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Training Manual for
FAA part 107 Remote Pilot
Small Unmanned Aircraft Systems

June 2019

NSF drone eelgrass mapping project along the west coast of North America

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1 Become a Drone Pilot

According to FAA.gov, in order to fly your drone under the FAA's Small UAS Rule (Part 107), you must obtain a Remote Pilot Certificate from the FAA. This certificate demonstrates that you understand the regulations, operating requirements, and procedures for safely flying drones.

1.1 Eligibility

To become a pilot, you must:

- Be at least 16 years old
- Be able to read, speak, write, and understand English
- Be in a physical and mental condition to safely fly a drone
- Pass the initial aeronautical knowledge exam
- Must be easily accessible by the remote pilot during all UAS operations
- Valid for 2 years. Certificate holders must pass a knowledge test every two years

1.2 Examination information

The examination has 64 questions, and each question is 3 multiple answer question. You need to get more than 70% to pass the examination. You can bring full function calculator.

You need to go to local site to take the test. For example, in Orlando, Call AVIATION INSTITUTE OF MAINTENANCE -ORLANDO 2725 S. US HIGHWAY 17/92 (407) 896-2800 to schedule the test. The site ID is: ORLANDO ABS32710

Information can be obtained from the FAA by phone, Internet/e-mail, or mail. To talk to the FAA tollfree 24 hours a day, call 1-866-TELL-FAA (1-866-835-5322). To visit the FAA's website, go to www.faa.gov. Individuals can also contact an FAA representative at faadronezone.faa.gov.

1.3 Reference material

Almost all reference material is available online at www.faa.gov in downloadable format. Commercial aviation publishers also provide published and online reference material to further aid the aviation pilot.

2 Preparing the Examination

This section we are going to learn the knowledge for preparing the drone examination. Including learn the airspace concepts, weather sources and radio communications, sectional charts, and drone physics. Figures of this section are from FAA Small Unmanned Aircraft Systems Study Guide.

2.1 Remember the numbers

- 0.55Lbs Minimum UAS to register
- 55 maximum UAS to register
- 13 age to register
- 16 age to take the test
- License valid for 24 months
- 400 feet above ground, or 400 AGL above a structure (varies).
- 500 feet below clouds
- 2000 feet horizontally from clouds
- 2000 feet horizontally from guy wires
- 100 mph max speed
- 3 SM visibility
- 8 hours without alcohol
- 0.04 blood alcohol level
- 1 year after narcotic conviction
- 30 minutes within civil twilight (30 minute before/after sunset/sunrise)
- $500 minimum damage for FAA report, 10 days to file FAA report

2.2 Weather sources and radio communication

2.2.1 Weather

- Density altitude
  As the density of the air increases (lower density altitude), aircraft performance increases. Conversely, as air density decreases (higher density altitude), aircraft performance decreases. A decrease in air density means a high density altitude; an increase in air density means a lower density altitude. Density altitude has a direct effect on aircraft performance.
- Fronts – divide weather
  As air masses move out of their source regions, they come in contact with other air masses of different properties. The zone between two different air masses is a frontal zone or front. Across this zone, temperature, humidity and wind often change rapidly over short distances.
- Wind shear – sudden change of wind
- Structural icing
  Two conditions are necessary for structural icing in flight: 1. The aircraft must be flying through visible water such as rain or cloud droplets 2. The temperature at the point where the moisture strikes the aircraft must be 0° C or colder.
- TS life cycle – cumulus, mature, dissipating
  It is virtually impossible to visually detect the transition from one stage to another; the transition is subtle and by no means abrupt. Furthermore, a thunderstorm may be a cluster of cells in different stages of the lifecycle.
- Humidity – less visibility, more efficient
- Unstable air – hot & humid
- Stable air – poor visibility, steady rain
- Nimbus – big heavy cloud

2.2.2 Radio frequencies

- CTAF
  A CTAF is a frequency designated for the purpose of carrying out airport advisory practices while operating to or from an airport without an operating control tower.
- MultiCOM 122.9 or 122.95
  A MULTICOM frequency of 122.9 will be used at an airport that is non-towered and does not have a FSS or UNICOM.
- UNICOM
  Most non-towered airports will have a UNICOM frequency, which is usually 122.8.
- AWOS weather

