Introduction to Aeronautical Charts

Session Time: Four, 50-minute sessions

DESIRED RESULTS

ESSENTIAL UNDERSTANDINGS

Preflight planning is an integral (and regulatory) component of safety for all flights whether they are manned or unmanned.

While some pilots subscribe to the "big sky theory," there are restrictions in certain areas of the sky, and all pilots are expected to know and understand these limitations.

ESSENTIAL QUESTIONS

1. How does an aeronautical chart allow a pilot to plan effectively for a particular flight?

LEARNING GOALS

Students Will Know

- The meaning of selected aeronautical chart symbols
- Where to locate information about airports, terrain, and other aeronautical chart features

Students Will Be Able To

- *Identify* different aeronautical chart symbols and what they mean. [DOK-L1]
- *Analyze* the topography, facilities, and obstacles in a given region for limitations that may affect a given UAS or manned flight. [DOK-L4]

ASSESSMENT EVIDENCE

Warm-up
As a class, students will compare road maps and aeronautical charts and create a list of how they are different. The students will then discuss why they might be different, and how the differences relate to their intended use.

Formative Assessment
Working in pairs, students will attempt to gather all the details about an airport from only a small portion of an aeronautical chart.

Summative Assessment
Working individually, students will identify aeronautical chart symbology, identify and explain chart concepts, and analyze chart information for limitations and impacts that may affect notional flights or planning.

LESSON PREPARATION

MATERIALS/RESOURCES

- Introduction to Aeronautical Charts Presentation
- Introduction to Aeronautical Charts Student Activity 1
- Introduction to Aeronautical Charts Student Activity 2
- Introduction to Aeronautical Charts Student Activity 3
- Introduction to Aeronautical Charts Student Activity 4
- Introduction to Aeronautical Charts Student Activity 5
- Introduction to Aeronautical Charts Student Activity 6
- Introduction to Aeronautical Charts Student Activity 7
- Introduction to Aeronautical Charts Student Activity 8
- Introduction to Aeronautical Charts Teacher Notes 1
- Introduction to Aeronautical Charts Teacher Notes 2
- Introduction to Aeronautical Charts Teacher Notes 3
- Introduction to Aeronautical Charts Teacher Notes 4
- Introduction to Aeronautical Charts Teacher Notes 5
- Introduction to Aeronautical Charts Teacher Notes 6
- Introduction to Aeronautical Charts Teacher Notes 7
- Introduction to Aeronautical Charts Teacher Notes 8
- **"Sporty's Sectional Training Chart: VFR Sectional Chart Segment + Legend"**
- FAA Aeronautical Chart User's Guide

Chart the Globe: Student Activity 5 (per group)

- Beach ball, balloon, pumpkin, or other round object to model a globe
- Markers appropriate for marking the "globe" material
- Tailor's cloth tape measure, or string and ruler

Chart Symbol Matching: Student Activity 7 (per group)

- 24 index cards, cut in half
- Black marker or other writing utensil

LESSON SUMMARY

Lesson 1: Introduction to Aeronautical Charts
Lesson 2: Introduction to the National Airspace System

The lesson begins with a Warm-Up in which students compare road maps and aeronautical charts to observe differences. This is followed by two activities which give students opportunities to explore aeronautical charts, legends, and the FAA's Chart User's Guide.

During the next session, students review key differences in types of maps and then begin to learn some of the primary features of aeronautical charts. Students learn how airports are displayed on aeronautical charts before completing two airport activities. In the first, students attempt to find a variety of different types of airports; in the second, students ascertain as much information about an airport as possible using only information that can be found on the chart.

In the third session, students learn about the depiction of landmarks and the importance of aeronautical charts to pilotage. Students will build a model globe to conceptualize grid mapping and also understand its limitations. Finally, students will understand the important ways in which the chart communicates altitude information to pilots.

In the final session, students challenge each other by mapping routes and identifying obstacles and obstructions that impact their routes. Students will then practice chart symbology recognition in a matching memory game and answer sample FAA Private Pilot Knowledge Exam questions relating to chart use. Finally, a Summative Assessment is conducted to evaluate student knowledge of the material presented in this lesson.

