The Chart Clinic – First in a Series

BY JAMES E. TERPSTRA

When you think of IFR charts, approach procedures, MEAs, MOCAs and the myriad of other associated acronyms, you hardly think of the type of reading material you would snuggle up with near a fireplace on a cold, winter evening. No one would confuse "Fate is the Hunter," "Overflight," or "Bombs Away," with the legend pages of the Airway Manual!

This series of articles is written so that pilots can get the most value from their Jeppesen Airway Manuals.™ Most of the charts and symbols are very familiar, because you use them on every trip. Other pages are read less often than the telephone book.

When using an IFR service, all materials can be lumped into one of two categories—enroute or terminal. The enroute operations use low altitude enroute charts, high altitude enroute charts, area charts, or RNAV/GPS enroute charts. Terminal operations normally use approach charts, standard instrument departures (SIDs) (soon to be called departure procedures (DPs), and standard terminal arrival routes (STARs). The opening subject of this series will be enroute charts.

Enroute Charts

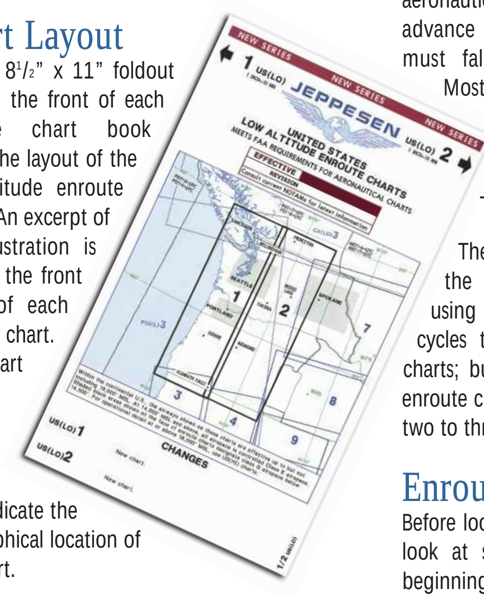
The first enroute charts used by most pilots are the low altitude enroute charts which portray the Victor airways. These low altitude airways are used in the airspace between the minimum usable IFR altitude up to 17,999' MSL. The high altitude enroute charts display the Jet airways, which begin at 18,000' MSL and proceed up through FL 450.

To cover the entire United States with low altitude enroute charts, there are 52 charts, even though a subscriber to the full US coverage doesn't get every one of the 52 charts. These charts are labeled at US(LO)1/2 through US(LO)51/52. It would be simple to design a chart series to cover the entire United States if our population were distributed equally throughout all the geographical coverages. Unfortunately, certain "hot spots," such as New York City, Miami, Dallas, and Los Angeles, attract large masses of people. These centers also require large masses of VORs and airways, condensed in small areas. Because of the unequal distribution of facilities, the enroute charts use different scales for chart depiction. Most of the scales used for the US are 1" = 10 NM, although a few of the charts use the scale of 1" = 20 NM. But, let's not get too academic. The real reason for mentioning scale is a reminder that when "eyeballing" distances on charts, an inch may represent five minutes on one chart and two and a half minutes on another chart. This can be developed into a "rule of thumbnail:"

> *Assuming your aircraft flies 300 knots, each nautical mile goes by in .2 minutes. This means that a "thumbnail" measurement on the 20 NM scale chart takes 3 minutes; on the 15 NM scale, a "thumbnail" takes 2 minutes; on the 10 NM scale, a "thumbnail" takes 1.5 minutes. Even though the distances are printed on the charts, there are many times when it is nice to know quickly how far an airport is off an airway, or your time to an intersection.*

Chart Layout

A large 8 1/2" x 11" foldout page in the front of each enroute chart book shows the layout of the low altitude enroute charts. An excerpt of this illustration is also on the front panel of each enroute chart. The chart outlines shown by heavy lines indicate the geographical location of the chart.



The shaded areas found on the front panel are used to depict the locations where area charts are provided. Because of some of the "hot spots" mentioned earlier, it is necessary to provide area charts with a larger scale to show more detail with less clutter in some of the major terminal areas. There are 18 area charts in the US for these "hot spots," using the scale of 7.5 NM to the inch on most charts.

Area charts are considered enroute charts and therefore are located with the enroute charts in your shipment. When you receive an Airway Manual service, however, we recommend that each area chart be removed from the enroute chart location and filed with the appropriate city. This keeps the area chart near the approach charts, SIDs and STARs and provides a better terminal package when operating to or from large airports.

Revision Cycle

If you owned your own VORTAC station and found when tuning to its frequency that you were receiving interference from a neighboring VORTAC, your first reaction would be to change your neighbor's VORTAC frequency (or your own), effective tomorrow. However, that wouldn't allow enough time to distribute the new VORTAC frequency to all users of the national airspace system.

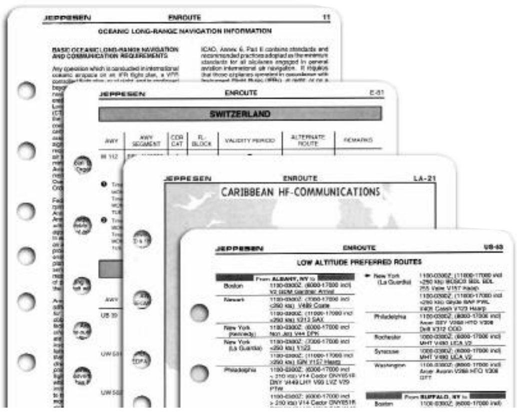
To solve this type of problem, the International Civil Aviation Organization (ICAO) member nations have agreed that at least 42 days of advance notice will be given when major aeronautical changes are made. Not only is the advance notice required, the effective date must fall on "day 1" of a 28-day cycle. Most of the 184 ICAO nations have agreed to this same cycle. Changes to the enroute charts are effective 0901Z on "day 1," which always falls on a Thursday.

The high and low altitude enroute charts in the United States and Canada are revised using every other 28-day cycle. During some cycles there are no changes to the enroute charts; but even if no changes are made to an enroute chart, it is reprinted and distributed every two to three cycles.

Enroute Text Pages

Before looking at the enroute chart symbols, let's look at some of those "front" pages at the beginning of the enroute manual. Each text page has a name centered at the top indicating the section to which it belongs. These names match the tab pages, which are used as dividers. In addition to the section name, a page number is found in the upper left or right corner. If the page number is "US-8," for example, that page would be found only in the United States Airway Manual. If the page number is not prefixed with letters, then that page is an international page and is included with all Airway Manual subscriptions.

When studying the legend pages and chart symbols, it helps if you understand that they are international in nature and description. This technique allows US pilots to use international charts and non-US pilots to use US charts without



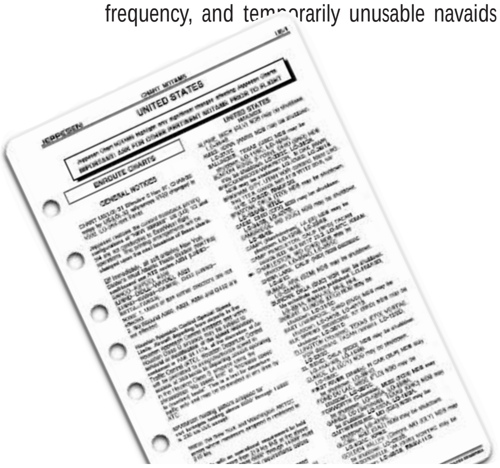
learning new symbols or abbreviations. For example, the letters “CTR” are used to indicate a control zone rather than the Letters “CZ” which seem to make more sense. The letters “CTR” are the official ICAO abbreviation for control zone.

Other pages found in the front of the enroute chart binder include:

- Air Defense Identification Zones
- Florida Keys Free Area
- In Flight Weather Advisory Reference Locations
- Stratification of United States Airspace System
- High Density Traffic Airports
- Preferred IFR Routes
- Tower Enroute Control (TEC) City Pairs

The list above is a reminder to refer to those pages occasionally. This will help you keep current on some of the seemingly “trivia” items that have been forgotten since ground school days.

Another important section is the “Chart NOTAMs.” The Chart NOTAMs are included behind their own tab. These pages are revised and reissued every two weeks. Pertinent NOTAMs (longer than the daily NOTAMs) in the national airspace system are included in the revision notice pages. The NOTAMs listed in the enroute section are appropriate to the enroute charts and are listed by the chart on which they are found. Notices of facility shutdowns, changes of frequency, and temporarily unusable navaids are included in the revision notice. Changes to these pages are indicated with a large arrow on the left side of the NOTAM information. *These pages should be reviewed before every flight.*



Even though the legend pages aren’t recreational reading, we recommend that you spend a few hours on the next layover reading those “enroute” pages.

Digital Briefing

Jeppesen Electronic Chart Clinic Second in a Series

By James E. Terpstra
Sr. Corporate Vice President, Jeppesen

Details, details, details. In the world of aeronautical charts you know the magnitude of details to get the content and the image just right. And now - add on top of that the world of bits and bytes to those charts. For every little piece of information that shows up in print, there is an additional world to make that information show up in the digital world.

