The Flight Environment – Aeronautical Charts

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In order to understand aeronautical charts we first must understand the longitude and latitude coordinate system. Imagine lines drawn from the North Pole to the South Pole. These are used to measure longitude in degrees starting at the zero degree Prime Meridian line running through Greenwich, England. As you move west or east of the Prime Meridian the degrees of longitude increase to 180 degrees half way around the globe. For example, the central section of the United States is about 90 degrees west of the Prime Meridian.

Lines of latitude start at the equator half way between the North Pole and the South Pole. The northern hemisphere is from the equator zero degrees latitude to 90 degrees latitude at the North Pole. The southern hemisphere is between the equator and the South Pole. One degree of latitude is equal to 60 nautical miles and therefore the distance from the equator to the North or South Pole is about 90 degrees times 60 or about 5400 nautical miles. The earth does not have a perfect globe shape and has a slightly higher radius at the equator.

The VFR Sectional charts are used for VFR navigation. Since the earth is a globe and our aeronautical charts are flat there will always be some distortion and the distances measured on the chart are not perfectly accurate but accurate enough for safe VFR chart navigation. The sectional chart is a conic projection. For example, the Omaha Sectional is between 40 degrees and 44.5 degrees North latitude and between 93 degrees and 101 degrees west longitude. Imagine a cone covering the northern hemisphere as shown with the earth's surface projected onto the curved cone surface. When the cone surface is made flat you have a relatively low distortion chart.

At the corner of the Omaha Sectional chart you can see that the 40 degree line of latitude is slightly curved. The adjoining chart will not match perfectly due to the distortion. A scale is found on the edge of the chart to be able to measure point to point distances. For example, a piece of scratch paper could be used to measure the distance between the Dodge Center airport and the small town of Douglas. Mark off the distance on the piece of scratch paper and move it over the scale. In this example the distance would be 12.5 nautical miles. In order to determine the longitude and latitude coordinates of a location the degree numbers must be found on the chart. For example, the closest markings on this chart excerpt are for 90 degrees west longitude and 41 degrees north latitude.

A degree unit is divided into 60 minutes and each minute is further divided into 60 seconds. Longitude and latitude lines are drawn every half of a degree. Minute marks are placed on each line of longitude and latitude. Longitude lines converge at the North and South poles, therefore, the actual distance of one minute of longitude varies from a nautical mile at the equator to zero at the North Pole. A minute of latitude, however, is the same and is equal to one nautical mile. The latitude tick marks can be used as a measuring scale for determining distances on the chart. Every 5 minutes the tick mark is slightly longer and at every 10 degrees the tick marks go to both sides of the longitude or latitude line. On the chart shown let's find the coordinates for the town of Brimfield which happens to be a VFR checkpoint for Air Traffic Control purposes.

Starting with latitude we draw a horizontal line across the chart and determine that there are 9 and ½ tick marks from the 41 degree line down to the line drawn through Brimfield. In the Northern Hemisphere going south results in a lower latitude reading. 41 degrees minus 9.5 minutes is 40 degrees and 50.5 minutes. When counting down from a degree line you must count back from 60 rather than 100 because there are 60 minutes in one degree. 41 degrees is the same as 40 degrees and 60 minutes, therefore 41 degrees minus 9.5 minutes equals 40 degrees and 50.5 minutes.

Next, we take the 90 degree West longitude and subtract 7 minutes to get 89 degrees and 53 minutes west longitude. In aviation we generally do not work with second units and you will see the number of minutes expressed as a decimal. For example, 89 degrees and 53 minutes and 50 seconds is 89 degrees and 53.83 minutes (89°-53.83'). Brimfield has the coordinates of 40°- 50.5' North Latitude and 89° - 53.0' West Longitude.

To find the coordinates for the tower a couple of miles west of Victoria we go through the same process; however, we count ahead to a higher number from the degree lines. We go up 2 minutes from the 41 degree latitude line to get the north latitude coordinate and 8.1 minutes farther west to get the longitude coordinate. The coordinates to enter into a GPS system as a user defined waypoint would be 41° 2.0' North and 90° 8.1' West.

Since lines of longitude and latitude are drawn every 30 minutes or one-half degree the point where the two red lines cross has the coordinates of 41 degrees, 0 minutes North and 89 degrees 30 minutes west. The town of Princeville is 15 minutes west of the 89 degree 30 minutes line which is 89 degrees and 45 minutes west. The latitude line is 4.5 minutes lower that 41 degrees or 40 degrees and 55.5 minutes.