BACKGROUND

Pilots are able to plan routes of flight and navigate using maps designed specifically for aviators. Aeronautical charts display terrain, landmarks, obstructions, airspace, radio frequencies, and more. Since each paper aeronautical chart shows a section of the United States, they are often called “sectional charts” or “sectionals.” Sectionals have traditionally been available as large, folded paper documents, but they are increasingly represented on electronic displays through apps and websites. Sectional aeronautical charts are graphic representations of the world as it appears to a pilot who is flying under visual flight rules (VFR). Pilots who fly under instrument flight rules (IFR) use a different type of chart designed for use in instrument conditions. This lesson covers only VFR charts. On the sectional chart, lakes and other natural features appear in their actual shapes, virtually every known airport is charted, and key information is highlighted throughout. Pilots can glance at a sectional chart and find their location, see key landmarks for orientation, identify towers or other obstructions that might be a hazard, and see local airports with all of their identifying information. While there are other important sources of planning and flight information, the VFR sectional chart contains a wealth of information. Because they are so important, the charts are updated regularly. Normally, the sectionals are re-published every six months. More frequent updates are published in the Chart Supplement, which is issued every 56 days. A Notice to Airmen (NOTAM) may be published for significant changes that occur between update cycles.

MISCONCEPTIONS

Contrary to some perceptions, pilots don’t just hop into a plane and go flying. Rather, the safest and most effective flight is on that is well-planned ahead of time. In their flight planning, pilots use “maps,” though not traditional maps like those used for driving or hiking. In fact, the maps used by pilots are more like those used in boating, one of the many “nautical” connections to aviation. Maps for pilots are specially designed for use in flight and are actually called aeronautical charts, sectional charts, sectionals, or just “charts.”

Another planning and flight instrument (one also used in boating) is a compass, but pilots can’t just compare the compass and the map and start flying. There’s actually more than one north—for example, magnetic north is different from the geographic north—and the difference between them is important during flight planning.

Finally, pilots can’t just fly at whatever altitude they want. Besides planning a compass direction, pilots must also plan an altitude. The charts they reference in their planning give them information about elevation and obstructions that help them know how high they need to be to complete a flight safely.

DIFFERENTIATION

To support student learning in the **EXPLORE** and **EXPLAIN** sections, find instructional videos that model how to use aeronautical charts to prepare them for upcoming activities.

To support student learning in the **EXPLAIN** section, demonstrate the following concepts: identifying landmarks using a sectional chart and satellite view or simulate pilotage skills while flying a simulator. If time permits, you may have students practice these skills.

Introduction to Aeronautical Charts Student Activity 7 works well as a differentiation activity. To prepare students for the Chart Symbol Matching Memory Game, allow students to practice on their own or in small groups using these online quizzes from Bold Method: Quiz: Do You Know These 6 Rare VFR Chart Symbols? and Quiz: Do You Know These 6 Uncommon VFR Sectional Chart Symbols?

LEARNING PLAN

ENGAGE

Teacher Material: Introduction to Aeronautical Charts Presentation
Student Material: "Sporty's Sectional Training Chart: VFR Sectional Chart Segment + Legend"

Session 1

Slides 1-3: Introduce the topic and learning objectives of the lesson.

Slide 4: Conduct the **Warm-Up**.

Warm-Up

Either on a classroom screen or on individual devices, have students access Google Maps (map view, not satellite view) and locate the towns of Helena-West Helena, Arkansas, and Colt, Arkansas. Colt is due west of the large city of Memphis, TN. Helena-West Helena is 50 miles south of Colt and is located along the river. Ensure the scale of the Google Map view is 5 or 10 miles. Google Maps scale is visible in the lower-right portion of the screen.

Have students find those same towns on their copies of the "Sporty's Sectional Training Chart: VFR Sectional Chart Segment + Legend," which should cover the Memphis, TN, and northeastern Arkansas area.

Have the class discuss the differences between the ways the two maps display the area between Helena and Colt.

Responses will vary. When possible, guide the conversation to the level of detail on each map and for whom the map is intended.

Have students consider what items or features one map displays that the other does not.

Responses may include towns, airports, train tracks, power lines, towers, etc. When possible, guide the conversation to the purpose for the particular symbology being included (or excluded). NOTE: since students have not yet learned the various symbols on aeronautical charts, they may say things like "little A's with dots in them" which could mean the symbol for a tower.

As the lists of differences begin to form, have the students consider the reasons for the differences in map types.

[DOK-L4; *analyze*]

Teaching Tips

If the Sporty's training sectional is not available, download digital copies of the sectional charts from the FAA or use SkyVector. All activities in this lesson can be accomplished with any of the three chart sources.

To use SkyVector:

1. Go to www.skyvector.com.
2. On the upper-left part of the screen, click on the globe icon (labeled "Charts")
3. Click in the rectangle for Memphis (Memphis will appear as a label when you are in the correct box)
4. Near the upper-right of the screen, click the word "Layers"
5. With the layers pop-up window open, UNCHECK the boxes for Text Weather, Temporary Flight Restrictions, and SIGMETs.

6. Now the map appears as a normal sectional chart. If you zoom out to see the entire chart, the legend and other data in the margins will be available.
7. Center the map near Memphis, TN, and accomplish the lesson material.