Some of that electronic data has no intelligence - we say it has just a pretty face. Raster charts are like that. To go one step higher in the intellectual chain, enter into the world of vector.

Vector Images

For those of us in the world of aviation, we know the term "vector" as something ATC gives us mostly in the terminal environment to efficiently move airplanes. If you ask controllers, they will tell you vectors are the simplest and earliest versions of RNAV. Controllers can place you anywhere without having to fly over a navaid.

To draw a parallel between the controller's vector and how the term "vector" is used in creating graphic images, imagine the controller's vector as a place where you began your particular flight path. At the point where the vector began, that is a point on the ground. The controller's vector then began as a heading which took you in a direction. That heading is compared to the line on a chart. When the controller gives you a change in your heading, the point at which the heading changed can also be defined as a point on the ground.

Looking back on those clearances, you had two points on the ground connected by a heading which created a track over the ground. That is exactly how vector charts and images are drawn.

When a graphic artist wants to define a line on a chart in vector format, he or she defines the starting point and the ending point. Once the beginning and ending points have been defined, then the line connecting those two points is defined.

For aeronautical charts, the beginning and ending points are typically defined as points of latitude and longitude. As an example, the line on a chart can connect a VOR and an intersection. The VOR and the intersection are both defined in the database each with a latitude and longitude. The line connecting the VOR and the intersection is then described with a number of attributes. The attributes usually include a description that says the line is solid (no dashes), it has a width, and it has a color. The attributes may even have a link (or connection) to a field in the database that describes additional information such as the minimum altitude, the aeronautical description of the line such as an initial approach segment, etc.

Defining the Ends of the Legs

For each line on a vector chart, the beginning and ending points are defined as a specific latitude and longitude. This allows each point on the chart to be precisely geo-referenced so that each point may be linked with GPS signals for moving map displays. Since each point is defined as a latitude and longitude location, the point will precisely match the latitude and longitude of the GPS signals. With charts based on vector formats, the airplane symbol generated by the GPS signal will be depicted *exactly* at the location on the chart that matches the airplane's location. Raster charts have the geo-referencing correct at many locations on the chart, but the points in between the geo-referenced spots will be inaccurate by the amount of stretching of the paper or the inexact plotting by the cartographer who originally drew the chart by hand.

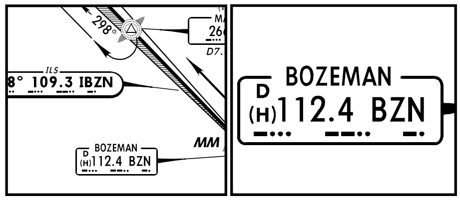
If the beginning point of a line is defined as a VORTAC, the automated cartography (or computer graphics system) that drew the vector chart used a "call" to access the VORTAC symbol out of a graphics symbol file. Each of the symbols in a vector chart is also drawn as a vector symbol.

So What Does This Vector Chart Mean for Me?

Assuming the GPS you are using has RAIM and other means to ensure its accuracy and integrity, the GPS signal that is used to overlay your airplane's position on a chart will be very precise. But if you are using that signal over a raster chart, the signal will be more accurate than the chart you are using. You might be lined up perfectly on the extended centerline of a runway on a Sectional Chart or WAC and find when you match that up with the outside world, you are not on the same path. That is because the geo-referencing is averaged and not precise over the entire chart.

On vector charts, when your airplane is lined up on the extended centerline, you can look outside and you will also see your airplane lined up exactly on the real extended centerline. On vector charts, when you pass over a fix or navaid on the chart, you are also precisely passing over that same fix or navaid in the real world.

Vector charts provide other advantages also. When you zoom close in to make the images and chart content larger, the lines and symbols are redrawn from the vector descriptions. Since they are redrawn, the larger images will be as crisp and clean as when viewed in their original size. This allows all images to be easily read at any zoom level.



In the illustration, note that the small navaid facility box for the Bozeman VOR is crisp in its regular size as it appears in vector format in JeppView. When zoomed into the maximum, the facility box for Bozeman remains just as crisp. This is because the image is regenerated from the vector points when zooming in closely. The "crispness" applies to text as well as lines.

Does File Size Matter?

In the previous article, the statement was made that the electronic sectional or WAC chart files were incredibly large at 7 to 12 megabytes. Is that really large with today's computers? *Yes.* The size by itself is not particularly large for ground-based computers, but when placed into an airplane, that size for a complete coverage of charts usually requires a CD. As you remember from training days, anything that spins wants to stay in its own plane of rotation. Can you imagine a CD not wanting to change its plane of rotation as you change the pitch and bank of your airplane? Files that are smaller fit on fixed media that don't rotate.

Also, with raster charts, the millions of pixels need to change location very fast on a moving map display in an airplane moving 200 to 300 knots. In order to get the raster pixels to move smoothly, it takes a lot of processing power. That's also expensive in an airplane when you consider certification.

Vector images can be stored in substantially smaller files. Vector files generally consume only 10% to 50% of the file size for an equivalent image, depending on the type of aeronautical chart.

In the next issue, we'll discuss charts that are generated out of a database "on the fly" without an image that has been previously composed by a graphic artist sitting on the ground.

By James E. Terpstra
Sr. Corporate Vice President, Jeppesen

Digital Briefing

At first glance, a chart is a chart is a chart is a chart. It's a little like when you got your first car. You probably were most concerned that it had four tires and a radio. As you gained more experience and the original thrill was behind you, other things became important - such as cruise control, stereo with lots of watts, ABS brakes, air conditioning, power windows, power seats - and you know the rest.

As you become more familiar with electronic charts, your wants and desires become more like your experience after your first car. Other things on charts become important. Things like clarity of the image, color, ease of changing from one chart to the other, and additional things such as the ability to turn off some of the information that is no longer important to you.

In the first two articles in this series on electronic charts, we discussed charts created using raster and vector technology. In this article, we will discuss charts that are "created on the fly" from an airborne database.

Database Charts

The term "database charts" is not exactly a standard term, so let me explain what is meant by those words. In a database chart, there is no graphic image that has been created by someone before you see it. The image, or chart, that you see is dynamically created by software each time you make a request to view the image and it gets regenerated each time you zoom, pan, or look somewhere else in the area of chart coverage.

With a database chart, there is a file stored in your computer. That file contains a database of textual descriptions of aeronautical information, although it will most likely be in a binary format when carried on board the airplane. As an example, the information about the Bozeman VOR in the database would include its identifier, frequency, latitude, longitude, elevation, class, service volume, station declination (magnetic variation), DME capability, etc. The actual VORDME symbol for the Bozeman VOR is not stored with the Bozeman VOR record in the database.

If you want to look at a chart of the Bozeman area, you would make the software program open a window near the Bozeman area. When you open the window, you can decide to have the window appear as a low altitude enroute chart, assuming you have the appropriate software. After you make that decision, the software knows you need the Bozeman VOR to appear in the window with all the other information that is included on the enroute chart. The software knows the size of the window and the latitude and longitude of the four corners and therefore searches the database and finds all information included in that latitude/longitude area. When it finds that the Bozeman VOR is inside that window, it accesses that database to find everything it is supposed to know about the VOR.

When it finds the Bozeman VOR record of information, it reads the record and sees the attribute that states the VOR is actually a VORDME and has a station declination of 11° east. From that information, the software then accesses a symbol file and places it at the correct geographical location on the chart. The software uses the station declination to know how many degrees to rotate the symbol so that the north arrow actually points to magnetic north.

To complete the visual image of the chart, the software must access the database to find the other attributes that describe the VOR and display that information in the navaid facility box. Now the software is presented with a challenge. Where to place the facility box?

Placing Aeronautical Information

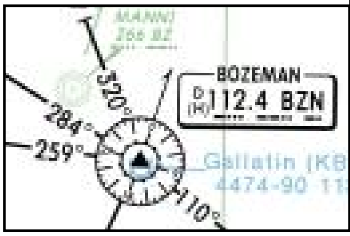
The software starts by trying to place the navaid facility box to the upper right of the navaid symbol. But - what if there is an airport in that location? What if the box is on top of an airway? What if the box conflicts with a restricted area?

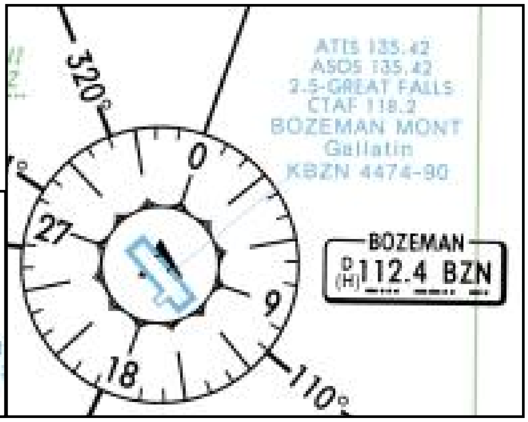
symbols that depict this information will appear on top of each other. That's OK. That's reality.

