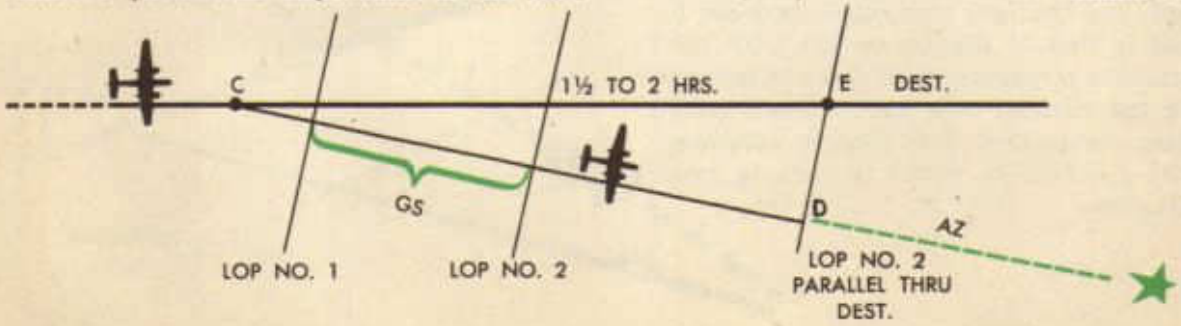
With these rules in mind, it is possible to study the various situations which arise when flying landfalls. It must be remembered



at all times that lines of position fall into two extreme categories, and any degree of variation between the two extremes is possible.

When lines of position fall in such a manner as to enable the navigator to determine an accurate groundspeed, they are said to be *speed* lines. This situation occurs when the lines of position are perpendicular, or nearly so, to the heading of the aircraft. Obviously the matter of interpretation becomes of paramount importance as the lines of position fall farther and farther from the perpendicular. Many varying factors influence this interpretation.

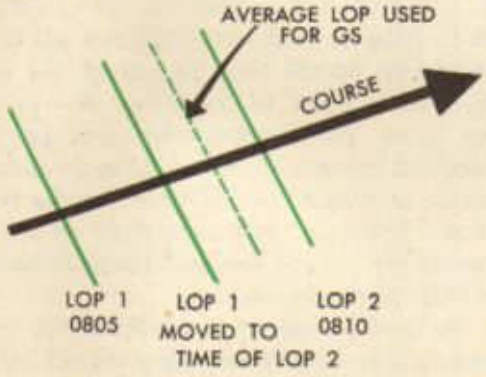
The following diagram indicates the proper procedure to follow when flying a landfall using speed lines. When the aircraft is navigated to a point about 200 or 250 NM or 1½ to 2 hours from destination, it must be turned to one side in order to know definitely which direction to turn upon arrival at the LOP through destination. The maximum error (DE) to assume under normal condi-



tions is 40 to 50 miles over a distance of 200-250 NM. By flying a heading approximating the azimuth or its reciprocal, yet far enough off course to allow for the assumed error, the aircraft flies the shorter distance.

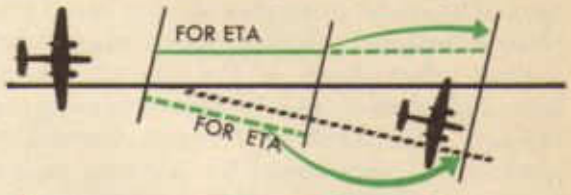
After deciding on the heading to fly from point "C," the navigator is faced with the problem of determining the groundspeed. This may be done by lines of position starting about half an hour from point C. There are several variations which may be used to obtain accurate information for plotting the line of position. Two or more observations can be taken close together and the arithmetic average of time and Ho used to plot one LOP.

At times it may be desirable to plot each LOP taken over a short period of time. If this is done, an average can be obtained by moving the first LOP by best information along the true course to the time of the last



and visually draw an average. The advantage of these methods lies in the fact that only one measurement is needed to determine groundspeed. However, in spite of this, many navigators prefer to plot the results of each observation in order to obtain as many groundspeeds as possible.