To download charts from FAA.gov:

1. Go to https://www.faa.gov/air_traffic/flight_info/aeronav/digital_products/vfr/.
2. Scroll down to "Memphis" and click on the PDF option.
3. These files are very large and may take time to download or refresh on some computers or internet connections.

EXPLORE

Teacher Materials: Introduction to Aeronautical Charts Presentation, Introduction to Aeronautical Charts Teacher Notes 1, Introduction to Aeronautical Charts Teacher Notes 2
Student Materials: Introduction to Aeronautical Charts Student Activity 1, Introduction to Aeronautical Charts Student Activity 2, **"Sporty's Sectional Training Chart: VFR Sectional Chart Segment + Legend"**, FAA Aeronautical Chart User's Guide

Slides 5-6:

Questions

Why would a person use Google Maps?

Responses may vary, but will likely include obtaining driving directions or planning a vacation/road trip.

Do you think a pilot could use Google Maps to plan a flight? Why or why not?

Responses may vary. Some students may suggest pilots could use the road information to find their way. If students suggest changing to a satellite view would be more helpful to pilots, reiterate the "Why?", guiding them to understand that the satellite view provides both more detail and the view of the earth that the pilots would see from their planes. In fact, some pilots do use the satellite view of Google Maps, Google Earth, or other online mapping tools such as Bing Maps, to get a general sense of what they may see on a VFR flight—especially when the flight is to a location that is new to the pilot. Other students may indicate that Google Maps can't be used by pilots; while their reasons may vary, the primary reason is the lack of detail and other information specifically relevant to a pilot. The best answer is that Google Maps can be used by pilots to plan a flight, but not exclusively.

Why would a map for pilots (called an aeronautical chart) be different from a map a driver or hiker might use?

Responses may vary, but should ultimately reflect the understanding that pilots see the world from above, so their charts need to represent what they can see. In addition, car drivers only need to figure out where they are on a road; since pilots are not confined to roads, they need to figure out where they are in relation to objects identifiable from the air. Finally, pilots require more detail and different types of information to effectively navigate than what is normally available on a road map.

What does an aeronautical chart have on it that Google Maps does not? Why does it have so many more details?

Responses may vary, but will likely include airports, airspace, towers, terrain features, and more small towns. Some of these details provide greater information for pilots to figure out where they are; others are specific to flight safety. For example, pilots need to know where obstructions like towers are so they can avoid running into them.

Students may have noted some details or markings on their chart but not been able to identify them.How do we find out what symbols on maps mean?

Generally, using a map key or map legend. Likewise, the aeronautical chart has a legend. The FAA also publishes a Chart User's Guide with much more information.

Slide 7: Divide the class into pairs. Provide the students with **Introduction to Aeronautical Charts Student Activity 1**, **"Sporty's Sectional Training Chart: VFR Sectional Chart Segment + Legend"**, and the **FAA Aeronautical Chart User's Guide**, and have them complete the questions. Sample responses are available in **Introduction to Aeronautical Charts Teacher Notes 1**. If time permits, allow the students to skim through the legend and User's Guide to find interesting symbols they can share with the class.

Slide 8: Divide the class into pairs. Provide the students with **Introduction to Aeronautical Charts Student Activity 2**, **"Sporty's Sectional Training Chart: VFR Sectional Chart Segment + Legend"**, and the **FAA Aeronautical Chart User's Guide**. Have the students conduct the scavenger hunt within the available time. Sample responses are available in **Introduction to Aeronautical Charts Teacher Notes 2**. Upon completion of the activity, have the students share their results with the class to see if any were able to identify some that others could not.

EXPLAIN

Teacher Materials: Introduction to Aeronautical Charts Presentation, Introduction to Aeronautical Charts Teacher Notes 3, Introduction to Aeronautical Charts Teacher Notes 4, Introduction to Aeronautical Charts Teacher Notes 5
Student Materials: Introduction to Aeronautical Charts Student Activity 3, Introduction to Aeronautical Charts Student Activity 4, Introduction to Aeronautical Charts Student Activity 5, **"Sporty's Sectional Training Chart: VFR Sectional Chart Segment + Legend"**, FAA Aeronautical Chart User's Guide

Session 2

Slide 9: Maps display the type of information that is important to the person using the map. Drivers basically need to know road numbers or names and some major landmarks, because drivers know they're always on the roads—they just need to know where on a road they are. Nautical or boating maps display the information important to those sailing boats. Pilots, however, have no roads and can turn in any direction at any time, so they need more information and different types of information to plan and navigate in three dimensions. Pilots need to be able to determine where they are, and they also need to be able to clearly understand where they can't go.

The slide contains images of three types of maps representing an area around Annapolis, MD, and the Chesapeake Bay area.