2.2.3 NOTAM (Notices to Airmen)

- 1800WXBrief.com

2.2.4 METAR (Meteorological Aviation Report)

Example: METAR KGGG 161753Z AUTO 14021G26KT 3/4SM +TSRA BR BKN008 OVC012CB 18/17 A2970 RMK PRESFR

- UTC time
- Windspeed
- 3/4SM – visibility
- BKN008 – cloud cover
- 18/17 Celsius

2.2.5 TAF (Terminal Aerodrome Forecast)

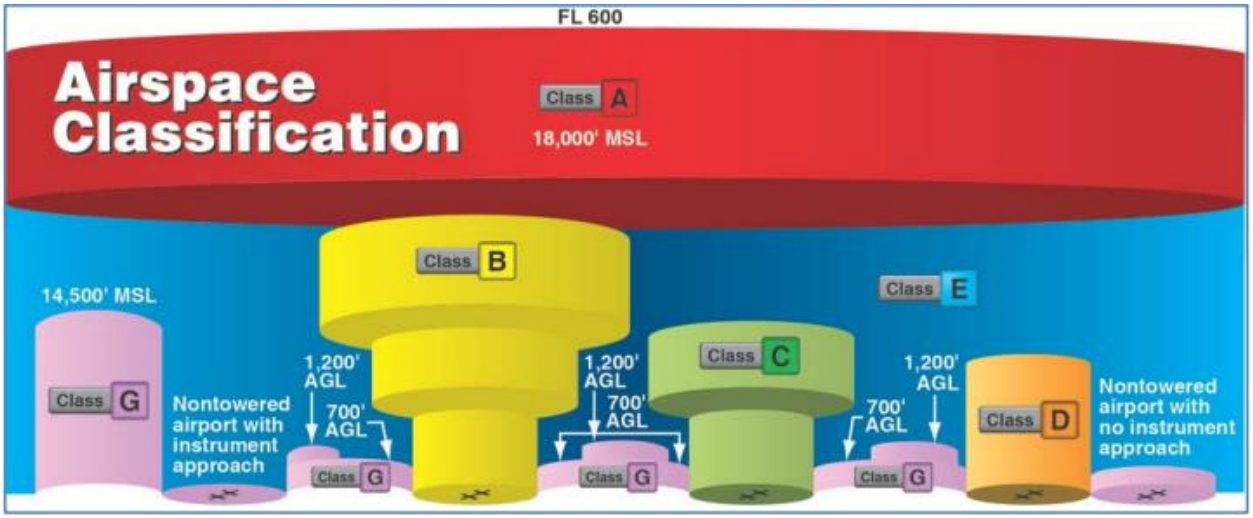
Example: TAF KPIR 111130Z 1112/1212 TEMPO 1112/1114 5SM BR FM1500 16015G25KT P6SM SCT040 BKN250 FM120000 14012KT P6SM BKN080 OVC150 PROB30 1200/1204 3SM TSRA BKN030CB FM120400 1408KT P6SM SCT040 OVC080 TEMPO 1204/1208 3SM TSRA OVC030CB

- Z – UTC time code
- KT – wind speed

2.2.6 Pilot's alphabet/Aviation alphabet

- Alpha
- Bravo
- Charlie
- Delta
- Echo
- …

2.3 Learn what is Airspace (Class A, B, C, D, etc.)

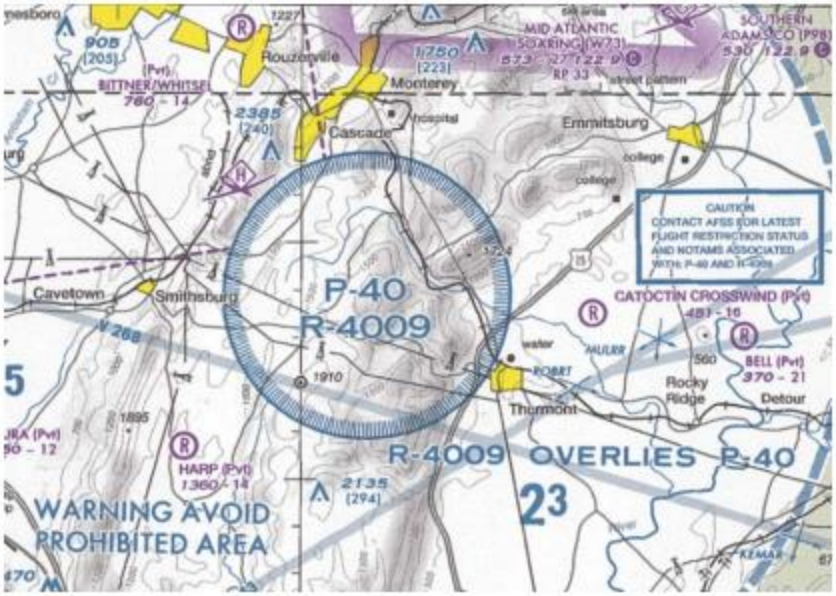


- Permission from ATC

Controlled airspace is a generic term that covers the different classifications of airspace and defined dimensions within which air traffic control (ATC) service is provided in accordance with the airspace classification. Controlled airspace that is of concern to the remote pilot is:

