Part 107 Remote Pilot knowledge test study materials

Adapted from content from PLS 198: Drones in Agriculture Slides and course by Travis Parker; UC Davis

Outline

- I. FAA regulations
- II. Airspace and VFR sectionals
- III. Weather
- IV. Aerodynamics and performance
- V. Traffic, risk management, and other important information

This covers stuff that WILL be on the certification test. Will you need all of it for safe drone operation? Nah.

But study up, get certified, and have a great time flying



Part 107 Remote Pilot in Command (RPIC) certification

- 60 question knowledge test for certification
 - Multiple choice
 - Three answers/question
 - 70% needed to pass (but seriously... let's do better than that)
- Required for *commercial*, but not *hobby/recreational* operations
 - Anything related to your source of income, that is not intended as a form of relaxation, is "commercial". This includes all university research

https://www.faa.gov/uas/commercial_operators/become_a_drone_pilot



Mwiinga operating that drone on beast mode

I. FAA regulations

- Who is eligible?
- Must be 16+ years old
- Must read, write, speak, and understand English (certain medical exceptions)
- Physical/mental state does not interfere with UAS operation
- Pass test
- Certificate valid for two years
- Already a pilot? Separate free course → safetyfaa.gov



Burcu in the cannabis field... in a mental state to fly?

This is what happens when she suggests I should "make my slides more interesting!"

Crew-related vocabulary

- **Remote Pilot in Command**: Person holding current remote pilot certificate, final responsibility for all operations
 - Test hint: If you ever get a question regarding "who is responsible for...", the answer is almost always the remote RPIC!
- Visual observer (VO): Crewmember that assists with see-and-avoid policy, extra eyes on the sky and objects on the ground

Visual observers

- Person manipulating the controls: Person operating the craft under direct RPIC supervision
- Flight crew: All of the above
- Flight crew can be made of just one RPIC, but more people increases situational awareness



Remote Pilot in Command Person manipulating the controls

Responsibilities of the RPIC

- <u>Everything! A classic test question.</u> The Remote Pilot is responsible for literally everything. Always. Did I already say... everything?
 - Detailed version:
 - See and avoid: Manned aircraft always have priority, no exceptions!
 - No member of crew may be intoxicated or in any way under the influence of drugs, including alcohol
 - Ensuring aircraft is airworthy
 - **Visual line of sight (VLOS):** Required with only very brief exceptions (e.g. drone passing behind telephone pole)
 - Maintain awareness of surroundings: Know where aircraft is and what airports, activity and property may affect your flight
 - Airspace: Know airspace approval if needed
 - Waivers: If rules must be waived



Some people prefer to fill their wallets with cash. Instead I have this swag 😎 😎 😁

Documents

- Basic
 - Pilot certificate
 - Aircraft registration
 - Waivers, authorization, or other documentation
- Modifications
 - Have a record of modifications, repairs, and other aircraft service
 - Firmware must be up-to-date, otherwise aircraft is deemed non-airworthy
- Log time
- Unique aircraft identifier on aircraft
 - Accessible without tools
- These can be kept electronically





Night flights

- No night flights
- Specifically, no flights between end of evening civil twilight (=30 mins after sunset) and beginning of morning civil twilight (=30 mins before sunrise)
- For operations during civil twilight, anti-collision lights visible for 3 miles

Enrique Iglesias hurting himself playing with a drone at a concert... at night. Don't be like Enrique. Fly during the day



Visibility

- Visibility from ground station must be ≥ 3 statute miles
- No flights near clouds: 2000 feet horizontally, 500 feet vertically
- Unassisted VLOS (except glasses)
- Binoculars and other vision aids may only be used momentarily to increase awareness



Flight restrictions

- Max groundspeed: **100mph = 87 knots**
- Max altitude: Maximum altitude of **400 feet above ground level** (AGL) *unless* within 400 feet of a structure



Weight

• sUAS = 0.55lbs up to but NOT INCLUDING 55lbs

• You have a UAS that weighs exactly 55 pounds. Can you fly it with a Part 107 remote pilot certificate?

• ... NO!

Right-of-way

• The short version: Airplanes have it. You don't.*

No flights over people

- Conduct operations in sparsely populated areas whenever possible
- Develop crowd control plan
- Take reasonable precautions to keep non-participants out of operating area

Operations from moving vehicles

- Operating from a car?
- OK!
- Operating from a **boat**?
- OK!
- Operating from an aircraft?
- ...not such a good idea





In the video, these people get ouchies

NR

Operations from moving vehicles

- Operating from a car?
- OK!
- Operating from a **boat?**
- OK!
- Operating from an aircraft?
- ...not such a good idea
- BUT... operations from boats and cars must be done in **sparsely populated areas** and with a plan to keep non-participants clear of aircraft
- No using UAS flights from moving vehicle to move other persons property







However...