The major differences among VFR aeronautical charts, nautical charts, and road maps are the types of information depicted, as each map is tailored for a specific type of user.

Slide 10: VFR aeronautical charts are published by the FAA, and they cover the United States, Puerto Rico, and some parts of Canada. VFR charts cover different sections of the USA, so they are referred to as VFR "sectional" charts. Pilots call them charts or sectionals; they don't call them "maps."

The sectional chart, which is the primary type of chart pilots use when flying VFR, has a scale of 1:500,000; in other words, one inch on the chart equals 500,000 inches (just under 7 nautical miles) of geographical distance. Pilots speak in terms of nautical miles (NM), not statute miles (SM). One nautical mile is 1.15 statute miles. A statute mile is what most people think of when they say “a mile.”

VFR sectional charts are named using a major city within the chart’s boundaries. For example, the sectional used in the earlier activities with Memphis, TN, is called the “Memphis Sectional.” Printed charts are large—some are about 21 inches tall and 55 inches wide—and they are printed on both sides. One side is the northern half and the other is the southern half of the sectional’s area. The half you are looking at is indicated on the legend with big arrows.

The FAA updates and republishes most sectionals every six months.

The layout of a sectional is displayed on the cover of each one. On that layout, purple areas highlight the location of Terminal Area Charts.

The slide contains a copy of the sectional “index” that appears on the front of each sectional. The Memphis sectional is hashmarked because the index came from a Memphis sectional.

Slide 11: Some major airports have “close-up” or “zoomed in” charts covering their local areas. Some examples include Seattle, Denver, Atlanta, and New York City. These charts are called Terminal Area Charts (TACs, pronounced “tacks”). TACs are a “close-up view” at twice the scale of a sectional, so they provide more detail than a traditional VFR sectional.

The slide contains a side-by-side representation of the same area on both a sectional chart and a TAC.

Terminal Area Charts are named for the Class B airspace or area they represent. For example, students have already discussed the Memphis TAC and the New York TAC. There are 30 areas enlarged to TAC scale.

The scale of a TAC is 1:250,000, so the same areas look twice as big as they did on the sectional. This provides more clarity and details, which is important to pilots flying in these congested areas.

Slide 12: In a few cases, there are special procedures to follow in congested areas. There is a unique section of the Federal Aviation Regulations (FARs) that contains Special Air Traffic Rules which cover just a few areas in the United States. This sometimes leads these areas to be known as “Part 93 airspace.” In New York City, for example, pilots can follow these special procedures to go sightseeing around the Statue of Liberty and along the Hudson and East Rivers without having to interfere with the intense air traffic going to and from the busy New York City area airports. The back of the New York TAC has detailed directions for flying in these Special Flight Rules areas, displayed at a scale of 1: 100,000. This means the view is enlarged even more than the typical TAC scale.

The slide contains an excerpt from the back of a New York TAC. It is a detailed enlargement to provide as much VFR clarity as possible. The images are distinct and obvious landmarks, and they are given easily recognizable labels. (The power plant in the northeast of the picture is labeled “Big Allis” because that is the colloquial name of the facility.) However, these drawings are labeled “not to be used for navigation.” They are intended as references only.

Slide 13: One of the most important details on a sectional chart is the display of airports. Students should have seen most of this information during the earlier student activities. The slide contains image excerpts from the sectional legend:

- The majority of airports appear in a magenta color, which the sectional legend indicates are nontowered.
- Airports with a control tower are in blue.
- An open circle is an airport with “other than a hard-surface runway,” which normally means a grass runway.
- A white line representing the runway in a solid circle indicates a hard-surface runway (or runways) from 1,500 to 8,069 feet long.
- Airports with runways longer than 8,069 feet are represented simply by an outline of the runway. The runway symbol is also aligned with the direction of the runway.

- Airports with “tick” marks at the north, east, south, and west positions of the circle have services available (e.g., fuel), and if there’s a star on the symbol, then the airport has a rotating beacon.

Teaching Tips

To encourage understanding of the detailed symbology, consider asking the students why they think the FAA chose to make certain distinctions in symbology. For example:

Why are towered airports one color, and nontowered airports a different color?

Possible responses may include that some pilots may seek out controlled fields, or that it lets inbound pilots know immediately if they need to talk to ATC.

The same question could be asked about depictions of services (the tick marks), runway surface type, etc. With regard to runway length, there is no operational reason for using 8,069 feet, though it does provide pilots with immediate awareness if a runway is particularly long. Instead, that is a graphical printing limitation related to the size of the circle representing the airport. There is no operational significance to the number itself. In fact, on the TAC—which has a different scale and thus a different printing limitation—the symbology for airports is slightly different, with runways longer than 1,500 feet (rather than 8,069 feet) represented by an outline.