Aeronautical charts that use the raster or vector technology typically have been created on the ground by experts in chart design and compilation. These chart compilers have performed all the drafting and compilation while at a desk so all the composition of information is laid out so that the information is easily read. One of the things the compilers do is to make sure that all information is placed in a location that has the minimum amount of conflict with other information.

So what do you do with the attributes that are generated by software from a database? After the fixed locations are generated, the software then attempts to place the facility box in the default location to the upper right of the navaid symbol. Smart software has what is known as "visual conflict detection" and "visual conflict resolution." It is one thing for the software to know that the facility box has a conflict with other information on the chart - but it is quite a leap beyond that to know what to do when the conflict has been detected.

The two illustrations depict the same location on an electronic enroute chart, but at different zoom levels. In the left illustration, the navaid facility box is as large as the VOR symbol and in the right, the navaid facility box is much smaller. Also, in the left illustration, the airport symbol is depicted, whereas in the right illustration, the runway layout can be seen.





Since the exact location of attributes such as a navaid facility box can change, the rules within the software state that all information that has a geographical location will be drawn first. This means that VORs, NDBs, airports, intersections, waypoints, restrictive area boundaries, and other aeronautical information that has a specific latitude and longitude on the earth's surface will be placed first and will not be moved - at all. This means that if a VOR is located on an airport, the two

In the next article, we will look at the advantages and disadvantages of the three types of formats: raster, vector, and database.

Jeppesen Electronic Chart Clinic
Fourth in a Series

By James E. Terpstra
Sr. Corporate Vice President, Jeppesen

There are millions and millions of bits and bytes all packed together trying to make something meaningful. All those zeros and ones racing around in that silicon trying to create an image that you and I know as a chart. To keep all of them in order is something beyond me, but the software programmers have a talent that seems to defy logic.

What comes out in the end, however, is something we make judgments about. Something that is the same as what we are used to on paper. This is one of the reasons that electronic charts appear similar to paper charts. Industry standardization committees have stated that the new generation of electronic charts should be created in a way so that a whole new learning process does not need to be accomplished to read electronic charts. It is called human factors.

We have all learned to read VFR and IFR charts during the process of becoming pilots. Human factors experts say that old habits die hard so changes should be evolutionary, not revolutionary. So then, why have electronic charts at all?

Why Electronic Charts?

Probably the best advantage of electronic charts is the new situational awareness that comes with having your airplane's position move on top of the chart display. Another obvious reason is not having to carry pounds and pounds of paper. A nice benefit with electronic charts is the savings of time necessary to file revisions.

But let's go beyond the obvious.

What if only the information you needed for each phase of flight was in front of you? What if you flew an approach and all the information behind you went away? What if only those communication frequencies for your specific flight appeared on the chart? What if none of the radials from a VOR that formed an intersection appeared on the chart because you were flying with a GPS using an overlay approach and the VOR was not necessary?

To look at the possibilities for this magic, we should review again the three main types of electronic charts. Raster charts are those that have been electronically scanned, geo-referenced (synchronizing latitude/longitude positions on paper), and then placed in a chart software program. The visual aeronautical charts such as Sectionals, WACs, TPCs, etc. fall into that category. In the FlightMap software program, virtually all the visual aeronautical charts are available. This means you can fly with an electronic chart that is identical to the familiar paper charts because the image is the same due to scanning technology.

Raster charts make it easy to fly with the familiar symbols such as roads, railroads, city patterns, water bodies, cities, man-made obstacles, color contours, etc. And the magic allows you to see all those images in your airplane with your airplane's position moving on top of the chart. It also makes it virtually impossible to not know where you are. But with raster, placing your heading at the top of the screen makes all the words and symbols upside down if you are flying south. And zooming in will cause the images to start breaking up so if you keep the zoom levels reasonable, they still look good.

One Grade Up

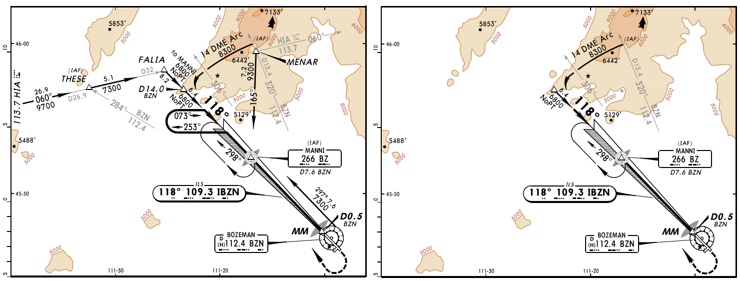
Raster charts have the limit of zooming, but vector charts do not. This means you can zoom into a level that allows you to see lots of details without having the image break apart. Vector also is much more precise than raster so your airplane's position should be within meters on the chart if your GPS sensor has that precision. You can precisely tell how close you are to your intended path.

Vector charts also carry intelligence. So if you want to search for something on the chart, a good search engine will find what you are looking for. All of the charts in JeppView are vector charts. When you look at the detail of any information on an approach chart, SID, STAR, or airport diagram, you will see what you are after in very readable detail at even the closest zoom level.

Vector charts also consume significantly less computer storage space which doesn't seem important in this day of gigabyte and terabyte storage. But, it is important when you consider the ability to move all the bits and bytes around at tremendous speeds for smooth movement in a fast airplane.

More Intelligence

Let's now explore the intelligence that is available in charts that are generated out of a database. Since the final graphic that you see on the screen for an approach chart is created from the information in the database, the intelligence exists to draw a chart that exactly meets the needs of you and your aircraft and your intended route of flight. To best illustrate this, look at the two different charts for the ILS Rwy 12 approach at Bozeman, Montana. The chart on the left is the plan view as it exists today. The chart on the right is the way it would be drawn if you flew the approach using the DME arc.



The FAA has designed the approach procedure in a way that facilitates arrivals from numerous directions. There is no radar at Bozeman so there are more feeder routes and initial approach segments than at locations where radar is available. If you are arriving from the northwest, there is a feeder route that starts at the Whitehall (HIA) VOR and proceeds via the 060° radial past THESE intersection to the FALIA intersection where you intercept the localizer and follow it to the airport.

MENAR intersection is on V-365 so it is also available for transitioning from enroute to the approach; however, it requires flying the procedure turn. If arriving from the east on Victor airways, the Bozeman VOR forms the airway and is also the beginning of the feeder route to the outer marker from which a procedure turn would be flown.

For illustration purposes, assume you have a DME and are arriving from the north on V-365. The beginning of the DME arc is the BZN 320° radial which is the radial that also forms V-365. Since the radials match, this allows you to fly the DME arc from the airway. Assuming you have a GPS or FMS, and also assuming that your new chart subscription is electronic and is connected to the avionics system, the approach transitions that you have elected not to use would not be displayed.

Numerous questions arise about how the decisions are going to be made for your selection of the appropriate transition to fly, but you can see the future with charts that include only what you need, when you need it.

Digital Briefing

Jeppesen Electronic Chart Clinic
Fifth in a Series

By James E. Terpstra
Sr. Corporate Vice President, Jeppesen

So now that you have the ability to display an enroute chart electronically, you also have the ability to modify what gets displayed and what does not get turned on. How much freedom do you want to create your own image? How much freedom *should* you have to create your own chart?

These are questions that you have obviously asked. And they are questions that many have asked.

The electronic enroute chart that is available in FliteStar® and FliteMap® has many options. But there are some fundamental rules that should never be violated. As an example of rules not to be broken, you as a pilot don't have the ability to change a VOR frequency, its name or its location. One of the basic rules is that you have the ability to change what is displayed and what is not displayed, but you *don't have the ability to change* information.

Determining Minimum IFR Altitudes

One of the first questions you might want to ask yourself is, "Should I fly airways or should I fly direct since I have an IFR GPS in my airplane?" One of the considerations, of course, is the determination of the minimum altitude. If you are flying in most places in the world at FL180, consideration for the minimum altitude is not a big deal since you are well above any terrain or obstacles. But if you wish fly a direct route at 8,000 from Salt Lake City, Utah to Denver, Colorado, terrain and obstacles are very important.

With FliteStar, there are many ways to determine the minimum altitude for an IFR (or VFR) flight across the Rocky Mountains. For starters, a flight plan can be computed between Salt Lake City (KSLC) and Centennial Airport (KAPA) using the option of favored route type. By selecting an RNAV direct route using GPS, the distance is 334.8 nautical miles - but radar coverage over the Rockies at lower altitudes is pretty spotty so it is probably better to try a computer flight plan on airways to see if the flying distance is very much longer. A computed flying plan on Victor airways comes up with a total distance of 351.8 nautical miles - only17 miles farther.

A whole discussion emerges. What will air traffic control allow on direct flights? What will they do if they lose you from radar coverage? What altitudes will they allow when they can't see you on radar? Do they have altitudes for direct routes?

The easy answer to all this is to file the airways, then all the airway minimum altitudes become usable. But with GPS, why zig zag across the country when a straight line is more efficient? Even though the 17-mile difference is negligible, there are many other cases where the difference in distance is significant.

All Air Route Traffic Control Centers (ARTCCs) have minimum IFR altitudes (MIAs) for their areas of coverage. These altitudes are known only to the Centers and are not published anywhere. But, they are available after you are airborne and ask for the minimum IFR altitudes in their sectors while flying direct. That doesn't do much good, however, for planning purposes.