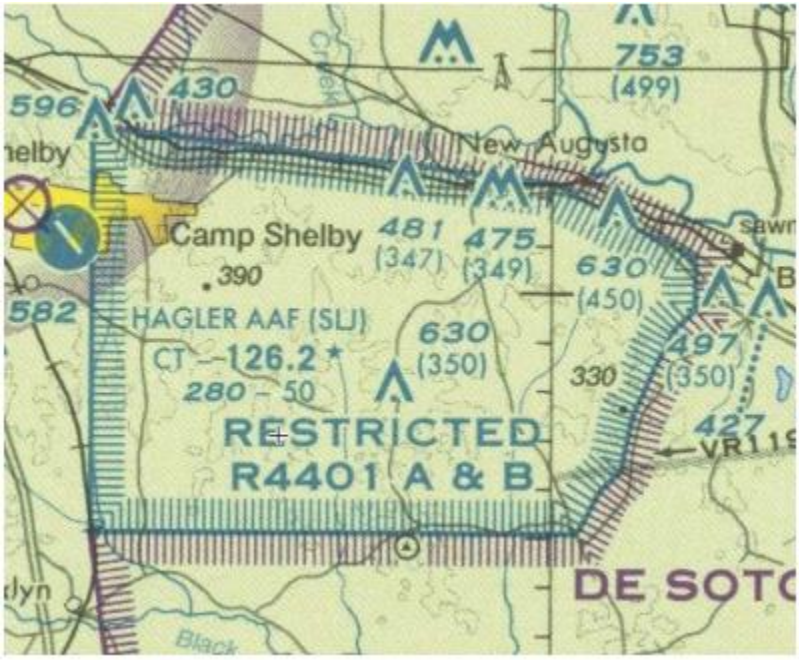
- Class B airspace: major airports.
  Class B airspace is generally airspace from the surface to 10,000 feet mean sea level (MSL)
- Class C airspace: small airports.
  Class C airspace is generally airspace from the surface to 4,000 feet above the airport elevation (charted in MSL)
- Class D airspace: very small airports.
  Class D airspace is generally airspace from the surface to 2,500 feet above the airport elevation (charted in MSL)
- Class E Airspace Class E airspace is the controlled airspace not classified as Class A, B, C, or D airspace.
- Uncontrolled Airspace Class G Airspace Uncontrolled airspace
  Class G airspace is the portion of the airspace that has not been designated as Class A, B, C, D, or E. It is therefore designated uncontrolled airspace. Class G airspace extends from the surface to the base of the overlying Class E airspace. A remote pilot will not need ATC authorization to operate in Class G airspace.

- Prohibited Areas
  Prohibited areas contain airspace of defined dimensions within which the flight of aircraft is prohibited.



- Restricted Areas

  Restricted areas are areas where operations are hazardous to nonparticipating aircraft and contain airspace within which the flight of aircraft, while not wholly prohibited, is subject to restrictions.



- Military Training Routes (MTR/IR/VFR)

  MTRs are routes used by military aircraft to maintain proficiency in tactical flying. Routes are identified as IFR (IR), and VFR (VR), followed by a number.