Slide 14: Divide the students into pairs. Provide the students with **Introduction to Aeronautical Charts Student Activity 3**, and have them perform the search for airports. Sample responses are available in **Introduction to Aeronautical Charts Teacher Notes 3**. The slide contains an image of a sectional with three interesting airport types in close proximity: “objectionable,” closed, and private.

Slide 15: The airport’s “data block” on the VFR sectional provides the name of the airport, communication frequency, runway length, airport elevation, and weather-reporting frequency (if available) among other information. The data block is more fully detailed in the chart legend.

Questions

What does the *L mean?

*According to the legend, *L means “lighting limitations exist; refer to the Chart Supplement U.S.” It likely means airport lighting is pilot-controlled, but only checking the Chart Supplement can verify that.*

Does this airport have fuel available?

Because it has tick marks around the circle, the airport should have fuel available at the published times in the legend.

Slide 16: Complete the **Formative Assessment**.

Formative Assessment

Divide the class into pairs and provide students with **Introduction to Aeronautical Charts Student Activity 4** worksheet. Students may reference the chart legend and the FAA Chart User's Guide, but should not need to see a sectional chart area itself nor the airport's information in a Chart Supplement. Sample responses are available in **Introduction to Aeronautical Charts Teacher Notes 4**.

[DOK-L1; *identify*]

Session 3

Slide 17: VFR sectional charts can also show landmarks like notable buildings or structures and rivers or canyons. Landmarks that are used by air traffic controllers (and pilots) as VFR checkpoints get a magenta flag and name. For example, due to its distinctive shape and location, the Tappan Zee Bridge is a VFR Checkpoint in the New York City area. VFR checkpoints are used by ATC to help direct traffic, and because of their prominence, these checkpoints may be the location of higher density air traffic.

The slide contains an image of the bridge and its symbol as a VFR checkpoint on the sectional.

Slide 18: One of the most important ways a pilot can use a VFR sectional is to find notable landmarks on the chart and locate them out the window, or find notable landmarks out the window and find them on the chart. Navigating from place to place by using landmarks or geographic features is called *pilotage*, and it is a key method of VFR navigation. Sectionals are designed to accurately represent the world as the pilot sees it to enable good pilotage.

With that in mind, blue is understandably used on sectionals to represent water, and absent any recent significant meteorological events, the shape of the lake, pond, shoreline, or other water area will be the same as it appears from the air. Sectionals use yellow for large towns or cities, which the FAA terms "populated areas." A common interpretation of the yellow area is that it replicates the shape of the populated area at night.

Slide 19: The main purpose of a map is to find the location of places and objects (or yourself, in relation to those places or objects). To do this with precision, latitude and longitude can be used. The grid lines that run north and south are lines of longitude, while the lines that run east and west are lines of latitude.

Slide 20: The equator may be the most famous line of latitude, and it is the 0° line of latitude, or "parallel", so called because latitude lines are all parallel to each other. Lines of latitude range from 0° to 90° toward the North Pole (northern hemisphere or northern latitudes), and from 0° to 90° toward the South Pole (southern hemisphere or southern latitudes). The South Pole is 90° south latitude, while the North Pole is 90° north latitude.

Lines of longitude are perpendicular to the lines of latitude, and they start at one pole and end at the other. Also called meridians, the most famous one may be the Prime Meridian, which represents 0° longitude and runs through the town of Greenwich, England (pronounced "GREN-itch"). Longitude is a measurement of 0° to 180° east or west of the Prime Meridian. The International Date Line can be found near the 180° line of longitude, directly opposite the globe from the Prime Meridian.

Slide 21: A specific location on Earth is given as a coordinate pair with the north or south latitude appearing first, and then an east or west longitude. Latitude and longitude coordinates on a VFR sectional chart may be given in degrees (°), minutes () and decimal minutes, followed by a cardinal direction (N/S/W/E). Whole degrees of latitude and longitude are numbered on sectionals.

Slide 22: For example, reference the **"Sporty's Sectional Training Chart: VFR Sectional Chart Segment + Legend"** or the Memphis sectional.

Questions

What airport would you find very close to 35° 30N 92° 00'W?

Heber Springs (HBZ) in Arkansas

Each whole degree of latitude and longitude is marked by a line on the sectional with the number of degrees, and every half-degree (or 30 minutes) also has a line (but no number). Every minute of latitude and longitude is marked by a tick mark, with every ten minutes a slightly larger line. When using latitude and longitude for locations, the FAA's Chart Supplement uses decimal minutes. In the previous example, the Heber Springs airport is not quite at the intersection of latitude and longitude lines.