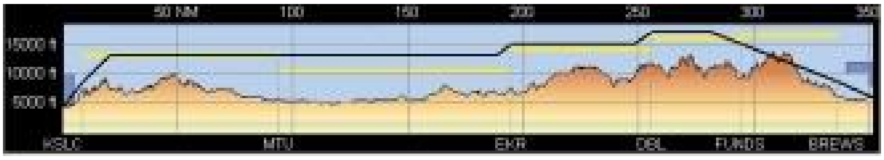
Determining the minimum altitudes for an IFR direct route is relatively easy. On the low altitude paper charts, the MORAs (Minimum Off Route Altitudes) are depicted in one-degree blocks inside of each degree of latitude and longitude. In FliteStar, the MORAs are included in the navigation log after the flight plan is computed. For the route from KSLC to KAPA, the MORAs are 14,100 feet, 16,800 feet, and 16,600 feet. Mighty high. The MORAs in the United States are the same figures as the OROCAs (Off Route Obstacle Clearance Altitudes) provided by the FAA. The MORAs and OROCAs provide 1,000 feet of obstacle clearance everywhere except in the designated mountainous terrain areas where 2,000 feet of obstacle clearance is provided.

ATC still hasn't decided if the MORAs are considered IFR minimum altitudes. As of now, they still believe the MORAs should be used only for consideration of obstacles but not minimum IFR altitudes since MORAs do not necessarily provide for communications coverage.

Consideration for Oxygen

The MORAs are so high that oxygen would be required for most of the route. By computing a flight plan using the airways, lower MEAs can be found that will allow for lower altitudes for portions of the flight. In FliteStar, the computed flight plan produces both a plan view and a profile view of the computed route.

Refer to the illustration of the profile view of the computed flight plan on airways from KSLC to KAPA. You can see the yellow horizontal lines that represent the MEAs on the selected airways. When responding to the queries on the flight plan wizard, an altitude of 13,000 feet was selected. The black line shows the requested 13,000-foot altitude, and that it is a satisfactory altitude until passing Meeker (EKR). After EKR, a higher altitude must be used because of the higher MEAs. After passing Table Mountain (DBL), an even higher altitude should be requested for crossing the Continental Divide just in front of you.



By looking at the yellow horizontal line, you can see that the MEA between Myton (MTU) and EKR is down to 10,000 feet, so a lower altitude could be requested for that 101.2-nautical mile segment if it is more comfortable without wearing oxygen equipment.

After DBL, the MEA becomes even higher after the FUNDS intersection, but by that time you would normally want to start a descent into the Denver area. The black line in the profile view cuts through the brown terrain near Denver. This indicates that if you start a normal descent into KAPA from your cruising altitude, your descent route would be below the terrain west of Denver.

From a practical standpoint, Denver Center would most likely have you in radar contact near the FUNDS intersection. Once you are in radar contact, Center would then be able to give you vectors with the minimum altitudes to start your descent and avoid the mountains.

In the next article, we will continue to look at the electronic enroute chart.

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By James E. Terpstra
Sr. Corporate Vice President, Jeppesen

Electronic enroute charts are here today. There are improvements that will make them even better in the future. When looking at the future, it is very difficult to predict what we will be using 5, 10 or 20 years from now. Here is what some of the true giants of the computing industry have said about the future of computing:

"I think there is a world market for about five computers." Thomas J. Watson, Chairman of IBM, 1943.

"There is no reason for anyone to have a computer in their home." Kenneth Olson, President of Digital Equipment Company, 1977.

"640K RAM ought to be enough memory for anybody." Bill Gates, CEO of Microsoft, 1981.

In this article, we continue to look at electronic enroute charts, as they are today rather than how they will look in the future. We wish our "crystal ball" was very clear, but right now we can only speculate about what we will see in hardware, software, data and displays in the next generation.

Flight Planning with Electronic Enroute Charts

Electronic enroute charts are now more than "just a pretty face." There is intelligence behind each image you see on a screen. And each image has a connection to other images on the screen. As an example, each airway is electronically connected to the navaid at the end of each airway. Also, each intersection on the airway is connected to the airway. Further, each airway is connected to the minimum altitudes for each segment.

So what does this mean to you?

For flight planning purposes, everything is connected so that any automatic routing will connect your departure airport to your destination airport via intersections, VORs, and airways when you elect to fly via the airways. If there is a turn at a VOR required to create the most efficient route, the connections will automatically be made. Since the data is electronic, the end result will also be a navigation log with all the VOR frequencies, leg lengths, airway minimum altitudes, etc. which provides a lot of intelligence for making decisions upon whether or not you want to fly via the computed route.

Removing Information

With an electronic chart image generated dynamically from a database, each class of element can be displayed or it can be turned off. As an example, you could turn off all the NDBs if you were on a GPS direct route using the electronic enroute chart in flight. The more information that is turned on, the more potential for "clutter" to be on the screen - the more that is turned off, the easier it is too see what's really important for your particular flight.

A paper chart is not the same as an electronic chart. When you look at a paper chart, all the information is arranged in such a way so that important information is not printed on top of other important information. A cartographer sitting at a desk with lots of time and experience has made the decisions for the placement of all the information.

The intelligence of a cartographer sitting at a work station just cannot be duplicated today with computers (at least not for a reasonable cost). When a new area is viewed on an electronic chart, the computer has to make many, many decisions on the proper placement of each item. Sometimes when the conflicts are just too great, the computer makes difficult decisions that are different than those a human would make. For example, some information might just get eliminated from the screen. Because of the computer's decisions, it is frequently best to turn off information that is not needed.

On a GPS direct flight, airports and VORs might also be considered for elimination since they can be turned on quickly if you need to know about airports along your route. On GPS flights, one of the more important pieces of information to leave displayed are the restricted areas, prohibited areas, and other areas that should be avoided. Each of these categories of information has its own "button" on the control bar, allowing it to be quickly turned on or off.

Vector Chart Themes

During most of my flying, I filed IFR flight plans even when the weather was CAVU. It is a good way to be in constant contact with ATC, and it keeps you current with copying clearances and conforming to IFR procedures so that when the weather is genuinely IMC, it is nothing out of the ordinary.

This means always carrying IFR enroute charts plus the appropriate terminal procedures for each flight. Additionally, I always carried Sectional Charts with me for both my passengers and myself. For passengers, it is a good way to get them involved in what is happening and it typically makes for more contented passengers. Then, when a large city or body of water comes within sight, you can look at the Sectional Chart and know where you are.

With electronic enroute charts, the "look and feel" of the chart can be changed depending on what type of information you want to see. As an example, the electronic chart can look like an IFR low altitude enroute chart, a high altitude chart, a VFR chart, or a number of other charts. While flying a GPS direct route, if you spot a ground feature you want to identify, you can turn on the vector theme for VFR charts and all of the things you are used to seeing on the Sectional Chart appear on the screen. Try that with a paper IFR chart!

In the illustration, the area around Wenatchee, Washington appears in a VFR vector theme.

Track Up versus North Up

Flying south? If you are flying south along the river toward Wenatchee, the airport would be to your left. But if you look at the VFR chart with the north at the top, the airport is to the right of the river. Confusing? Sometimes it's just easier to turn the chart upside down so the top of the chart is south when you are flying south, then everything will appear in its proper orientation.

With electronic charts, you can set the display to read "track up." Assuming your electronic chart is connected to your GPS or FMS, this means that the top of the enroute chart will always be the view out your front window. Now things to the right of the airplane appear on the right side of the chart display. With charts that are dynamically generated from a database, this means all the text is also generated "on the fly." The good news is that the text will always be "read right" so it will not be upside down when the chart is rotated with the front end of the airplane.

In the next article, we'll begin looking at the plans the FAA has for the level of certification they expect for various types of electronic chart installations.

DIGITAL BRIEFING

JEPPESEN ELECTRONIC CHART CLINIC
SEVENTH IN A SERIES

BY JAMES E. TERPSTRA
SR. CORPORATE VICE PRESIDENT, JEPPESEN

Now let's see . . . we have categories. Category I, II, and III for how close you can get to the runway without seeing it. Category A, B, C, D, and E for defining the different stall speeds of airplanes with respect to landing minimums. And we also have classes. Class A, B, C, D, E, and G for airspace definitions. And now we have yet another group of classes. As you now begin to use electronic charts in your airplane, the requirements are broken down into Classes 1, 2, and 3.

The FAA has issued Advisory Circular 120-76, which specifies the different classes of Electronic Flight Bags (EFB). Electronic charts are but part of the larger group of digital information comprising any EFB.

What is an Electronic Flight Bag?

An EFB is an electronic display system consisting of the display, software, and data which were initially meant to replace all the paper carried around in those 30+ pound flight bags, but EFBs actually do much more. We, as pilots, have long recognized the benefits of adapting portable computing devices, such as laptop computers and personal digital assistants (PDAs), to perform a variety of functions traditionally served by paper. These portable electronic devices (PEDs) are now being used to replace the hard copy chart information contained in our flight bags. Thus, the term Electronic Flight Bag has entered into our vernacular.