- Military Operations Areas (MOAs)

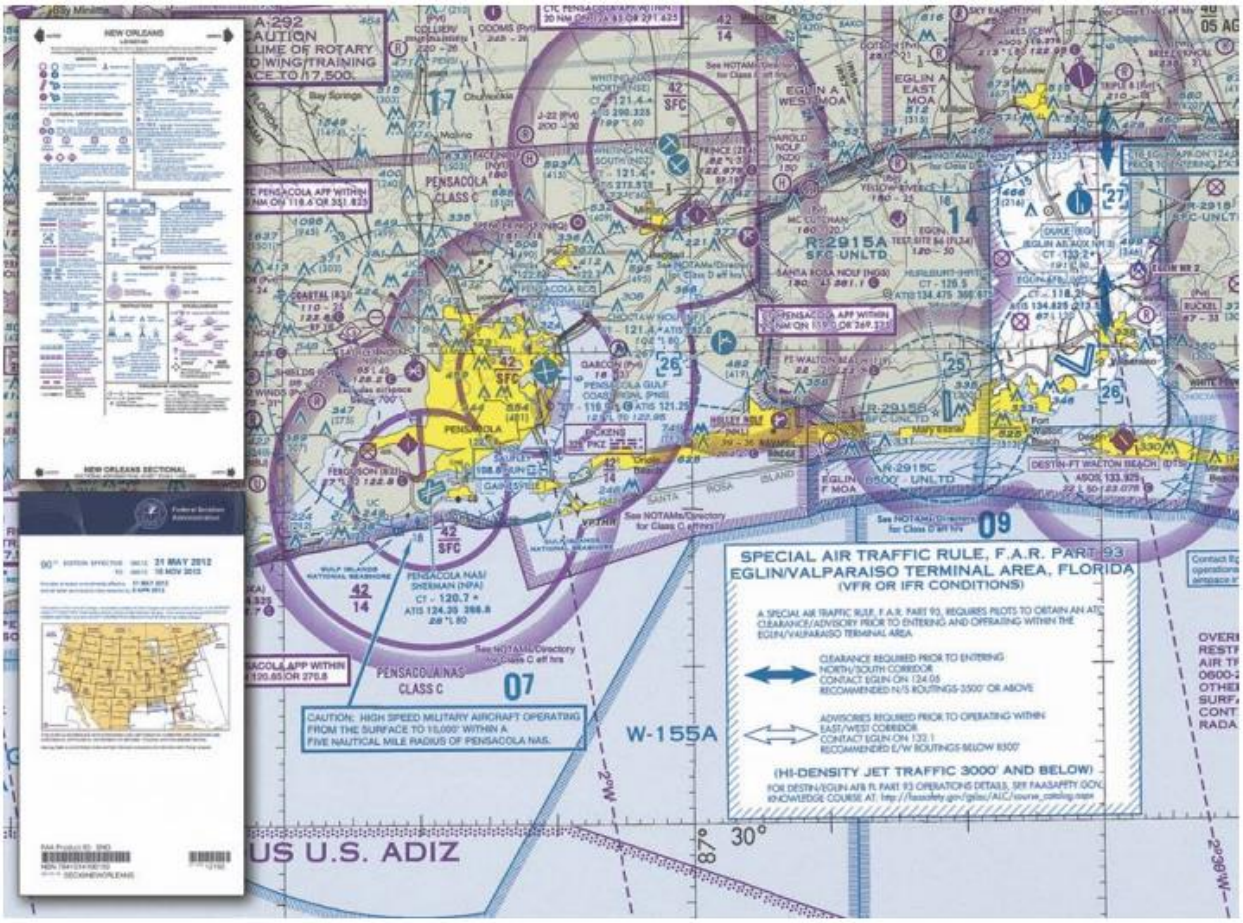
  MOAs consist of airspace with defined vertical and lateral limits established for the purpose of separating certain military training activities from IFR traffic.

2.4 Recognize the sectional charts

2.4.1 sectional chart and legend

Sectional charts are the most common charts used by pilots today. The charts provide an abundance of information, including airport data, navigational aids, airspace, and topography. Below is an excerpt from the legend of a sectional chart.

When taking the exam, pay attention on the chart legend! Most of the information can be looked up on the legend. By referring to the chart legend, a pilot can interpret most of the information on the chart. A pilot should also check the chart for other legend information, which includes air traffic control (ATC) frequencies and information on airspace. These charts are revised semiannually except for some areas outside the conterminous United States where they are revised annually.