Questions

Are there more precise coordinates for the HBZ airport we just found?

*Instead of 35° 30N 92° 00W, it could be 35° 3**1**N 92° **01**W.*

In fact, the Chart Supplement indicates the HBZ airport's actual location is 35° 30.7N 92° 00.78W.

Slide 23: Divide the class into groups of three or four, or as required based on the materials available. Provide the students with **Introduction to Aeronautical Charts Student Activity 5**. Have them build their globe and respond to the questions within their group, and then share the group's responses with the rest of the class. Sample responses are available in **Introduction to Aeronautical Charts Teacher Notes 5**.

Slide 24: The earth rotates on an axis, and the north and south poles are points along that axis. Because these are actual locations on the planet where the axis would pass through, they are the geographic north and south poles. Latitude and longitude lines are laid out over the planet in reference to these points, and any directions based on the geographic poles and lines of longitude and latitude are called "true directions."

Lines of latitude and longitude on a VFR sectional indicate true directions.

The most basic primary navigational tool available in every certified airplane, the magnetic compass, aligns with the *magnetic* poles, which are not in the same location as the geographic poles. In 2019, the magnetic north pole (where the north end of a compass needle would point) is located in northern Canada. It's about 1,300 miles from the geographic north pole.

The slide contains an image from the Pilot Handbook of Aeronautical Knowledge showing the difference in locations between the geographic, or true, north pole (TN) and the magnetic north pole (MN).

Slide 25: Sectional charts are aligned with true north, but there are magenta dotted lines that indicate what is called magnetic variation. Magnetic variation is the difference of how many degrees a compass would read compared to true, or geographic north.

Referencing the chart excerpt on the slide, if a pilot were to fly north from over the town of Crum to a spot over the town of Wayne, the true course would be 0° because the course is parallel to a line of longitude. However, the north magnetic pole is far north and to the left of the pilot, meaning a true course of 0° would not be a magnetic course of 0°. In this case, the pilot's magnetic compass would read 007°—consistent with the magenta "7°W" line on the pilot's route, which indicates 7° of west variation. True and magnetic courses will be covered in depth during the second semester of the **Pilot Pathway**.

Slide 26: One of the most important pieces of information that a sectional chart conveys is the height of terrain and obstructions. For example, a pilot needs to know if there are any towers high enough that they might pose a collision hazard during a flight. Pilots also need to know the elevation of the ground so that they can plan a flight's altitude appropriately.

Sectional charts show elevations in a few ways, from wide areas to individual points.

The slide contains an excerpt from a sectional that will be used to demonstrate these height symbols.

Slide 27: Wide area elevations are displayed in each "quadrant." Quadrants are outlined by 30-minute by 30-minute latitude/longitude rectangles, and within each of these quadrants there are two large blue numbers. These numbers represent the Maximum Elevation Figure (MEF), which is the highest elevation within a quadrant, including terrain and other vertical obstacles (towers, trees, etc.). The first digit represents thousands of feet of altitude above mean sea level (MSL), and the second digit is hundreds of feet.

In the example image, the MEF is 45, representing 4,500 feet MSL. When a human-made obstacle is the highest in the quadrant, the MEF is normally generated by taking the height of the obstacle, adding 100 feet, and rounding up to the nearest hundred. When a natural terrain feature is the highest in the quadrant, the MEF is generated by taking the elevation of the feature, adding 300 feet, and then rounding up to the next hundred. One reason for the additional height for terrain is that the base elevation does not account for natural obstructions like trees. Generally speaking, were a pilot to fly at the MEF in the quadrant, the pilot would be at least 100 feet above any known obstacles.

Questions

What feature drives the MEF in the example chart?

Students may be quick to focus on the towers near Alderson in the center of the quadrant, near the MEF symbol. However, using the math presented above, this would result in an MEF of 4,400 feet, not 4,500 feet, based on those towers. Instead, it appears the MEF is driven by the 4,189-foot ground elevation in the northeast corner of the quadrant (near the text that says "Williamsburg"). Adding 300 feet and rounding up to the nearest hundred results in an MEF of 4,500 feet.

Teaching Tips

If the concept of latitude, longitude, and quadrangles needs further clarification, you may use this Gold Seal Flight Training Video to clarify the concepts.

- "Sectional Charts: Latitude and Longitude" (Length 6:40)
  https://video.link/w/n55v

  For teachers who are unable to access Safe YouTube links, the video can also be found here: https://www.youtube.com/watch?v=de1JxnfzZNA

Slide 28: The next more detailed display of elevation is created by contour lines and color. In the sample image, near the MEF a shade of green (lower elevations) fades into a series of increasingly darker shades of tan (higher elevations). The contour of the hills in this area is shown by the shape of the coloring and the spacing of the contour lines. The closer together the lines, the steeper the gradient.