Regardless of the method used to establish a line of position, the greatest problem is concerned with the determination of the time to turn on an LOP paralleled through destination. The LOP selected to advance through destination depends upon the interpretation

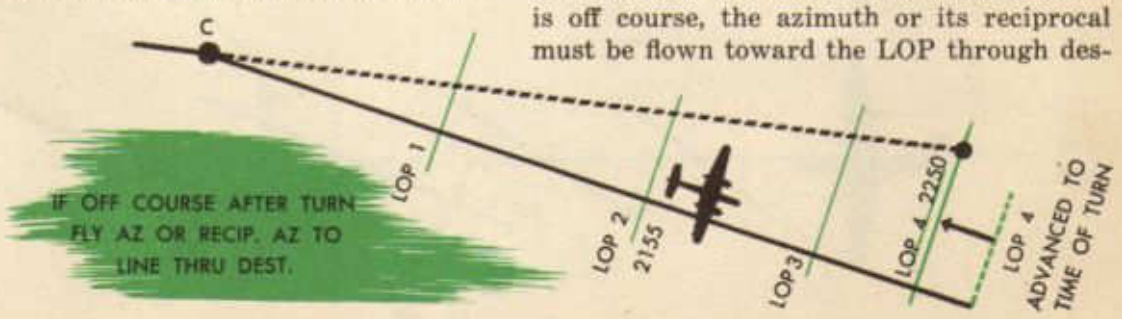


ETA TO LOP MAY BE COMPUTED ALONG EITHER ORIGINAL TC OR ALONG ASSUMED TRACK. THE 2 TIMES WILL BE THE SAME.

of the lines of position taken during the flight, but each interpretation is based on the fact that a line passed through a triangle parallel to one side divides the other two sides in the same ratio.

A simple and practical method of flying a landfall utilizes the groundspeed obtained from the last LOP to determine the ETA to that LOP paralleled through destination. Lines of position are taken as usual in order to keep station as well as to evaluate the last LOP. Obviously, much depends upon the accuracy of the last LOP; therefore the average of several observations taken over a short period of time is usually used to establish this position. This last LOP is taken at a time which allows a sufficient period for the calculations and chart work necessary to determine the ETA to its parallel through destination. The accuracy of this ETA is checked again by observations immediately before and after turning on the advanced LOP toward destination.

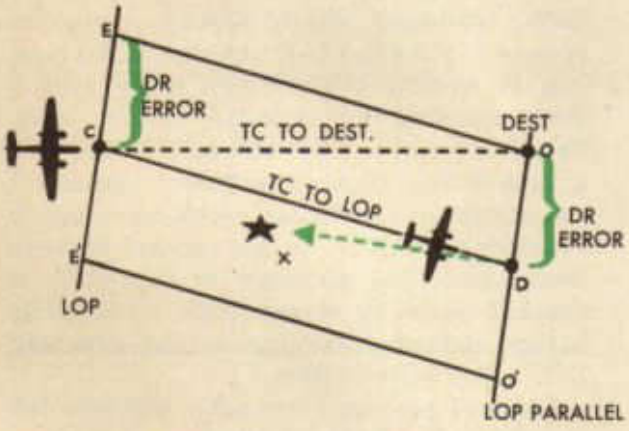
Lines of position taken after the turn fall parallel or nearly so to the true course of the aircraft. If it is ascertained that the aircraft is off course, the azimuth or its reciprocal must be flown toward the LOP through des-



tination. The best available information, usually TAS, is used to determine when this LOP has been reached. Care must be taken, however, when weighing these lines of position. It must be remembered that speed line observations are relatively easier than observations taken abeam of the aircraft; therefore, information gained before turning on the last LOP paralleled through destination must not be outweighed by material gained from an insufficient number of course line observations.

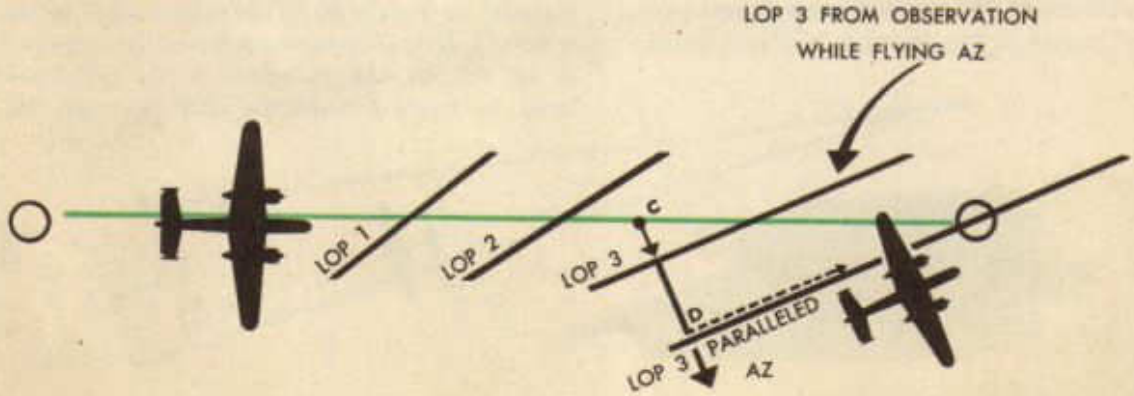
It has been mentioned several times that the navigator must be careful to assume an error which will place the aircraft definitely on one side of destination. The amount of this assumed error depends on the maximum possible navigation error. The direction of flight is determined by the azimuth of the LOP through destination.