Sectional charts can be purchased in paper form as a subscription at a given price or downloaded online from the FAA Charting Office for free as a picture file or pdf. The front side panel of the chart has the name of the chart and the scale. Sectional charts have a scale of 1:500,000 which means one inch on the chart is 500,000 inches in the real world. The arrows on this Omaha Sectional chart directs you to the northern and southern portions of the covered area. The chart index has the boundaries of all sectional charts in the Continental United States so that you can see all of the adjoining charts. Some charts overlap in coverage. Terminal area charts are available for congested areas which provide much more detail. A magenta box is used to show the availability of the terminal area charts. The effective dates are shown on the front panel of the sectional chart. Sectional charts are revised every 6 months. All pilots need to know that there are likely corrections or new information available since the published date. The Airport Facility Directory and current Notice to Airman information can be checked to find the changes. For example, a new tower may be constructed since the current chart was published.

What makes aeronautical charts different than road maps is the great detail in displaying elevation information. A pilot must know the minimum altitude above sea level to clear terrain and obstructions and to have safe separation from clouds and other aircraft. Shades of green, tan, and brown are used to depict different elevation levels above sea level. For the chart excerpt shown the highest terrain is

14,255 feet MSL located at 40 degrees 15 minutes North and 105 degrees 37 minutes west. In addition to color coding additional contour lines are drawn to get a more exact determination of the terrain elevation.

On the chart excerpt shown the color coding legend can be used to find the 7,000' and 5,000' MSL elevations on the chart. A contour line connects points of the same elevation level. Additional contour intervals may be used on a sectional chart. Typical intervals for a contour line would be 250, 500, or 1,000 feet. Contour lines at 4,000, 4,500, 5,000 and 5,500 are shown on this chart excerpt. Contour lines help identify rugged mountain topography. Mountain peaks have spot elevation figures to help pilots avoid flying too close to the terrain where windshear and turbulence hazards may exist.

The Maximum Elevation Figures on a sectional chart identify the minimum altitude to clear terrain or obstructions bounded by lines of longitude and latitude. Remember that latitude and longitude lines are drawn every one-half degree or 30 minutes. In this example the maximum elevation figure of "29" means that you must fly above 2,900 feet MSL just to clear the highest terrain elevation or obstruction. Also, in this example, a second Maximum Elevation Figure is shown next to the tower that is the highest obstruction for that area. The height of the obstruction is 2799 but the elevation figure is 2900. The reason for the difference is that in colder than normal atmospheres the altimeter will read high putting the aircraft closer to the obstruction. The altimeter potential error is factored in and the figure is rounded to the nearest one hundred feet. I recommend that you plan cross country flights in non-mountainous areas so that your flight altitude is at least 1,000 feet above the maximum elevation figure for your location. In mountainous areas fly at least 2,000 feet above the maximum elevation figure.

The Sectional Chart has a significant amount of information in the legend that will help you to interpret the charts. In this unit you need to become familiar with the display symbols for airports. The additional airport information on the legend panel is also important to know. Pilots should know how to interpret the airport data shown next to every airport on the chart. The legend provides information on the use of communication frequencies which will be covered in more detail in the course later. Another example is airport lighting codes that tell the pilot whether runway lights are on all during the night or have to be activated by the pilot using a communications radio. Sectional charts have frequency panels such as control tower frequencies or selected approach and departure control frequencies.

When using a paper chart, the north side of the chart is printed on one side of the paper sheet and the south side is printed on the other side of the sheet. Directions for plotting a course from a point on one side to a point on the other side is provided on the chart.

Airspace information is also available on sectional charts such as Special Use Airspace or Prohibited and Restricted Areas. The airport symbol here shows a towered airport with at least one hard-surfaced runway greater than 8069 feet or that has some multiple runways less than 8069 feet. The open dot in the center shows the location of a VOR, VOR-DME, or VORTAC electronic navigation facility on the airport. A towered airport may close at night and the traffic rules and airspace will change.

In this excerpt we can determine that the Sylvania airport is non-towered and fuel is available at least Monday through Friday 10:00 A.M. to 4:00 P.M. Directory supplemental information will need to be consulted for details and for availability at airports with hard-surfaced runways greater than 8069 feet. Take note of the star symbol indicating that a rotating airport beacon is in operation sunset to sunrise. Some airports are deemed objectionable because the airport may adversely affect airspace use.

Decoding the airport data shown the name of the airport is Marshall County and it has an FAA identifier code of "C75". An Automatic Weather Observation Station Type 3 broadcasts airport information including weather on the frequency of 119.425 Mega Hertz. The field elevation is 568' MSL and the longest hard surface runway is 3,200 feet. Lighting limitations exist and the pilot needs to check the FAA Airport Facility Directory to determine how to activate the runway lights. The ticks around the airport symbol means that fuel service is available at least during normal business hours through the week. The Common Traffic Advisory Frequency (CTAF) is 122.8 Mega Hertz and should be used to make position reports and to communicate with other airplanes that are equipped with radios. The traffic pattern should be right turns when using runway 31.