EFB applications being deployed today do even more than the paper they are replacing. Not only do they deliver more information, they do so in a robust, integrated fashion that further enhances situational awareness and safety in all phases of flight, both in the air and on the ground.

Each of the three classes defined by the Advisory Circular allows for different functions; however, it should be noted that, with the exception of Subpart F—which applies to operators of large and turbine-powered, multi-engine airplanes—the Advisory Circular does not apply to FAR Part 91 operators.

The "lowest" of the three classes might be considered Class 1 since it covers electronic equipment that is completely portable. The next higher class, which allows more capability, is Class 2. It covers PEDs that are mounted to the aircraft in a docking station or cradle that has received a supplemental type certificate (STC). The highest class, with the most capability, is Class 3. It covers EFBs that are installed avionics systems that may have ***all*** EFB functions.

Class 1 Requirements

Class 1 consists of laptops, PDAs, or any electronic computing device that generally includes commercial-off-the-shelf (COTS) computer operating systems. They can be used for a number of "things", including non-interactive performance calculations, the hosting of Flight Operations Manuals or Airplane Flight Manuals, flight logs, FARs, weight and balance calculations, etc. Class 1 EFB systems are not attached to an aircraft-mounting device and do not require an administrative control process (a logbook entry) for use in your aircraft.

You may replace many documents with a Class 1 device, but the device cannot be used for takeoff or landing and cannot be connected to a GPS. Also, it cannot be "hardwired" to your aircraft's power, but it may be connected to recharge the battery.

In summary, the requirements for Class 1 EFB systems are:

- May be used on the ground and during flight as a source of *supplemental information.*
- Must be battery powered and must not be connected to your aircraft's power during normal use.
- Batteries may be recharged onboard the aircraft when not in use.
- May not provide a data link connectivity to other aircraft systems during flight.
- May not use a GPS source.
- The EFB, including the charger, must be stowed for takeoff and landing.

The most common question is, "Do I still need paper?" The AC says the Class 1 EFB is for "supplemental use only" and goes on to say, "the operator must have paper onboard at all times." These statements apply to FAR Part 91, Subpart F operators, and may not apply to other Part 91 operations.

For use under FAR Parts 121, 125, and 135, the principal operations inspector (POI) needs to evaluate and accept the data as presented. Additionally, for operators under FAR Part 121 and 135, training is required as appropriate.

Class 2 Requirements

Class 2 consists of PEDs that are connected to an aircraft mounting device during normal operation and require an administrative control process for use in the aircraft. A Class 2 EFB may use the aircraft's power and have data link connectivity. The mounting devices for the EFB require aircraft evaluation group (AEG) evaluation and certification approval from the FAA certification branch.

One of the big advantages of Class 2 over Class 1 is that the EFB can read (but not send) data from the aircraft busses, that includes the GPS, as long as it can be proven that there is no interference. In Class 2, the mounting device for the EFB must be a structural cradle that can be proven crashworthy.

Class 2 devices can do everything that Class 1 devices can. Additionally they can also be used for reference materials and checklists using pre-composed information, approach charts, navigation charts, and performance calculations. One of the best features of Class 2 is the ability to have dynamic interactive electronic aeronautical charts (e.g., enroute, area, and airport surface maps) using a moving map display that includes centering and rotating the chart; although Class 2 does not allow the display of your own aircraft's position on the chart. The FAA believes that placing your airplane on the display of a moving electronic chart would be so compelling that it would be very tempting to use it for primary navigation. In order to provide a system that includes navigation, a higher level of integrity for the software is required.

In summary, the requirements for Class 2 EFB systems are:

- When a POI is involved, the POI should document the EFB Class 2 compliance for performing its intended function. This is primarily related to COTS electronic equipment such as pen tablet computers.
- Mounting in a crashworthy cradle.
- EFB data link ports require FAA certification approval to ensure non-interference and isolation from aircraft systems.
- Operators must determine non-interference with existing flight systems for all phases of flight.
- Class 2 EFB systems are portable equipment and may be removed from the aircraft through an administrative control process (logbook entry).
- For a Class 2 paperless cockpit, each flight crew member must have an independent EFB system.
- A Class 2 "reduced paper" cockpit requires a single reliable EFB system and one complete paper set of all applicable data.
- Paper can be removed from the flight deck for a Class 2 system by FAA approval after proving the reliability of the system for a 6-month period and filing a report. For air carriers, the authorization must be granted via issuance of OpsSpec A025. For the six-month operational evaluation period, both the EFB and paper copies are required.
- The FAA Certification Branch evaluation and design approval for class 2 devices is limited to airworthiness approval of the cradle (crashworthiness), data link connectivity, and the EFB power connection.
- Reference material, checklists, performance calculations, and navigation charts, such as approach charts, need to be pre-composed. This means they cannot be generated "on the fly" from a database and cannot use software to compute aircraft performance. The pages of information have to be created on the ground and then loaded in the EFB in the airplane.

Class 3 Requirements

Class 3 EFB systems are considered installed equipment and require a Supplemental Type Certificate (STC) or certification design approval that includes, but is not limited to, conducting a functional hazard assessment and compliance with RTCA document DO-178B. DO-178B is the document used by the FAA to certify software in aircraft systems such as autopilots, FMSs, and many other computer-based systems in modern aircraft.

The Class 3 EFB system certification requirements may enable additional functionality (e.g., GPS, or Automatic Dependent Surveillance-Broadcast (ADS-B), that can provide moving maps suitable for situational awareness or navigation).

Class 3 systems are the most sophisticated of the three, because they are the systems which are installed in the aircraft panel and integrated with the other avionics in the airplane. Because of this level of sophistication and integration, the FAA will be involved in the certification of the system.

What about Currently Installed Systems?

There are EFB systems in the field which have obtained Operational Approval. They are still OK. *Since the Advisory Circular describes just one means of certification and is not new rulemaking, any currently operational systems are valid.*

After reading through the Advisory Circular, it becomes apparent that the FAA wants to facilitate the move to a paperless cockpit. They are, however, reluctant to approve everything that comes to them just because it will relieve a lot of effort and provide many new safety features (situational awareness, as an example). The FAA wants to walk before they run to ensure the new systems provide all the reliability necessary to keep the aeronautical information in front of us at all times. This is obviously important when operating in IMC.

In the next article, we will continue by exploring electronic approach charts, SIDs (DPs), STARs, and the other terminal charts.

Digital Briefing

Jeppesen Electronic Chart Clinic
Eighth in a Series

By James E. Terpstra
Sr. Corporate Vice President, Jeppesen

Filing revisions . . . and more revisions . . . and more revisions. As a full-time instrument flight instructor for years, filing revisions was the last thing on the list of priorities to be accomplished. After the revisions pile became higher than comfortable, watching football on Sunday afternoon became a two-pronged task—file those revisions while keeping an eye on the game.

A few weeks ago while filing a complete *worldwide* set of approach charts, SIDs, STARs, airport diagrams, etc., the revisions took about 35 seconds. Actually, as I sat there and waited for the revision process to complete itself, I was complaining internally about how long it was taking. Then, suddenly, I realized I was complaining about a mere 35 seconds, and that the same process with paper charts would have taken hours instead of seconds.

More than a "Dumb Page Turner"

Electronic charts, however, should do more than just replicate paper. Even though the reduction in revision filing time alone seems worth it, other features that take advantage of the many benefits offered by electronic media are also available.

But first, the format of the charts. All Jeppesen charts are produced by computer graphics, and have been since 1982. They are generated from a worldwide aeronautical database, the same as used in airborne avionics. When they are completed, they go through a process wherein the same files are routed in two directions. Files are converted to raster format and sent to the printer, and also sent in vector format to the master file for JeppView.

Why do you want to know this? If you have both a paper and JeppView subscription, all the charts are the same. The charts you print from JeppView will be identical to those published in your paper subscription.

When JeppView First Starts

When your JeppView application is first opened, the screen shows a view of your coverage area. Little white dots represent the location of every IFR airport in your coverage. In addition, the JeppView disc in your drive is coded with four digits separated by a hyphen. There are 26 JeppView discs issued each year (one every 14 days), and the discs are numbered according to the disc number followed by the year in two digits. The current disc at the time of this writing is 20-02, or the 20th disc of 2002. If your disc is out of date, a message will be displayed that lets you make the decision as to whether you use the out-of-date disc for a couple of weeks.

When you respond to "Continue," the next display shows the list of cities and five columns labeled: ICAO, IATA, Airport Name, City Name, and State. To find an airport, you can type in any of the types of information indicated by the titles of the columns. As an example, you can type in KLAS, the ICAO identifier for Mc Carran Field in Las Vegas, NV; you can type in LAS, the IATA identifier; you can type in Las Vegas; you can type in Mc Carran; or you can type in NV. The search engine allows many different ways to access an airport, but, of course, all search engines work best when given unique information to search with. Typically, using the ICAO identifier produces the best results.