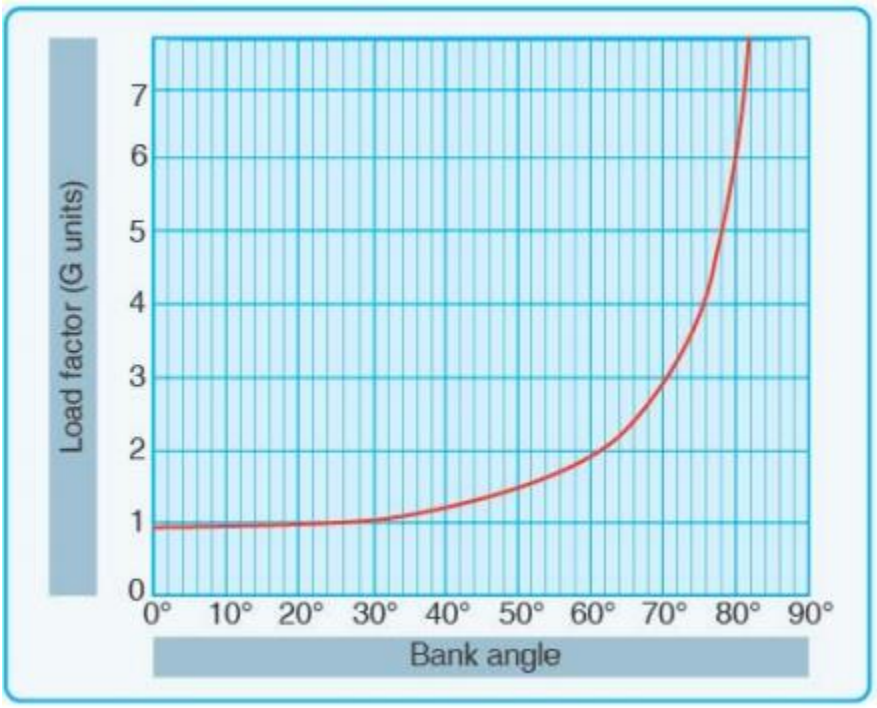
2.4.2 Latitude and Longitude (Meridians and Parallels)

The equator is an imaginary circle equidistant from the poles of the Earth. Circles parallel to the equator (lines running east and west) are parallels of latitude. They are used to measure degrees of latitude north (N) or south (S) of the equator. The angular distance from the equator to the pole is one-fourth of a circle or 90°. The 48 conterminous states of the United States are

located between 25° and 49° N latitude. Any specific geographical point can be located by reference to its longitude and latitude. Washington, D.C., for example, is approximately 39° N latitude, 77° W longitude. Chicago is approximately 42° N latitude, 88° W longitude.

2.5 Airplane physics and drone manipulations

2.5.1 Load factor



Turns—the load factor increases at a terrific rate after a bank has reached 45° or 50°. The load factor for any aircraft in a coordinated level turn at 60° bank is 2 Gs. The load factor in an 80° bank is 5.76 Gs. The wing must produce lift equal to these load factors if altitude is to be maintained.

2.5.2 Emergency procedures

- A remote pilot is responsible for the safe operation of the small UA at all times.
- Before every flight, a remote pilot will conduct a preflight inspection of the aircraft.
- When a remote pilot does experience an inflight emergency, the pilot may take any action to ensure that there is not a hazard to other people or property.
- PIC is responsible all the time.
- PIC can supervise other people to manipulate the drone.
- 2.4.3 Performance of Small UAV
- Increasing the temperature of a substance decreases its density. Pilots can expect the density to decrease with altitude.

- As the water content of the air increases, the air becomes less dense, increasing density altitude and decreasing performance.

2.5.3 Vision and Flight

To scan effectively, pilots must look from right to left or left to right. They should begin scanning at the greatest distance an object can be perceived (top) and move inward toward the position of the aircraft (bottom). For each stop, an area approximately 30° wide should be scanned. The duration of each stop is based on the degree of detail that is required, but no stop should last longer than 2 to 3 seconds. When moving from one viewing point to the next, pilots should overlap the previous field of view by 10°.

2.5.4 Risk Management

- Anti-authority
  Antidote: Follow the rules.
- Impulsivity
  Antidote: Not so fast, think first.
- Invulnerability
  Antidote: It could happen to me
- Macho
  Antidote: taking chances is foolish
- Resignation
  Antidote: I'm not helpless. I can make a difference.

3 Sample Questions

The FAA published the following 24 sample questions as study material for the Remote Pilot Recurrent Knowledge Test. These questions represent the type of questions found on the test, but are not actual test questions.

1. A small UA causes an accident and your crew member loses consciousness. When do you report the accident?

A) No accidents need to be reported
B) When requested by the UA owner
C) Within 10 days of the accident

As a Remote PIC, you are required to report a qualifying accident to the FAA within 10 days. This is really important. According to the FAA, an accident is defined as:

1) At least serious injury to any person. By serious, they mean injuries like a loss of consciousness, a skin laceration that requires suturing, a broken bone, or head trauma.
2) Damage to any property (other than the small UA) if the cost is greater than $500 to either repair or to replace the property, whichever number is lower.