Some of the gray contour lines also have elevation numbers on them, and the concentric lines represent 500-foot intervals unless otherwise noted.

The margin of the sectional will have a partial terrain coloring legend, and the Aeronautical Chart User's Guide will have a complete copy of the color key. The slide contains a copy of the terrain coloring key from the Aeronautical Chart User's Guide.

Terrain can be important to pilots not only because of the risk of collision, but also because terrain can influence wind patterns. For example, rapidly rising terrain can contribute to updrafts or downdrafts, and hills can contribute to low-level turbulence.

Slide 29: Spot elevations like hilltops are marked with a black dot and a number in feet MSL.

The symbol that looks like an inverted V with a dot is a relatively short tower (less than 1,000 feet AGL), with the dot indicating where the obstruction actually is on the chart. Towers taller than 1,000 ft AGL have a more pronounced (and taller) symbol. Importantly, these towers have guy wires that can extend out hundreds of feet, and these wires are not indicated on the charts.

Obstructions are labeled with two numbers. The top number is the height of the obstruction in feet MSL. The number in parentheses is the height of the obstruction above ground level.

Slides 30-31: Charts are constantly changing to meet the needs of pilots. In recent years there has been a proliferation of wind turbines for energy production. Wind turbines, or windmills, have their own symbol; however, groups of windmills (or "windmill farms") do not have every individual windmill charted. Instead, the area of the "farm" is outlined with the windmill symbol inside it.

Slide 31 shows two images from sectionals. Windmill farms are marked on each image.

Questions

What is the height of the wind turbine farms depicted on the slide?

The left example indicates 1734 ft. in the box next to the windmills; the right indicates 1760 ft.

What does the "UC" label mean?

The legend says UC means "under construction" or "position and elevation unverified." However, the Aeronautical Chart User's Guide states that if a windmill farm has a "UC," it specifically means the height of the tallest windmill is unverified (page 33).

Slide 32: Whether flying a manned or unmanned aircraft, pilots need to know whether they'll run the risk of hitting something. Is the aircraft capable of flying above the obstruction, or does the pilot need to fly around it? Is there a possibility of more air traffic at a specific point? Can the aircraft climb fast enough to crest rising terrain? What about the risk of updrafts, downdrafts, or turbulence caused by terrain features? How does the elevation along the route affect the aircraft's performance? The information on a sectional chart is valuable when planning a flight.

The slide contains an image from a stunt scene from an old movie. The steeple was made to come apart when the aircraft struck it, which explains how a wood and fabric aircraft could strike a building without damaging itself.

Slide 33: Airspace is also critically important to pilots. Many kinds of airspace are represented on aeronautical charts, including terminal areas around airports, military training routes, and wildlife areas. In the next lesson, you will learn about the National Airspace System (NAS) and how it is represented on sectionals.

EXTEND

Teacher Materials: Introduction to Aeronautical Charts Presentation, Introduction to Aeronautical Charts Teacher Notes 6, Introduction to Aeronautical Charts Teacher Notes 7
Student Materials: Introduction to Aeronautical Charts Student Activity 6, Introduction to Aeronautical Charts Student Activity 7, **"Sporty's Sectional Training Chart: VFR Sectional Chart Segment + Legend"**, FAA Aeronautical Chart User's Guide

Session 4

Slide 34: Divide the class into pairs. Provide the students with Introduction to Aeronautical Charts Student Activity 6. Have the students create flight routes and swap with another pair to do the analysis of symbols. The two pairs that swapped should get back together to discuss the routes once complete. Sample responses are available in **Introduction to Aeronautical Charts Teacher Notes 6**.

Slide 35: Additional practice or **Differentiation activity**

> **Teaching Tips**
>
> The number of activities in this lesson have given the students many opportunities to learn about the many symbols used on sectional charts. If you feel the class needs additional practice, you require an additional activity (perhaps for a substitute teacher to supervise), or some students need a differentiated activity, then **Introduction to Aeronautical Charts Student Activity 7** may be appropriate.

Divide the class into pairs. Provide the students with **Introduction to Aeronautical Charts Student Activity 7**. Have them create the matching cards and play the game. Once complete, have the students discuss any observations they have about chart symbology, including symbols that may be particularly difficult or easy. Sample responses are available in **Introduction to Aeronautical Charts Teacher Notes 7**.

EVALUATE

Teacher Materials: Introduction to Aeronautical Charts Presentation, Introduction to Aeronautical Charts Teacher Notes 8
Student Material: Introduction to Aeronautical Charts Student Activity 8

Slide 36-47: Review the Private Pilot Knowledge Test questions.