Also, you don't always need all of the letters when searching for something. As an example, you can key in MC CAR and it will find KLAS and only one other airport. From there, you then press the listing for Las Vegas and the list of procedures for "Vegas" shows up.

By touching each column label, it causes the list to be displayed alphabetically by the specific label you just touched. This is helpful if you want to see all the airports for one city, for instance.

If you want to see only those airports for a given state (or country), two buttons at the top of the screen allow you to choose "Complete List" or "Only State:" so only the charts for the selected state appear in the list of available cities. This is helpful if you know you will need fuel about the time you cross over the state of Arkansas, and the list of available airports is much shorter than your entire subscription coverage.

Tabs for Airports in Flight Plan

Let's take a flight from Bowman Field in Louisville, Kentucky, to the Haines Airport in Three Rivers, Michigan. Since Bowman Field is the departure airport, you can touch the listing and drag it over to the window next to the word Departure, and the airport identifier KLOU appears on the Departure Tab on the right side of the screen. Next, drag the Three Rivers airport listing to the window next to the Destination window, and the letters KHAI show up on the Destination Tab and the great circle distance of 224 nautical miles appears between the two locations. The illustration shows the airport identifiers as they appear on the tabs.

To easily find an alternate, touch the Map Tab. When the map appears, use the right mouse button to select the area you would like to review for possible alternates. To aid in your selection of an alternate, check the "Show 25 NM Rings" box, and distance rings will be shown at 25-mile intervals.

For demonstration purposes, let's select KAZO, Kalamazoo, Michigan, since it has an ILS approach and is within the first 25 NM ring. Now, touch the KAZO identifier and drag it into the Alternate Airport box, and the letters KAZO appear on the Alternate Tab. In addition, the distance between your destination and alternate, 17 nautical miles, is shown, displaying distance by great circle route.

When you make the flight from Louisville to Three Rivers, the locations will still be under the Departure, Destination, and Alternate Tabs respectively. Just before departure, touch the Departure Tab (KLOU), and the listing for the Bowman Field airport appears. From that point, you can touch the airport chart and any others you need for take off and departure from Louisville.

In the next article, we will continue discussing JeppView.

Digital Briefing

Jeppesen Electronic Chart Clinic
Ninth in a Series

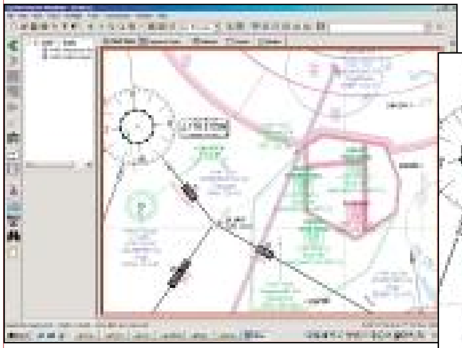
By James E. Terpstra
Sr. Corporate Vice President, Jeppesen

Desktop computers, laptops, tablet computers . . . we certainly live in an age of change. In 1973, the first electronic handheld calculator was available for about $349, and the adapter was an option for another $49. That electronic calculator could add, subtract, multiply, and divide and was about 2" thick.

And those were the "good ol' days"?

The personal computer (based on DOS) was introduced in 1982 with no hard drive, one 720-kilobyte floppy drive, and only 640 kilobytes of memory and that was an option. In 1986, a 10-megabyte hard drive was over $600 and was almost the size of a shoebox.

Today we are the fortunate beneficiaries of huge advances in computer technology. Speeds are up, storage is massive, screen resolutions are color photo quality . . . all of which make electronic charts possible.



Direct route altered to avoid R-6608B

Taking a Trip with Electronic Charts

To illustrate the use of electronic charts, let's take a trip from Manassas, Virginia, to the resort airport at Hilton Head, South Carolina. For the flight, we'll fly a normally aspirated Cessna 210 with a GPS that is IFR certified for enroute, terminal, and approaches.

Using the flight planning features of Jeppesen FliteMap®, a direct flight from Manassas (KHEF) to Hilton Head (KHXD) is shown to be 419.6 nautical miles. Upon a closer look at the straight line between the two airports, the route passes through the edge of Restricted Area R-6608B which is from the ground up to 10,000 feet MSL. Oops! For a route clear of the restricted area, "grab" the route of flight on the screen with the cursor and drag it to the closest intersection (FLUKY). When filing an electronic flight plan through DUAT, or by calling a Flight Service Station, it is easier to use intersections as descriptions for the route of flight.

About midway through the flight, there is another restricted area, and FliteMap shows the altitude restrictions for R-5311A, B, and C. Looking at the altitudes for all three areas, we need to fly around R-5311, so the route of flight should be "rubber banded" again to the west to avoid the restricted area. The route of flight can be dragged over to the MYOWN intersection, which avoids R-5311.

Straight-In Approach at Hilton Head

At Hilton Head, there are five instrument approach procedures. One of them is the GPS Rwy 21 approach, in which you arrive from the north. A straight line from the MYOWN intersection to Hilton Head can be slightly modified with the "rubber band" in FliteMap to make the route straight to the TERLY intersection, the GPS Rwy 21 initial approach fix. With these slight modifications to route around the restricted areas and to fly direct to the IAF, the total distance including the GPS approach is only about one mile further than a straight line between the two airports.

Weather

For current weather, click on the Weather tab toward the top of FliteMap, and a screen appears for dialing DUAT. Once connected, using either a dial-up or Internet connection, a wide selection of weather and preflight services is available. Included are "Standard WX: Route", "Radar Maps [NEXRAD]" and many others, all of which are available for download and display.

After obtaining the current weather, it can be overlaid on top of the route of flight to see what impact it may have on our route. For this flight, the NEXRAD weather shows some thunderstorms, but they are far enough away that they shouldn't impact the flight. In addition, winds aloft can be displayed graphically, using wind arrows to show their impact at our chosen cruising altitude of 8,000 feet.

Chart NOTAMs

Before departure, there are a number of sources we can turn to for NOTAM information. The DUAT services and the Flight Service Stations can inform you of recently issued NOTAMS which might affect this flight. Additionally, JeppView has two locations to obtain NOTAMS affecting charts. At the top of the page when charts are in view, a tab for "Chart NOTAMs" will show whether or not there are any NOTAMs that affect the chart with information that has changed between chart cycles. For Hilton Head, the only Chart NOTAM is a generic NOTAM about Phase 3 Overlay GPS approach procedures.

To the left of the chart, another tab labeled "NOTAMs" shows the chart NOTAMs for the enroute charts. If any NOTAMs affect the enroute chart information, the temporary information can be found by clicking on this tab. Remember, the most current NOTAMs are only available from DUATs and Flight Service Stations.

Other JeppView® Tabs

Other useful information about Hilton Head such as fuel, oxygen, magnetic variation, latitude and longitude, time zone, and other details can be found by pressing the tab that includes the airport's identifier plus the word "Info."

Did you forget what LAA means? How about ASOS or AWOS or TWEB or VDP? A tab labeled "Glossary" is on the left side. Also, the meanings of the symbols found on approach charts, SIDs, and STARs, as well as enroute chart information can be found under the tab labeled "Legend."

While flying into Hilton Head, you most likely will have the GPS Rwy 21 chart in view. If Savannah Approach changes the approach in use, the tab at the top labeled with the airport identifier followed by the word "Charts" will let you find the additional charts for Hilton Head without having to start all over looking for Hilton Head in a long list of other airports.

Looking closely at some of the JeppView buttons, you will notice that some are marked with underlines. These indicate the availability of shortcuts using the CTRL key in combination with other keys, and help to find things without having to chase around with the small cursor. Using CTRL-C, the list of other charts for the active airport appears. If you are looking at a chart and want to find another airport, CTRL will display the master list of airports. CTRL-I will display the airport information and CTRL-N will display the Chart NOTAMs.

Printing

Once you have selected the airports, you can print all the charts to carry with you as a backup if you view the charts electronically while enroute. If you want to reduce the total number of charts you print, you can select the chart types you desire, so that if you don't want to fly DPs (SIDs) or STARs, they won't be printed. When printing, you can select the option to print each chart on a separate sheet of paper. The charts are a little oversized, but they are very easy to read.

The printer icon at the very top of the display launches your print efforts. If you want, the charts can be printed two on a full size sheet of paper, which makes the charts the same size you are used to seeing.

In the next article, we will finish with a view of the future for electronic charting.

The Chart Clinic – Tenth in a Series

By James E. Terpstra
Sr. Corporate Vice President, Jeppesen

Back then we thought we were pretty sophisticated! Not by today's standards, but with the technology that was available then, maybe we were. Back in 1968, just the idea of not having to fly over navaids on an IFR cross country was brand new. Narco first sold their CLC-60 RNAV computer in 1968 and it was an amazing tool. It worked, but there was a lot of effort to create an RNAV flight plan. To create each waypoint, the bearing and distance had to be computed or plotted so the RNAV system knew where to electronically move a VORTAC.

That first RNAV computer used the existing VOR and DME receivers in the airplane as its input and then the user entered the radial and distance where to move the VORTAC. In the first RNAV computer, the system allowed an offset of only 42 nautical miles, but it was a computer which could be used to create and fly direct routes without having to fly over any existing navaid facilities.