If either of these two conditions is met, the accident report must be made within 10 calendar days of the operation that created the injury or damage. It can either be submitted electronically at http://faa.gov/uas, by calling your FAA Regional Operations Center (ROC) or by calling or visiting your nearest jurisdictional Flight Standards District Office (FSDO).

2. A small UA must be operated in a manner which

A) does not endanger the life or property of another
B) requires more than one visual observer
C) never exceeds 200 feet AGL

It goes without saying that no person may operate an sUAS in a careless or reckless manner that endangers another person's life or property. This has been the primary principle cited by the FAA in many of its investigations and enforcement actions.

3. You plan to release golf balls from your small UA at an altitude of 100 feet AGL. You must ensure the objects being dropped will

A) not create an undue hazard to persons or property
B) land within 10 feet of the expected landing zone
C) not cause property damage in excess of $300

It goes without saying that no person may operate an sUAS in a careless or reckless manner that endangers another person's life or property. This has been the primary principle cited by the FAA in many of its investigations and enforcement actions.

This is a good example of a question where the most conservative/safest answer choice is the correct one.

4. After having dinner and wine, your client asks you to go outside to demonstrate the small UAs capabilities. You must

A) pass a self-administered sobriety test before operating a small UA
B) not operate a small UA within 8 hours of consuming any alcoholic beverage

C) ensure that your visual observer has not consumed any alcoholic beverage in the previous 12 hours

The Part 107 regulations state that the pilot's blood alcohol level needs to be less than .04 percent, and at least 8 hours need to pass between drinking alcohol and piloting an unmanned aircraft (or taking part as another crewmember).

A remote pilot with a blood alcohol level of .04 percent or greater after 8 hours cannot fly until the blood alcohol falls below that amount. Even though blood alcohol may be well below .04 percent, a pilot cannot fly sooner than 8 hours after drinking alcohol. Although the regulations are quite specific, it is a good idea to be more conservative than the regulations.

5. During a flight of your small UA, you observe a hot air balloon entering the area. You should

A) yield the right-of-way to the hot air balloon
B) ensure the UA passes below, above, or ahead of the balloon
C) expect the hot air balloon to climb above you altitude

When it comes to other larger aircraft you might encounter, from helicopters to gliders, powered parachutes, and balloons, you and your sUAS should yield right of way.

6. (Refer to FAA-CT-8080-2H, Figure 78.) You have been hired to use your small UAS to inspect the railroad tracks from Blencoe (SE of Sioux City) to Onawa. Will ATC authorization be required?

A) Yes, Onawa is in Class D airspace that is designated for an airport
B) No, your entire flight is in Class G airspace
C) Yes, you must contact the Onawa control tower to operate within 5 miles of the airport

Once you've identified Blencoe and Onawa in the southeastern part of the map, you'll notice that there's no controlled airspace between both locations. It's Class G airspace from the ground up to 1,200 ft. AGL, and no permission is required during your flight operation.

7. According to 14 CFR part 107, what is the maximum groundspeed for a small UA?

A) 87 knots
B) 87 mph
C) 100 knots

Under Part 107, a Remote Pilot-in-Command cannot fly an unmanned aircraft faster than 100 mph, or 87 knots.

8. (Refer to FAA-CT-8080-2H, Figure 78.) You have been contracted to inspect towers located approximately 4NM southwest of the Sioux Gateway (SUX) airport operating an unmanned aircraft. What is the maximum altitude above ground level (AGL) that you are authorized to operate over the top of the towers?

A) 400 Feet AGL
B) 402 feet AGL
C) 802 feet AGL

This is a great question. After locating Sioux Gateway (SUX) airport, you can use the scale at the bottom of the Sectional Chart excerpt to measure 4NM southwest. You should see a cluster obstruction / tower icon with two heights being shown, 1,498 ft. MSL and 402 ft. AGL.

So the topmost part of the highest tower in that cluster sits at 402 ft. AGL…and remember that under the Part 107 regulations, you're allowed to fly up to 400 ft. over the topmost part of the tower. So the correct answer is 402 + 400 = 802 feet AGL.