- Moving other people's property is legal as long as:
 - It is not done from a moving vehicle
 - The property is **not dropped**
 - Total weight of UAS and cargo <55 lbs
 - Done within state lines
 - No "undue hazards"



Certificate of waiver and airspace authorization

- Waivers allow you to get around most of these rules if approved by the FAA
- You need to demonstrate your ability to conduct the operation safely
- Start waiver process 90 days in advance.
- Authorization allows you to fly in airspace where UAS are not allowed to be flown
- Must also apply to the FAA
- Issued up to 6 months
- Need it for more than 6 months? You can get a waiver for that (strange technicality)
- If approved, bring your paperwork when you fly!
- <u>A</u>irspace <u>A</u>uthorization, Waive a rule

Hobbyist drone flights:

If you are on this page... This isn't you



Aircraft registration

- Registration is simple and easy
 - \$5/aircraft
 - Takes two minutes
 - Card with registration info is available immediately
- The FAA wants this to be a simple process
- registermyuas.faa.gov
- Display the registration number on the UAS so that it can be seen/accessed "without tools," e.g. in the battery compartment is okay



Small UAS Certificate of Registration Name: University of California, Davis Manufacturer: DJI Model: Matrice 100 Serial Number: FA181553080666 Certificate Number: FA33EAKP4K Issued: 03/26/2018 Expires: 03/26/2021

II. Airspace & Sectional Charts

How do I find out the class of airspace I want to fly in?



A - Above

Wedding Cakes: B - Big C - Classy D - Dinky

G - Ground E - Everywhere Else



Skyvector.com



How are airspace boundaries shown on VFR sectionals?

- Class B: Thick <u>B</u>lue line
- Class C: Thick <u>C</u>rimson/red line
- Class D: Dashed blue line
- Class E: Red dashed line (When it extends to surface) or red hazy line (700 feet AGL)
- Notice: alternating Blue/Red/Blue/Red with size of airport

Airspace & Sectional Charts

Class A airspace

- <u>A</u>irliners cruise here
- Extends from 18,000 MSL to 60,000 ft (above Mean Sea Level (MSL))
 - Way above where you can fly a sUAS, so less common on knowledge test





Note: Terminal Aeronatical Charts (TACs) useful for busiest areas











Special-use airspace

- Prohibited airspace
 - Highly restricted, no flights (few nationally)
 - Blue hashmarks, P-##
- Restricted airspace
 - Blue hashmarks, R-####
 - Think artillery, missiles, military bombardment
 - "Hot" = in use that day. No chance of flight approval
 - "Cold" = not in use. Possible approval.
- Military operations area (MOA)
 - Magenta hashmarks
 - Often involves aerial acrobatics
 - Use extreme caution

• Warning area

- Blue hashmarks, W-###
- Off the coasts, could be goofballs out there
- Alert area
 - Okay to fly, just be aware of common activities (e.g. skydiving site)
 - A-###





VFR Advsy - VFR Advisory Service shown where ATIS not available and frequency is other than primary CT frequency.

F.A.R. 91

Location

Identifier

UNICOM

285 Elevation in feet

- L Lighting in operation Sunset to Sunrise
- *L Lighting limitations exist, refer to Airport/Facility Directory.
- 72 Length of longest runway in hundreds of feet; usable length may be less.

When facility or information is lacking, the respective character is replaced by a dash. All lighting codes refer to runway lights. Lighted runway may not be the longest or lighted full length. All times are local.

Unverified

Heliport

Selected

Abandoned - paved having landmark value, 3000 ft. or greater

Flight Park Selected

Ultralight

Services-fuel available and field tended during normal working hours depicted by use of ticks around basic airport symbol. (Normal working hours are Mon thru Fri 10:00 A.M. to 4:00 P.M. local time.) Consult A/FD for service availability at airports with hard-surfaced runways greater than 8069 ft.

Provide the second in operation Sunset to Sunrise.





NOTICE: Guy wires may extend outward from structures.



Avoid skeletal structures by 2000 feet

A few other important VFR Symbols



=From 1500 to Top (meaning bottom of next layer)



=VOR, navigational aid for manned aircraft



=Mode C veil for manned aircraft, doesn't affect airspace or sUAS

Military training routes and civilian routes

What does IR218 represent? What does VR1265 represent?