This concept was so new, the use of RNAV would also create interesting discussions with controllers. While en route, there were times you wanted to go to an intersection via present position direct and the controller would ask, "Can you really do that in that little airplane?"

Off-Airway Navigation

In the previous article, we discussed flying shorter distances by flying off the airways. There are two series of Jeppesen charts that can be used to draw direct routes. The Jeppesen high and low altitude enroute charts are one of the ways to make it happen. The easiest is the RNAV enroute series which uses 11 charts to cover the entire U.S. Most of these charts are drawn to a scale of 30 nautical miles to the inch, so it is easy to place adjacent charts next to each other and have a straight line go across more than one chart. The Area Navigation Enroute Charts were first published in 1968 when Narco introduced their CLC-60 RNAV computer to the marketplace.

To look at the charts in a way they would typically be used, let's look at a flight from Centennial Airport just southwest of Denver, Colorado to Westcliffe Airport toward the bottom of the illustration.

For most airports on the chart, there is a tabular listing in front of the chart subscription series that gives detailed information for establishing a waypoint at an airport. As an example, look at the entry for Centennial. It lists the airport as "CENTENNIAL/DENVER" to include both the airport and city name. To the right of the airport name is the airport elevation of 5,880 feet. The next line includes Centennial's coordinates for those systems which can use coordinates but do not have a stored database of airport coordinates. To the right of the coordinates is the airport identifier.

CENTENNIAL/DENVER				5880
N39 34.2	W104 51.0		APA	
116.3	FQF	224.9/12.8		5789
115.4	BJC	135.8/24.5		5730

Following the coordinates are two VORTACs or VORDMEs that are within 40 nautical miles of the airport with the bearings and distances to the airport reference point (ARP). At Centennial, the two navaids and their bearings and distances are Falcon (FQF) and Jeffco (BJC). With the RNAV systems that electronically move VORTACs, a waypoint can be created at Centennial by tuning to FQF's frequency of 116.3 and setting the bearing to 224.9° and the distance to 12.8 nautical miles and activating the RNAV function. Some RNAV systems have the ability to input the VORTAC elevation to automatically compensate for the DME's slant range distance. For those systems the FQF elevation of 5,789 feet would be entered.

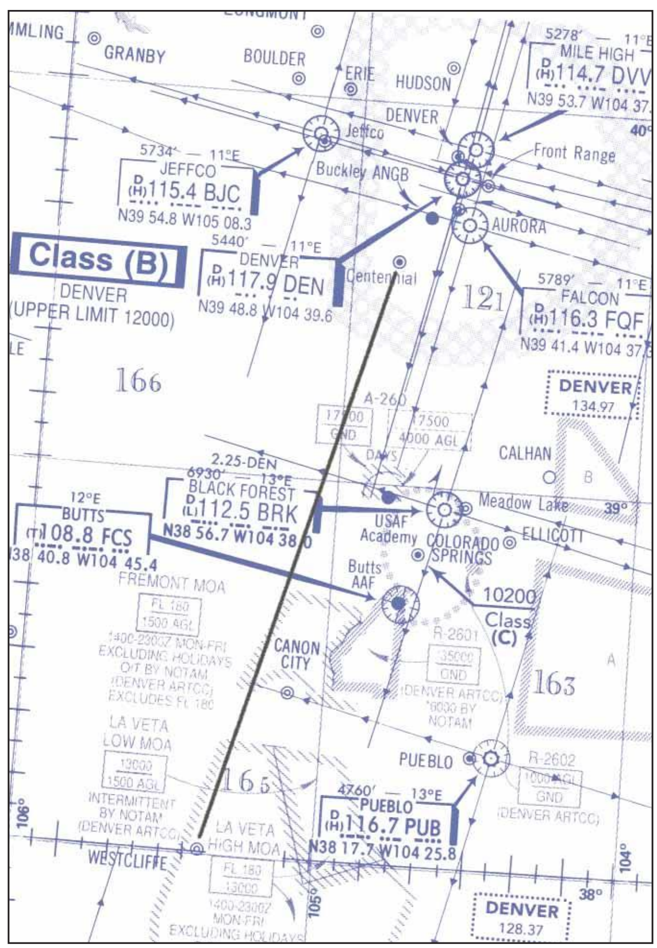
Note that Jeffco is listed as the second navaid but it is not the second closest VORTAC to Centennial. The second navaid is selected for the listing at a location that may provide a better navaid if approaching from the west rather than having both VORTACs located very close to each other.

Since the flight is going to the south, the best navaid to tune when departing Centennial Airport is the Falcon VOR because it is the most southern of the navaids that are within reception range. Before departure, you would tune the VOR frequency to 116.3 MHz and enter 224.9 degrees and 12.8 NM into the RNAV computer. The magnetic course to set from Centennial is 185°. With the RNAV set up this way, you would fly with a FROM indication when departing Centennial.

There is another method for determining the RNAV bearing and distance offset that works better if the RNAV has a distance capability of 199 nautical miles or more. Since Westcliffe Airport is not that far away, you could calculate the bearing and distance from FQF all the way to Westcliffe and be able to depart Centennial with a TO indication and the distance to go would read the distance remaining to the Westcliffe. Since the bearing and distance from FQF to Westcliffe is 185° and 106.6 NM, these values set into the RNAV make it much easier to fly the route. Typically when departing an airport, the departure pattern is not on a straight line out of the airport. With the destination set in the RNAV, as soon as you are out of the pattern, you can set in the bearing to Westcliffe and that becomes the new magnetic course. *It's easier this way!*

Determining Magnetic Courses

The magnetic course from Centennial to Westcliffe can be determined by a number of methods. The easiest method, of course, is a computer flight planning software package. But, since that is not always convenient when sitting at the airport or in the airplane, there is a Jeppesen plotter included with the RNAV charts that can be used to plot the course. If there is a GPS receiver in the airplane, the destination airport would be set in the GPS receiver and the magnetic course is automatically computed. In the VORTAC RNAV systems, the course has to



be pre-determined and set in the course selector before departing the airport to provide course guidance right after takeoff when the VOR is within navaid reception range.

Since the Falcon VOR can't be used for the *entire* flight, you will need to tune to the next VOR sometime after leaving Centennial. The first RNAV waypoint is easy to determine by looking at the route of flight and the location where it crosses the 270° radial of the Black Forest VOR. There are four cardinal compass points on the VOR which have radials extended 40 nautical miles from each VOR. The 40 miles is based on the FAA's service volume for "L" class navaids. Even though the VORs can be electronically moved much farther than 40 nautical miles, the reception range still is 40 NM for "L" class navaids. The service volume of the different classes of navaids is shown in a graphic on the RNAV charts.

On each of the four extended radials of the VORTACs, there are small tick marks spaced at 10 nautical mile intervals. By looking at the route of flight, you can see the route crosses the 270° radial at 19 miles. You can create a waypoint by tuning to Black Forest on 112.5 MHz, setting the RNAV bearing to 270° and the RNAV distance to 19 NM and engaging the RNAV function. When filing the flight plan, the waypoint description would be written as BRK270019.

For the **altitude** on this flight, it is easiest to use the grid MORAs (minimum off-route altitudes) that are included at one-degree intervals. There is a number just to the east of Centennial Airport which contains a large number "12" and the smaller number "1." This MORA indicates the minimum flight altitude of 12,100 feet which will clear all terrain and obstacles by at least 2,000 feet. We will discuss more details regarding altitudes in the next article.

Long-Distance Flights

One of the most important items on the RNAV charts is the graphic portrayal of the special use airspace (SUA). One of the biggest problems in creating a direct route is trying to determine if the route will go through a prohibited or restricted area or MOAs. For most direct routes, the chances of going through special use airspace are good. The FAA says that all direct routes should be planned to avoid prohibited or restricted airspace by at least three nautical miles. If a bend in a direct route is required to avoid SUA, the turning point needs to be part of the flight plan.

For all random RNAV flights, there needs to be a least one waypoint in each ARTCC through whose area the random route will be flown. These waypoints must be located within 200 NM of the preceding center's boundary. When specifying these waypoints, they can be communicated in the flight plan using the frequency/bearing/distance format or latitude and longitude. All aircraft flying with latitude and longitude systems flying above FL 390 must use latitude and longitude to define the turning point. The format for latitude and longitude is four numbers for the latitude and five numbers for the longitude separated by a forward slash "/." As an example, a turning point at N39° 28.0' W104° 54.5' would be stated as 3928/10455 on the flight plan.

In the next article, we will look at the high altitude charts and some international charts.

The Chart Clinic – Eleventh in a Series

By James E. Terpstra
Sr. Corporate Vice President, Jeppesen

Imagine, for a moment, that you are flying DC-3s over the bush country of Africa or the jungles of South America in the 1940s and 1950s. NDBs were the main radio navigation aid and formed the few airways that did exist. And, failures of NDB ground stations in those days were not uncommon. VORs were starting to appear in the late 50s, but they were few and far between.