9. Upon request by the FAA, the remote pilot-in-command must provide

A) a logbook documenting small UA landing currency
B) a remote pilot certificate with a small UAS rating
C) any employer issued photo identification

At the end of the day, any officer of the FAA (that includes law enforcement) is allowed to make any test or inspection of what you're up to. The unmanned aircraft system, the remote PIC, your visual observer, your flight logs, and any other documents, records, or reports need to comply with the applicable FAA regulations. You name it — they can check it.

This question is somewhat tricky. While you're technically supposed to be keeping a logbook, the "landing currency" phraseology is more fit for manned aircraft pilots, who have to maintain a minimum number of flights to keep their license current. The more correct choice is "a remote pilot certificate with a small UAS rating."

10. The refusal of a remote PIC to submit to a blood alcohol test when requested by a law enforcement officer

A) is grounds for suspension of revocation of their remote pilot certificate
B) can be delayed for a period up to 8 hours after the request
C) has no consequences to the remote pilot certificate

You can lose your remote pilot certificate and/or not be allowed to apply for a certificate in the first place for up to one year if there's been any recent federal or state alcohol or drug violations. That includes refusing to submit to a blood alcohol test.

11. (Refer to FAA-CT-8080-2H, Figure 25, Area 3.) The floor of Class B airspace at Dallas Executive (RBD) is

A) at the surface
B) 3,000 feet MSL
C) 3,100 feet MSL

Dallas Executive (RBD) sits in Class D airspace from the surface up to 3,000 ft. MSL (blue-dashed lines), and then at 3,000 ft. MSL, it becomes Class B airspace. We know this because of the 110/30 fraction next to the airport icon. This indicates that in this closed-off part of the blue solid Class B lines, this particular area of Class B airspace starts at 3,000 ft. MSL and goes up to 11,000 ft. MSL.

12. (Refer to FAA-CT-8080-2H, Figure 23, Area 3.) What is the floor of the Savannah Class C airspace at the shelf area (outer circle)?

A) 1,300 feet AGL
B) 1,300 feet MSL
C) 1,700 feet MSL

First, identify both the inner circle and outer magenta solid line circles around Savannah airport. Then, look for the fraction that shows 41/13. This indicates that in this outer portion of Class C airspace, the floor of the airspace is 1,300 ft. MSL, and the ceiling of the airspace is 4,100 ft. MSL.

13. (Refer to FAA-CT-8080-2H, Figure 78. Near the center of the figure.) What class of airspace is associated with SIOUX GATEWAY/COL DAY (SUX) Airport?

A) Class B airspace
B) Class C airspace
C) Class D airspace

We know that SIOUX GATEWAY/COL DAY (SUX) Airport sits in Class D airspace because of the blue-dashed circle around the airport. Remember that Class D airspace always starts at the surface, and you can look at the number in the brackets to see what height the Class D airspace goes up to.

14. (Refer to FAA-CT-8080-2H, Figure 20, Area 1.) The Fentress NALF Airport (NFE) is in what type of airspace?

A) Class C
B) Class E
C) Class G

We know that Fentress NALF Airport (NFE) sits in Class E airspace because of the magenta-dashed circle around the airport. This indicates Class E airspace starting at the surface.

15. (Refer to FAA-CT-8080-2H, Figure 75, Area 6.) During preflight planning, you plan to operate in R-2305. Where would you find additional information regarding this airspace?

A) In the Aeronautical Information Manual
B) In the Charts Supplements U.S.
C) In the Special Use Airspace area of the chart

R-2305 is a Restricted Area. More information about Restricted Areas can be found on the border of a Sectional Chart. There's a lot of information that is shared in the border, including a Special Use airspace section for areas like R-2305.

16. (Refer to FAA-CT-8080-2H, Figure 21.) You have been hired by a farmer to use your small UA to inspect his crops. The area that you are to survey is in the Devil`s Lake West MOA, east of area 2. How would you find out if the MOA is active?

A) Refer to the chart legend
B) This information is available in the Small UAS database
C) Refer to the Military Operations Directory

An MOA is a Military Operating Area. More information about MOAs can be found on the border of a Sectional Chart. You'll see information like the name of the MOA, the operating altitude and time of use, the radio frequency and the controlling agency/contact facility that manages the MOA.

17. (Refer to FAA-CT-8080-2H, Figure 23, Area 4.) What is the required flight visibility for a remote pilot operating an unmanned aircraft near the Plantation Airport (JYL)?