This towered airport is part time as indicated by the small star immediately following the control tower frequency of the 119.5. The "C" in the circle means that pilots will use the tower frequency as the Common Traffic Advisory Frequency when the tower closes. The Unicom frequency is NEVER used for CTAF at a towered airport. Use the Unicom to communicate with a Fixed Base Operator on the airport.

The Obstructions legend is very helpful to identify the various types of obstructions. Obstructions can be a single tower or a group of closely spaced towers. The inverted "V" shaped symbol shown here is for a tower or obstruction less than 1,000 feet above the ground. The top figure is the height of tower above sea level at the very top of the tower. The figure in parenthesis is the height of the tower above ground level. The elevation of the ground at the base of the tower can be determined by subtracting the above ground level height of the tower from the MSL height at the very top of the tower. This obstruction symbol means that the physical height of the tower above ground level is at or exceeds 1,000 feet.

Often towers are built in a group and the highest top of the structures in the group is depicted on the chart. The highest tower in the group shown is 1,326 feet above ground level putting the top of the highest tower at 3,386 feet MSL. Towers usually have supporting wires connected to the tower from the ground which are very hard to see during the day and impossible to see at night.

As stated earlier towers can be constructed in groups. Notice the tower symbols with the additional lightning bolts representing high intensity lights are on the tower but those lights may only operate part time. Sometimes the obstruction is a building or an exhaust stack as shown here. In large cities tall buildings are marked by an obstruction symbol and by the contraction "bldgs" for buildings.

Wind turbines have a unique symbol. A wind turbine farm is enclosed by a dashed line on sectional charts and the maximum MSL height of the farm is shown in a rectangular box. The letters "UC" next to any obstruction symbol means that the obstruction is under construction or it has been reported that the position and elevation of the obstruction or farm cannot be verified.

The yellow highlighted area on this chart excerpt shows the location of the symbols used to depict power transmission lines. In addition to fixed ground obstructions pilots need to be vigilant when flying near active parachute jumping areas or where glider operations are found.

Pilots are requested to maintain a minimum altitude of 2,000 feet above the surface of National Wildlife Refuges and other sensitive areas. Federal statutes prohibit certain types of flight activity and/or provide altitude restrictions over designated U.S. Wildlife Refuges, Parks, and Forest Service Areas. These designated areas are charted on Sectional Charts. Check the Airman's Information Manual for more information about flight over sensitive areas.

At large airport hubs such as Los Angeles or Chicago, the Terminal Area Chart provides the needed detail to be able to safely navigate under Visual Flight Rules. The Terminal Area Chart (TAC) has most of the same depictions found on the VFR Sectional Chart and includes additional detailed information to enhance navigation in busy terminal areas like these. Special VFR procedures including directed paths through the terminal area are provided on the chart and often require an ATC clearance.

At the FAA.GOV website VFR navigation charts such as the Sectional Chart can be downloaded as a digital file in PDF or TIFF file format. The digital charts are exactly the same as a paper chart. As you might expect, most flight operations are using digital navigation maps on portable devices and/or in installed avionics equipment. Paper charts do have an advantage though and that is they are very reliable because they do not need batteries or an electrical system!

With a GPS and satellite receiver a moving map and other information products such as NexRad weather or airport directory information can be used on hand held devices to supplement your installed aircraft avionics package. These portable electronic devices require the purchase of software applications and service subscriptions to have these enhanced capabilities. These hand held carry on devices cannot be used to replace installed certified avionics needed for flight in controlled airspace under Instrument Flight Rules. Check the FAA regulations on the use of hand-held navigation and information devices.

A moving map is possible with GPS. The navigation map page on the G1000 Multi-Function Display is where you can see the benefits of a moving map. The color coding for terrain is the same as a VFR Chart published by the FAA and the basic depictions for airports and airspace and other items are also the same as published charts. The big advantage of a moving map is that the map can be oriented with North Up as seen here or the moving map can be rotated so that the track or heading of the aircraft will be at the top and the range can be adjusted to zoom in or out on the map. Using a map pointer items such as airports, airspace, highways, cities, obstructions, can be selected and information is provided at the top of the MFD page. A small map inset is available on the G1000 Primary Flight Display. On the MFD navigation map page the range can be set low to zoom in on the airport. On the airport information page the airport diagram and the radio frequencies can be displayed at the same time. The airport layout can be explored using the map pointer.