TFRs and NOTAMs

- Temporary Flight Restrictions (TFRs): Flying over certain areas prohibited, including major public events (including UCD football games), appearances by public figures, natural disasters, and military activity
 - It is extremely important to not fly in a TFR!!! Easy way to lose certificate!
 - I recommend Skyvector for these, tfr.faa.gov also works
- Notices to Airmen (NOTAM): These let you know about unusual activity or circumstances that might affect flight, such as other sUAS use or aerial acrobatics
 - Can be accessed at pilotweb.nas.faa.gov

III. Weather

- We will learn to read:
 - METARs
 - Terminal Aerodrome Forecasts
- Stable vs. unstable air
- Clouds and fog

METAR

- Almost guaranteed to be on test!
- Can be found on most weather websites, including aviationweather.gov
- Check it out! KEDU = UC Davis airport

METARs (example 1)



So what does this mean?

At KEDU (UC Davis airport) on the first day of the month at 23:35 Zulu time, the auto-generated report showed wind coming from 0 degrees from north at 0 knots. Visibility was 10 statute miles with clear skies. The temperature was 25°C and dew point was 8°C. The pressure correction was 29.83 in. Hg and the station type was A01

METARs (example 2)

KEDU 122155Z COR 13510KT 15SM FEW030 SCT070 BKN110 OVC150 12/M09 A2998 RMK LAST COR 2215

COR = Corrected

FEW030 SCT070 BKN110 OVC150 = Few clouds at 3000 AGL, scattered clouds at 7000 AGL, broken clouds at 11000 AGL, and overcast at 15000 AGL

CLR = Clear (automated report); FEW = Few (1/8 to 2/8 of sky covered); SCT = Scattered (3/8 to 4/8 of sky covered); BKN = Broken (5/8 to 7/8 of sky covered); OVC = Overcast (total sky coverage). "Ceiling" is lowest broken or overclast cloud layer

M09 = Dew points is -09 degrees C

LAST COR 0015 = Last corrected 15 minutes past the hour

Intensity	-	Light intensity	blank	Moderate intensity
Intensity	+	Heavy intensity	VC	In the vicinity
Descriptor	MI	Shallow (French: Mince)	PR	Partial
Descriptor	BC	Patches (French: Bancs)	DR	Low drifting
Descriptor	BL	Blowing	SH	Showers
Descriptor	TS	Thunderstorm	FZ	Freezing
Precipitation	RA	Rain	DZ	Drizzle
Precipitation	SN	Snow	SG	Snow Grains
Precipitation	IC	Ice Crystals	PL	Ice Pellets
Precipitation	GR " <u>GR</u> itty rain"	Hail (French: <i>Grêle</i>)	GS "<u>G</u>ritty <u>S</u>now"	Small Hail and/or Snow Pellets (French: <i>Grésil</i>)
Precipitation	UP	Unknown Precipitation		
Obscuration	FG	Fog	VA	Volcanic Ash
Obscuration	BR " <u>B</u> aby <u>R</u> ain"	Mist (French: Brume)	HZ	Haze
Obscuration	DU	Widespread Dust	FU " <u>Fu</u> mes"	Smoke (French: <i>Fumée</i>)
Obscuration	SA	Sand	РҮ	Spray
Other	SQ	Squall	РО	Dust or Sand Whirls
Other	DS	Duststorm	SS	Sandstorm
Other	FC	Funnel Cloud		
Time	В	Began At Time	E	Ended At Time
Time	2 digits	Minutes of current hour	4 digits	Hour/Minutes Zulu Time

Terminal aerodrome forecast

- General weather conditions for an area within 6 statute mile radius
- Like a METAR, but for 24 hours

KSMF 012341Z 0200/0224 16008KT P6SM SCT250 FM021300 34009KT P6SM SCT250 FM021800 33012G20KT P6SM SCT250

0200/0224 = From the second at midnight until the following midnight P6SM = Visibility 6 statute miles plus FM021300 = from the second at 1300Z 33012G20KT= winds from 330 degrees at 12 knots gusting to 20 knots

In the days of impossibly powerful god-like AI and routine weather websites, why are we still learning this? Because... reasons. Presumably

Weather briefs

- Manned aircraft are encouraged to call flight service station for weather briefs
- Can be done online or by calling 1-800-wx-brief
- Three kinds of weather briefing
 - Standard: Most complete weather information, plus notices about temporary activities that may affect flight
 - Abbreviated: updates for those who already have had standard briefing
 - Outlook: For forecast 6+ hours in the future

AWOS, ASOS, ATIS

- Airport information broadcasts, shown on VFR sectionals, provide weather and other airport info
- AWOS (Automated Weather Observing System)
- ASOS (Automated Surface Observing System)
- ATIS (Automatic Terminal Information Service)

Stable vs. unstable air

- Very common test questions!
- Stable air:
 - Stratiform (horizontal-layered) clouds
 - Lower visibility (think smog, fog, haze)
 - Slow, steady precipitation

• Unstable air

- Vertical clouds, cumulus/cumulonimbus
- Higher visibility (think of thunderstorms clearing away haze, smog)
- Inconsistent rain, as in thunderstorm



