Principals of Safe UAS Operation

Preparation for becoming a remote pilot.

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Safety first.
Safety last.
Safety everywhere
in between.

What is a UAS

- UAS are remotely piloted, often (semi) autonomous, aircraft.
- UAS = Unmanned Aerial Systems.
  - Includes the drone, the pilot(s), flight crew, base station, flight controllers, and software.
- UAV = Unmanned Aerial Vehicle.
  - Commonly called a drone, a UAV is the part of the system that actually flies.
- sUAS = small UAS (< 55 lbs.)
- UAS encompassed every unmanned aircraft from a hobbyist RC planes to large military drones.

Unmanned Aerial Systems (UAS) aka Drones

From:

To:

And everything in between.

Types of UAS
Fixed wing v. rotary wing

- Fixed wing UAS
  - Just like regular airplane.
  - Good endurance.
  - Need large area to take off/land.

- Rotary wing UAS
  - Just like helicopter.
  - Poor endurance.
  - Can take off and land from small areas.

Rules: The past, the present, and the future…

- The Federal Aviation Administration (FAA) regulates UAS use for governmental, research, and commercial use.
- Old UAS regulations were very restrictive…
  - Section 333 Exemption.
  - Certificate of Authorization or Waiver (COA).
- Now, under Part 107, there is a “Remote Pilot” certificate, which has opened up commercial UAS aviation to thousands of operators.

Brief Overview of Part 107

- Must be under 55 lbs. including payload.
- Maintaining unaided visual line of sight.
- Must have 3 statute miles of visibility.
- Must stay away from clouds.
- Staying below 400 feet AGL.
- Cannot fly at night.
- Cannot fly over people or moving vehicles.
- May not fly in Temporary Flight Restrictions (TFR).
- My not fly in controlled airspace.
- You can apply for waivers to be exempt for some of these rules.

What does it take to get a Part 107 Remote Pilot Certificate

- Currently:
  - Pass a knowledge exam at a FAA approved test center with a score no less than 70%.
  - Pass a background check.
  - Quicker, free, online application for current manned pilots.
- In the future:
  - There may be practical exams or other challenges.
- What you need to know to pass a Part 107 knowledge exam.
  - You will need to know how to:
    - Know and understand C.F.R. Title 14, Chapter 1, Subchapter F, Part 107.
    - Read a aeronautical VFR sectional chart.
    - Understanding of weather.
    - Understand the basic physics of flight.
    - Know the basic systems of a fixed wing aircraft.
    - Be able to decode weather briefings.
    - A fair bit more…

Terms: Speed

- Ground speed – Speed of the aircraft relative to the ground.
  - Measured by GPS or by timing your UAS between 2 points on a known distance.
  - Often not the same as true airspeed.
- True airspeed – The actual speed of the aircraft relative to the movement of the air.
  - Often not the same as ground speed.
- Indicated airspeed – The airspeed reported by instruments.
  - This is normally calibrated for standard atmospheric pressure at sea-level.
  - Is not corrected for non-standards atmospheric pressures.
- Calibrated airspeed – Some more sophisticated equipment can correct for atmospheric pressure and instrumentation error.
  - More accurate than indicated airspeed.

Terms: Altitude

- UAS Terms – Note, these are not standardized and may change between UAS.
  - Relative altitude – The altitude from the UAS point of origin. Normally where it gets its first GPS fix.
  - Above takeoff (ATO) – Same as relative altitude.
- Standard Aviation Terms
  - Absolute Altitude – aka Above Ground Level (AGL), this is the distance between the aircraft and the ground directly bellow.
    - Used for FAA altitude limits.
    - Some flight planners miss-use this term (looking at you Mission Planner).
  - Pressure altitude – The altitude MSL assuming a standard atmospheric pressure (29.92 Hg)
  - Density altitude – The altitude MSL corrected for current atmospheric pressure.
  - Indicated Altitude – What the altimeter indicates.
    - Normally MSL, but for UAS it could be ATO, MSL, or AGL (make sure you know which!).
    - May or may not be corrected for atmospheric pressure.
    - May or may not be corrected for instrumentation error.
    - Assume that your sUAS does not correct for anything unless specified in the manual.
  - True altitude – aka Mean Sea Level (MSL), is the altitude above the average sea level.

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Terms: Units of Measurement

- Distance
  - Statute mile (imperial mile) (SM) – 5820 ft.
  - Nautical mile (NM) – 6076 ft.
- Speed
  - Miles Per Hour (mph) – Speed in statute miles per hour.
  - Meters per Second (m/s) – Number of meters traveled in 1 second.
  - Knots (kts.) – Nautical miles per hour.
    - Knots are the normal unit of measurement in aviation.
  - Some UAS may use MPH or m/s (kts. are less common). *Don't get these confused!*
- Altitude
  - Flight Levels – May be seen in weather briefings, and MTR route instructions.
    - FL300 = 30,000 ft, pressure altitude.
  - FAA uses feet, but many UAS use meters.
  - For FAA reports use feet.
  - Part 107 does not care what unit of measurement you use for your instrumentation.
  - COA's may require altitude to be reported in feet.