A) 5 statute miles
B) 1 statute mile
C) 3 statute miles

This is kind of a trick question. You can't find visibility requirements on a sectional chart. The minimum visibility for any sUAS operations is always 3 statute miles (SM), no matter where you are flying. It's a regulations question, not a sectional chart question. The chart is a red herring meant to throw you off. We're not huge fans of this question, but this is a good representation of the kind of trickery you may experience on the FAA's Aeronautical Knowledge Test.

18. (Refer to FAA-CT-8080-2H, Figure 21, Area 1.) After receiving authorization from ATC to operate a small UA near Minot International airport (MOT) while the control tower is operational, which radio communication frequency could be used to monitor manned aircraft and ATC communications?

A) UNICOM 122.95
B) ASOS 118.725
C) CT-118.2

The radio frequency that sUAS operators can tune into to listen to manned aircraft chatter from incoming or outgoing pilots is called the Common Traffic Advisory Frequency (CTAF).

The CTAF frequency is always going to be to the left of the circle C icon.

After locating the Minot International airport (MOT) icon on the chart, look for the airport information text next to the icon. Remember that in the testing supplement legend, you're actually being told exactly where a lot of information is on the Sectional Chart.

In this example, the CTAF is 118.2, which also happens to be the Control Tower frequency. That's why you're seeing "CT" in the answer choice instead of "CTAF."

19. (Refer to FAA-CT-8080-2H, Figure 24, Area 6.) What type of airport is Card Airport?

A) Public towered
B) Public non-towered
C) Private non-towered

Do you see the "PVT" next to the name of the airport? This indicates that CARD Airport is a private airport. And the magenta coloring means that this is a non-towered airport.

20. (Refer to FAA-CT-8080-2H, Figure 20, Area 4.) A small UA is being launched 2 NM northeast of the town of Hertford. What is the height of the highest obstacle?

A) 399 feet MSL
B) 500 feet MSL
C) 500 feet AGL

Once you find Hertford — you'll see the text on the chart, as well as yellow shading which indicates population density — use the scale at the bottom of the Sectional Chart excerpt to measure 2 NM northeast. You'll see a few different tower icons…the highest one is either 514 ft. MSL or 500 ft. AGL. Since the AGL choice is being offered as an answer, that's the correct one.

21. (Refer to FAA-CT-8080-2H, Figure 24, Area 3, and Legend 1.) For information about the parachute operations at Tri-County Airport, refer to

A) notes on the border of the chart
B) Chart Supplements U.S.
C) the Notices to Airmen (NOTAM) publication

The Chart Supplement U.S., formerly called the Airport/Facility Directory, provides the most comprehensive information on a given airport. It contains information on airports, heliports, and seaplane bases that are open to the public. It's published across seven books, and the information in each of these books is updated every couple of months. You can access these charts digitally by using a tool like http://skyvector.com and clicking into the airport icon.

Chart Supplements are great for learning more about things like parachute drop zones or glider operations, traffic pattern information, operating hours, noise abatement, and really any other information about an airport that doesn't fit into the nice and colorful Sectional Chart. It's a great resource to keep in your back pocket when doing airspace research and flight mission planning.

22. What precautions should a remote PIC do to prevent possible inflight emergencies when using lithium-based batteries?

A) Store the batteries in a freezer to allow proper recharging
B) Follow the manufacturer's recommendations for safe battery handling
C) Allow the battery to charge until it reaches a minimum temperature of 100 °C

Always store your LiPo batteries in a cool, dry place. Shoot for room temperature. Do not store them in a hot garage or in a refrigerator or freezer.

This is a good example of where the most conservative answer choice is correct — "Follow the manufacturer's recommendations for safe battery handling." This is a much stronger choice compared to the other two options.

23. When a remote pilot-in-command and a visual observer define their roles and responsibilities prior to and during the operation of a small UA is a good use of

A) Crew Resource Management
B) Authoritarian Resource Management
C) Single Pilot Resource Management

The definition of Crew Resource Management (CRM) is "the effective use of all available resources—human, hardware, software and information—prior to and during flight to ensure the successful outcome of the operation."

24. What actions should the operator of an sUAS do if the manufacturer does not provide information about scheduled maintenance?

A) The operator should contact the FAA for a minimum equipment list
B) The operator should establish a scheduled maintenance protocol
C) The operator should contact the NTSB for component failure rates for their specific sUAS

If your UA manufacturer does not provide a maintenance schedule, you'll need to establish your own scheduled maintenance protocol.