Fog types

- Radiation fog
 - As heat **radiates** into space (especially at night), water in air near ground precipitates, fog radiates more heat away causing deepening of fog layer
- Advection fog
 - Warm air blows over cool surface: here as air the cool rock is causing fog to form
- Upslope fog
 - Warm air cools as it moves up mountain
- Precipitation fog
 - When warm rain falls through cool air, evaporates and re-condenses





Clouds

- Low:
 - Stratus
 - Cumulus
 - Nimbostratus
 - Cumulonimbus
- Middle:
 - Altostratus
 - Altonimbus
- High:
 - Cirrus
 - Cumulus





IV. Aerodynamics and performance





Performance

- High performance corresponds with
 - High speed
 - High rate of climb
 - Higher maximum altitude
 - High maneuverability
 - Long endurance





Factors that decrease performance

- Weight
- High altitude*
- High density altitude*
 - Air density as far as performance is concerned
 - High density altitude is like flying at high altitude
 - Low density altitude is like flowing at low altitude
 - High temperature*
 - High humidity*
 - Water vapor is lighter on average than air, props have less to "push against"
 - Low pressure *
- Wind
- Obstacles

*reduces air density. Note that this reduces drag, but also reduces lift

Stalls

- All aircraft can stall
- Critical angle of attack is the point at which a stall begins



Load factor



Payloads

- No hazardous payloads
- Before each flight, RPIC must determine whether payloads are within limits allowed by craft, effects on **center of gravity** and performance will be, and consider effects of fuel burn if applicable



V. Traffic, risk management, and other important information









Airport traffic

- Numbered by direction they face relative to north, in tens of degrees
 - Runway 00 faces due north, runway 09 faces due west (090 degrees)



Compass Rose/Runway Orientation Overlay



Airport traffic patterns

- This is *suggested* for manned aircraft by the FAA
- Very important for monitoring radio



Radio traffic

- sUAS users should not report their activities via radio/CTAF
- Often it is a good idea to monitor the actions of manned aircraft to yield them the right-of-way
- Common Traffic Advisory Frequency (CTAF) for an airport indicated by

a©:



 The FCC regulates radio traffic. Many sUAS use 5.8 GHz for control and 2.4 GHz for imagery transmission. Lost links/flyaways may be due to interference in these wavelengths (WiFi)

Hazardous attitudes

- ON EVERY TEST!
- Impulsivity
 - "Do it quickly!"
- Invulnerability
 - "It won't happen to me"
- Macho
 - "Watch this!"
- Anti-authority
 - "Don't tell me..."
- Resignation
 - "What's the use?"











Drugs/alcohol

- You may not serve as ANY crewmember for an sUAS flight if you:
- Consumed any alcoholic beverage within the last eight hours
- Have a blood alcohol concentration of **0.04%** or greater
- Are **under the influence** of alcohol
- Are using a drug that affects your mental or physical capabilities
- FAA understanding is that it takes 3 hours for a standard drink to be metabolized fully

Risk Management 1

- Consider if any of the following may influence your ability to fly:
- 1) Illness
- 2) Medication
- 3) Stress
- 4) Alcohol
- 5) Fatigue
- 6) Emotional state

Risk Management 2

- **PAVE** is an acronym for things to consider before flight:
- <u>P</u>ilot
 - See previous slides
- <u>A</u>ircraft
 - Consider your familiarity with the aircraft, and its maintenance and firmware status
- en<u>V</u>ironment
 - Weather, airspace, terrain
- <u>E</u>xternal pressure
 - The need to impress is a particularly powerful motivator, be careful not to take on a project unless you are confident you can conduct it safely

Accidents

- You are required to tell the FAA within 10 days if an accident has occurred that:
 - Has caused serious injury
 - Loss of conscious
 - Head trauma
 - Broken bones
 - Lacerations that require sutures
 - Others (unspecified)
 - Greater than \$500 in damages, excluding cost of sUAS
- FAA has accident reporting portal online, can also call

Failsafe RTH Illustration



Flyaways

- Begins as lost link
- The pre-set procedure is not executed properly
- To reduce the chance of a flyaway:
- Check home point before flight
- Calibrate compass
- Consider interference from metal objects and powerlines
- Know how to switch flight modes, know kill switch control
- If flying with FAA authorization, you are required to notify ATC about the flyaway immediately!

KILL SWITCH DJI Phantom 3 Standard or DJI Matrice 100



Scanning techniques



View 30 degrees at time for 2-3 seconds, scanning from far away to closer, overlapping by 10 degrees

Summary

- I. FAA regulations
- II. Airspace and VFR sectionals
- III. Weather
- IV. Aerodynamics and performance



Congratulations on making it to the end! Now go

beast mode on that knowledge test and get

airborne like this inspiring DJI Inspire

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