When the airway structures were being put together in early aviation, many governments simply provided the NDBs and connected them with only an airway name – and that's it. Airway A-1 (amber 1) would be published with the airway designator and sometimes a minimum reception altitude, but rarely would an altitude be provided for just obstacle clearance. This would mean that a minimum altitude would be provided for normal operations, but with an engine failure, there was no minimum altitude which provided obstacle clearance. When talking to pilots who flew in that era, they will almost always tell you about the numerous engine failures they had during their careers.

Pilots in those days started to ask Jeppesen to provide minimum obstacle clearance altitudes because of all the engine failures. Airlines needed them for drift down information. But governments weren't prepared to provide the information – and most countries still don't provide minimum obstacle clearance altitudes even today.

MORAs

The answer? We created MORAs – minimum off route altitudes. There are two types of MORAs – one is called a route MORA and the other is the grid MORA. Because of the imprecise navigation provided by NDBs and the ADFs used in the airplanes, the early route MORAs provided an obstacle clearance within 10 nautical miles on both sides of the airways and within a 10-nautical mile radius around the ends of the airways. The 10-nautical mile criteria is with us today. To create the route MORAs today, the enroute chart compilers at Jeppesen analyze the visual aeronautical charts for each respective location around the world to determine the ground elevations below the airways to produce the route MORA for each airway segment.

Not only did engines fail, but the NDBs and ADFs did also. But even more peculiar was the fact that some governments would turn their NDBs off if they thought no one was using them at the moment. It saved power, and no one would have to stand by the electrical generator to run the NDB.

This meant that even though the NDB was not very precise, sometimes they weren't even there. In that case, even the 10-nautical mile radius wasn't adequate. So – the grid MORA was created. The grid MORAs provided (and still do) an obstacle clearance altitude within a latitude and longitude grid block, usually of one degree by one degree.

Obstruction Criteria

In order to provide one standard for the whole world, the minimum vertical distance between the MORA and the highest obstacle along the route was determined to be either 1,000 feet or 2,000 feet, depending on the elevation of the terrain and obstacles below. When flying over precipitous terrain and when flying at higher altitudes, the amount of error between indicated altitude and true altitude increases. As a result, 1,000 feet of obstacle clearance was provided for the lower altitudes. For all terrain and obstacles greater than 5,000 feet, it was decided to create an obstacle clearance of 2,000 feet.

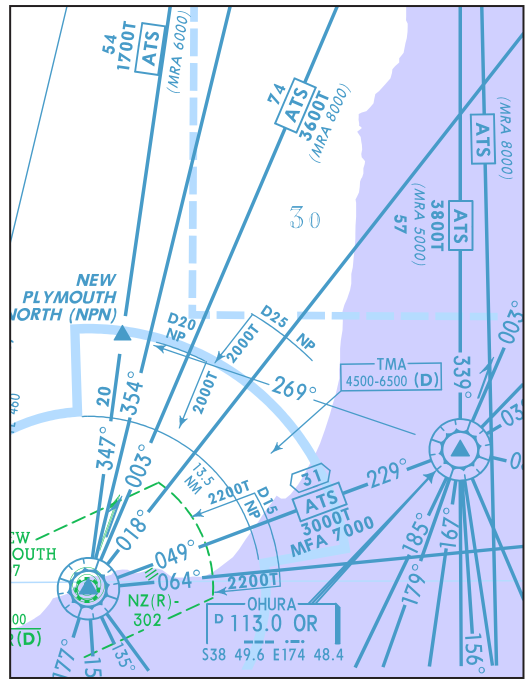
On Jeppesen charts, all MORA altitudes which are 6,000 feet or lower have an obstacle clearance of 1,000 feet. If the MORA altitudes are 7,000 feet or greater, the obstacle clearance is 2,000 feet.

Meanwhile, the FAA was also creating minimum altitudes that took into consideration the effects of precipitous terrain. The FAA created designated mountainous terrain which included a large portion of the western United States and some areas in the east. When the FAA creates minimum altitudes, they also use 2,000 feet of obstacle clearance, but the 2,000 feet only applies in designated mountainous terrain. There are some cases where the FAA provides obstacle clearance as low as 1,600 feet in the designated mountainous terrain area. The 1,600-foot value can be used when there are very good local altimetry sources and when the local terrain is not very precipitous.

In 1995, the FAA and the military liked the concept of the MORA and decided to create a similar concept. One of the difficulties with the MORA is that it provides *only* obstacle clearance. MEAs in the United States provide not only obstacle clearance, but they also provide a minimum altitude for reception of both navigation aids and communication, and they also are within controlled airspace.

Because the FAA and the military wanted the minimum altitudes to imply *only* obstacle clearance, they created a new minimum altitude called the Off Route Obstacle Clearance Altitude (OROCA) which meets the same criteria as Jeppesen's MORAs. One exception is that the OROCA provided by the FAA now includes 2,000 feet of obstacle clearance altitude only in designated mountainous terrain areas. The OROCA is also only provided in the United States by the FAA. The MORAs on Jeppesen charts in the United States are the same altitudes as the OROCAs.

An interesting irony? The MORAs which were created in the late 1940s have now again become very important. Engines and navigation are much more reliable, so they are not needed as much as they were for emergencies. But, with GPSs and FMSs, direct routes are flown off airways, and the only available minimum altitudes are the MORAs.

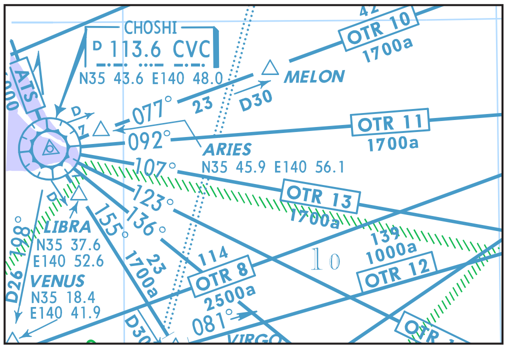


The grid MORAs are found on all the enroute and area charts. (This is not done in some areas where incomplete surveys of the terrain are provided by a government.) In the illustration above, northwest of the Ohura VOR in New Zealand, the value of 30 indicates that the MORA in the latitude/longitude grid bounded by S38° to S39° and E174° to E175° is 3,000 feet above sea level. The large numbers indicate the altitude in thousands of feet and the small number is the altitude in hundreds of feet.

In the illustration at the top of next column, east of the Chosi (Japan) VOR, the oceanic route OTR 11 has an altitude designated as 1700a. The letter "a" to the right of the altitude value indicates that this is a route MORA. There are not as many route MORAs as there were in the past because governments are specifying more minimum route altitudes than before.

Minimum Enroute Altitudes

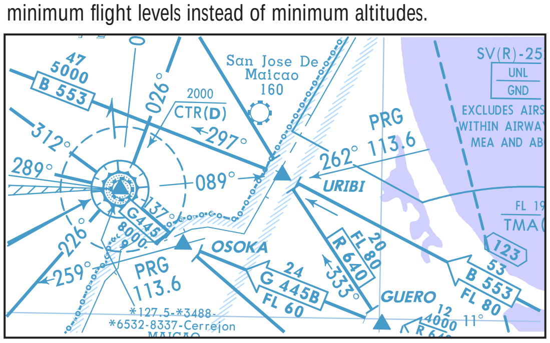
As an interesting note, the International Civil Aviation Organization (ICAO) does not have MEA as an official abbreviation. The MEA's are used only by the United States, Canada, and a few other countries.



In the United States, both the minimum enroute altitude (MEA) and the minimum obstruction clearance altitude (MOCA) are provided by official FAA sources. These altitudes are not provided by all governments, however. In the illustration at left, north of the Ohura VOR, the ATS (Air Traffic Service) route shows 3800T. The New Zealand government supplies a minimum obstacle clearance altitude, but not an MEA. The MOCA is 3,800 feet. There is no MEA on this route, but there is a minimum reception altitude (MRA) indicated by the MRA 5000 in parentheses. Northwest of the Ohura VOR are numbers 2000 followed by the letter T. These are associated with DME rings of 15, 20 and 25 nautical miles from NP. When these are depicted, this means the minimum obstacle clearance altitude inside these rings is 2,000 feet. These are used frequently in Australia and New Zealand as a way of indicating the minimum altitude when arriving at an airport and not flying on the airways.

Note that the airway north of Ohura is simply labeled ATS which means it is an air traffic service route. *It does not have a unique airway identifier!* This means it has no way of getting into the airborne databases since it can't be uniquely identified.

In many countries, the minimum altitudes to be flown on airways are not really altitudes – instead they are flight levels. In the third illustration, shown below, the minimum altitude for B 553 is 5,000 feet on the northwest end of the airway and the minimum is flight level 80 on the southeast end of the airway. When the minimum is FL80, this means the altimeter will read 8,000 (feet) with the altimeter set to 29.92" or 1032.5 hectoPascals. The philosophy changes when you change from the Columbia to Venezuela when flying in South America. Most airways in Europe also have minimum flight levels instead of minimum altitudes.



We have many areas that need worldwide standardization. Minimum altitudes for airways is one of them.

In the next article we will conclude the discussion of enroute charts.