Slide 48: Conduct the **Summative Assessment**.

> **Summative Assessment**
>
> Distribute Introduction to **Introduction to Aeronautical Charts Student Activity 8**. In this summative assessment, students will individually identify aeronautical chart symbols and analyze chart information for limitations that may affect a proposed flight in planning scenarios. Sample responses are available in Introduction to **Introduction to Aeronautical Charts Teacher Notes 8**.
>
> [DOK-L1; *identify*, DOK-L4; *analyze*]

Summative Assessment Scoring Rubric

- Follows assignment instructions
- Postings show evidence of one or more of the following:
    - Correct recall of flight planning resources, mapping concepts, and chart symbology
    - Reasonable application of chart symbology analysis to notional scenarios
    - Evidence and explanation of the above that demonstrate understanding of the material
- Contributions show understanding of course of the concepts covered in the lesson
- Contributions show in-depth thinking including analysis or synthesis of lesson objectives

Points **Performance Levels**

9-10 Correctly understands all flight planning resources, mapping concepts, and chart symbology and makes a reasonable application of chart symbology analysis to scenarios, with explanation.
7-8 Correctly understands most flight planning resources, mapping concepts, and chart symbology, with some errors, and makes generally reasonable applications of chart symbology analysis to scenarios, with some incomplete analysis or errors.
5-6 Correctly understands some flight planning resources, mapping concepts, and chart symbology, with errors, or makes generally reasonable applications of chart symbology analysis but lacks adequate explanation.
0-4 Provides few, if any, correct ideas about flight planning resources, mapping concepts, and chart symbology, and/or makes poor application of chart symbology analysis with inadequate explanation.

STANDARDS ALIGNMENT

COMMON CORE STATE STANDARDS

- **RST.11-12.2** - Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
- **RST.11-12.4** - Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 11-12 texts and topics*.
- **WHST.11-12.6** - Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.
- **WHST.11-12.8** - Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.
- **WHST.11-12.9** - Draw evidence from informational texts to support analysis, reflection, and research

FAA AIRMAN CERTIFICATION STANDARDS

PRIVATE PILOT

I. Preflight Preparation

TASK D: Cross-Country Flight Planning

- Knowledge - The applicant demonstrates understanding of:
    - **PA.I.D.K1** Route planning, including consideration of different classes and special use airspace (SUA) and selection of appropriate and available navigation/communication systems and facilities.
    - **PA.I.D.K2** Altitude selection accounting for terrain and obstacles, glide distance of the airplane, VFR cruising altitudes, and the effect of wind.
    - **PA.I.D.S1** Prepare, present, and explain a cross-country flight plan assigned by the evaluator including a risk analysis based on real-time weather, to the first fuel stop.
    - **PA.I.D.S2** Apply pertinent information from appropriate and current aeronautical charts, Chart Supplements; NOTAMs relative to airport, runway and taxiway closures; and other flight publications

VI. Navigation

TASK: Pilotage and Dead Reckoning

- Knowledge - The applicant demonstrates understanding of:
    - **PA.VI.A.K1** Pilotage and dead reckoning.
    - **PA.VI.A.K2** Magnetic compass errors.
    - **PA.VI.A.K3** Topography.
    - **PA.VI.A.K4** Selection of appropriate:
        - **PA.VI.A.K4a** Route
        - **PA.VI.A.K4b** Altitude(s)
        - **PA.VI.A.K4c** Checkpoints
    - **PA.VI.A.R1** Collision hazards, to include aircraft, terrain, obstacles, and wires.

XI. Night Operations

TASK: Night Operation

- Knowledge - The applicant demonstrates understanding of:
    - **PA.XI.A.K5** Night orientation, navigation, and chart reading techniques.
    - **PA.XI.A.R1** Collision hazards, to include aircraft, terrain, obstacles, and wires.

REMOTE PILOT

V. Operations

TASK: Airport Operations

- Knowledge - The applicant demonstrates understanding of:
    - **UA.V.B.K1** Types of airports, such as towered, uncontrolled towered, heliport, and seaplane bases.
    - **UA.V.B.K2** ATC towers, such as ensuring the remote pilot can monitor and interpret ATC communications to improve situational awareness.
    - **UA.V.B.K4** Traffic patterns used by manned aircraft pilots.
    - **UA.V.B.K6** Sources for airport data:
        - **UA.V.B.K6a** Aeronautical charts
        - **UA.V.B.K6b** Chart Supplements

REFERENCES

FAA Aeronautical Chart User's Guide
https://www.faa.gov/air_traffic/flight_info/aeronav/digital_products/aero_guide/media/editions/cug-complete.pdf

FAA Charts
https://www.faa.gov/air_traffic/flight_info/aeronav/digital_products/vfr/