In the accompanying diagram the navigator calculates the aircraft to be at C and his maximum error to be CE. The azimuth of the body being used is indicated by the dotted line DX; therefore, the desired heading of the aircraft during the landfall approximates the reciprocal of this azimuth. A glance is sufficient to show that by turning off to the right, the LOP will be reached sooner than by turning off to the left. The exact heading of the aircraft may be determined by measuring OD equal to the assumed error CE and drawing CD. Now, suppose the aircraft were actually at E instead of C. By flying the heading EO, which is parallel to CD, it would arrive at the LOP over destination. If the aircraft were actually at E′ it would arrive at O′. This would result in flying a much longer time along the LOP before reaching destination, but the navigator would know which way to turn upon arrival at the LOP. Thus, the assumed error must be the maximum navigation error in order to place the aircraft definitely on one side of destination.



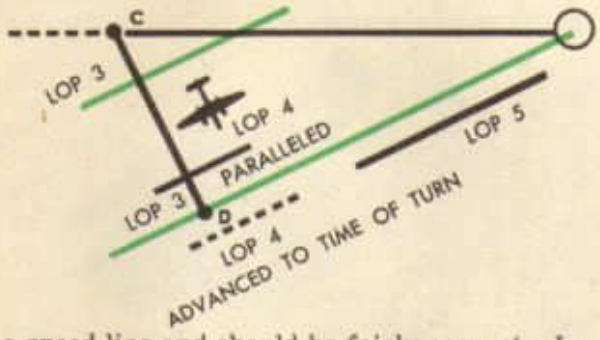
In the discussion of the speed line landfall it was noted that the aircraft was placed on an LOP through destination; therefore, observations with the aircraft on this heading result in lines of position which are parallel, or nearly so, to the true course of the aircraft. These lines of position are called course lines. The fundamental concepts of the landfall remain unchanged regardless of the angle at which the LOP crosses the true heading; however, the procedure required for use of the course line is slightly different from that of the speed line.

In the landfall using course lines, the fundamental idea is to place the aircraft along an LOP paralleled through destination. The difficulty with course lines lies in the fact (1) that the observations are less accurate, and (2) that the wind effect is more noticeable. Fact number one (1) may be offset somewhat by making observations while flying the azimuth to the LOP through destination.



This procedure is explained in the diagram. It must be noted that the lines of position cut the true course at a sharp angle; therefore, it is practical to place the aircraft on the LOP paralleled through destination shortly after departing. As the angle increases it becomes necessary to fly closer to destination before turning off to get on the LOP. This becomes a matter of interpretation, especially since groundspeeds cannot be accurately determined from course lines. Lines of position No. 1 and No. 2 are taken for practice. It is decided that it is practical to fly over to the LOP through destination rather soon after departing; therefore the aircraft is calculated to be at C by the best available information. Using coordinates of point C, predetermine the azimuth. At point C the aircraft is turned on the heading CD, which parallels the azimuth or its reciprocal.

After turning at point C, an LOP is obtained immediately. Since the aircraft is flying on the azimuth, the LOP obtained will be



a speed line and should be fairly accurate. In the diagram this is LOP No. 3. Parallel No. 3 through destination and obtain an ETA by DR, metro, or TAS to point D. The distance used to determine this ETA is between LOP No. 3 and LOP No. 3 paralleled and not from point C.

Just before the ETA to the No. 3 paralleled is up, another LOP should be obtained in order to double check the position of the aircraft. This LOP will also be a speed line. Advance this LOP to the time of turn, and check the aircraft's position in relation to the LOP paralleled through destination. If the azimuth of the body is changing rapidly, it may be desirable to parallel the last LOP through destination in order that future observations will be more nearly parallel to the true course. In any event, the azimuth or its reciprocal must be flown to the desired LOP.

It must be noted that the wind may consistently blow the aircraft from the LOP through destination; therefore, constant checking is necessary. Occasionally, it may be desirable to make observations when the aircraft is on the LOP instead of the azimuth, but care must be taken to realize the danger of inaccurate shots due to the motion of the aircraft. Ordinarily the azimuth of lines of position change markedly before destination is reached; therefore, it may become necessary at times for the navigator to parallel additional LOP's through destination and fly azimuths in order to interpret his observations properly.

Finally, at times, landfalls which start out with course lines end with speed lines, or vice versa. Much of the confusion which results from this situation may be eliminated by computation of an azimuth for a TAS ETA at destination. This will serve to provide a basis for planning the landfall before it is actually flown.

AFTER TURN TO DESTINATION

DON'T STOP NAVIGATING