Other Terms:

- **Air Traffic Control (ATC)** – A service operated by appropriate authority to promote the safe, orderly, and expeditious flow of air traffic. This service may be provided by private, public, or military offices.
- **Area of Operations (AO)** – The area in which the UAS will be flown. Ideally enclosed by a virtual fence.
- **Certificate of Authorization/Waiver (COA)** – An authorization issued by the Air Traffic Organization to a public operator for a specific UAS activity.
- **Civil Morning/Evening Twilight** – This is the time when the sun is between 0 degrees and 6 degrees below the horizon. This time may differ depending on any obstructions, such as mountains, on the horizon at any specific location.
  - Normally this is 30 minutes before official sun up, and 30 minutes after official sun down.
- **Code of Federal Regulation (CFR)** – the general and permanent laws published and enforced by the U.S. federal government.
- **Digital Elevation Model (DEM)** – A digital, or 3D representation of a the surface of the ground.
- **Digital Surface Model (DSM)** – A DEM, but including trees, buildings, etc.
- **Digital Terrain Model (DTM)** – See *Digital Elevation Model.*

Other Terms Continued:

- **DROTAM** – NOTAM specifically for UAS, these are not be listed with normal NOTAMs.
- **Federal Aviation Administration (FAA)** – the U.S. national aviation authority and an agency of the U.S. Department of Transportation tasked with regulating all aspects of America civil aviation.
- **Federal Aviation Regulation (FAR)** – rule proscribed by the FAA governing all aviation activities in the U.S.
- **Flight** – The time the UAS is flying, starting from takeoff and ending when the UAS has come to a full stop on the ground.
- **Flight Crew** – People who are members of the team who are allowed in the AO during flight. These include the RPIC, VO, PMC, and RSO.
- **Flight Standard District Office (FSDO)** – Local FAA office.
- **Instrument Flight Rating (IFR)** – Regulations for flying in poor visibility, bellow VFR. Requires a IFR rating.
- **LiPo** – An abbreviation for Lithium-polymer battery.
- **Mission Area (MA)** – The area that the UAS will be collecting data.
- **National Transportation Safety Board (NTSB)** – The NTSB is an U.S. governmental investigative agency responsible for civil transportation accident investigation, including all aviation accidents and incidents.

Other Terms Continued, Yet Again:

- **Near Infrared (NIR)** – A sensor the records still images in the near-infrared part of the electromagnetic spectrum that lies between visible red and infrared.
- **Night** – The time between the end of evening civil twilight and the beginning of morning civil twilight, as published in the Air Almanac, converted to local time.
- **Notice to Airmen (NOTAM)** – A notice containing information concerning the establishment, condition, or change of any component, facility, service, procedure, or hazard which is essential knowledge for flight operations.
- **Person Manipulating the Controls (PMC)** – The person who is actually controlling the UAS.
- **Pitot Tube** – The pitot tube is a instrument used to measure fluid (in this case air) flow velocity.
- **Red, Green, Blue (RGB)** – A sensor the records still images in the visible range of the electromagnet spectrum.
- **Remote Pilot in Command (RPIC)** – The PIC responsible for UAS operations.
- **Return to Land (RTL)** – A command that causes a UAV to return to its takeoff locations.

Other Terms Continued, for the Last Time:

- **Temporary Flight Restriction (TFR)** - A temporary "no-fly zone". Often around open air events, emergencies or disasters, and VIP's such as the President.
- **Unmanned Aircraft System (UAS)** – An unmanned aircraft and its supporting equipment, control station, data links, telemetry, communications, navigation equipment, etc. A UAS may be controlled either by a PIC on the ground or by automated systems.
- **Small Unmanned Aircraft System (sUAS)** – A UAS that is under 55 lbs.
- **Visual Flight Rating (VFR)** – Regulations for flying "by sight". There a minimum visibility rules set for VFR flight.
- **Visual Line of Sight (VLOS)** – Unobstructed line of sight by the unaided human eye. Prescription eyeglasses, contacts, or sunglasses are not considered vison aids for this purpose. The use of binoculars, spotting scopes, telescopes, etc. are not permitted to be used to maintain VLOS. VLOS ends when a UAS is at a range where it orientation and relative location to other aircraft can no longer be determined.
- **Visual Observer (VO)** – A member of a UAS flight crew who is responsible for keeping VLOS on the UAS during flight and reporting to the PIC any obstructions to safe flight.
- **Zulu Time (Z)** – Also called Coordinated Universal Time (**UTC**), is the time at the zero meridian, written using a 24 hour format where the day begins at midnight, 0000, and ends at one minute to midnight, 2359. 3:00pm in Blacksburg VA daylight saving time (Z - 4 hours) is 1900Z.

Basic Requirements for a Commercial UAS Operator

- Must be 16 years of age.
- Must be fluent in, be able to read write and speak, English.
- No physical or mental condition that would cause you to operate a UAS in an unsafe manner.
- Must pass the FAA knowledge exam at an approved test center.
- Must undergo a TSA background check.
- Part 61 certified holders take a different route…
  - Take a online course at www.faasafety.gov
  - Pass the test at the end of the course.
  - You already have a TSA background check.
  - You will need to visit a CFI, FAA examiner, or FSDO to verify your identity for the online application.

How to apply for a FAA Remote Pilot Certificate with Small Unmanned Aircraft Systems Rating

- Study this material, the FAA Study Guide, and the AC 107-2.
- Study Title 14 Chapter I, Subchapter F, Part 107 and all referenced material at www.ecfr.gov.
- Find a approved test center. There is a PDF of all of the test centers in you digital packet.
- Take the FAA Unmanned Aircraft General – Small knowledge test.
  - 60 questions, you must make 70% or better.
  - Get a printout of the test report.
  - You will need a form of ID with: Picture, signature, DOB, and permanent address.
    - Drivers license or other government ID.
- Go to IACRA (https://iacra.faa.gov). Register as an applicant and confirm all the info.
  - Fill out the application and submit your test report.
  - The FAA will email you instructions on how to print your temporary certificate.
  - The FAA will mail you your permanent certified within 120 days.

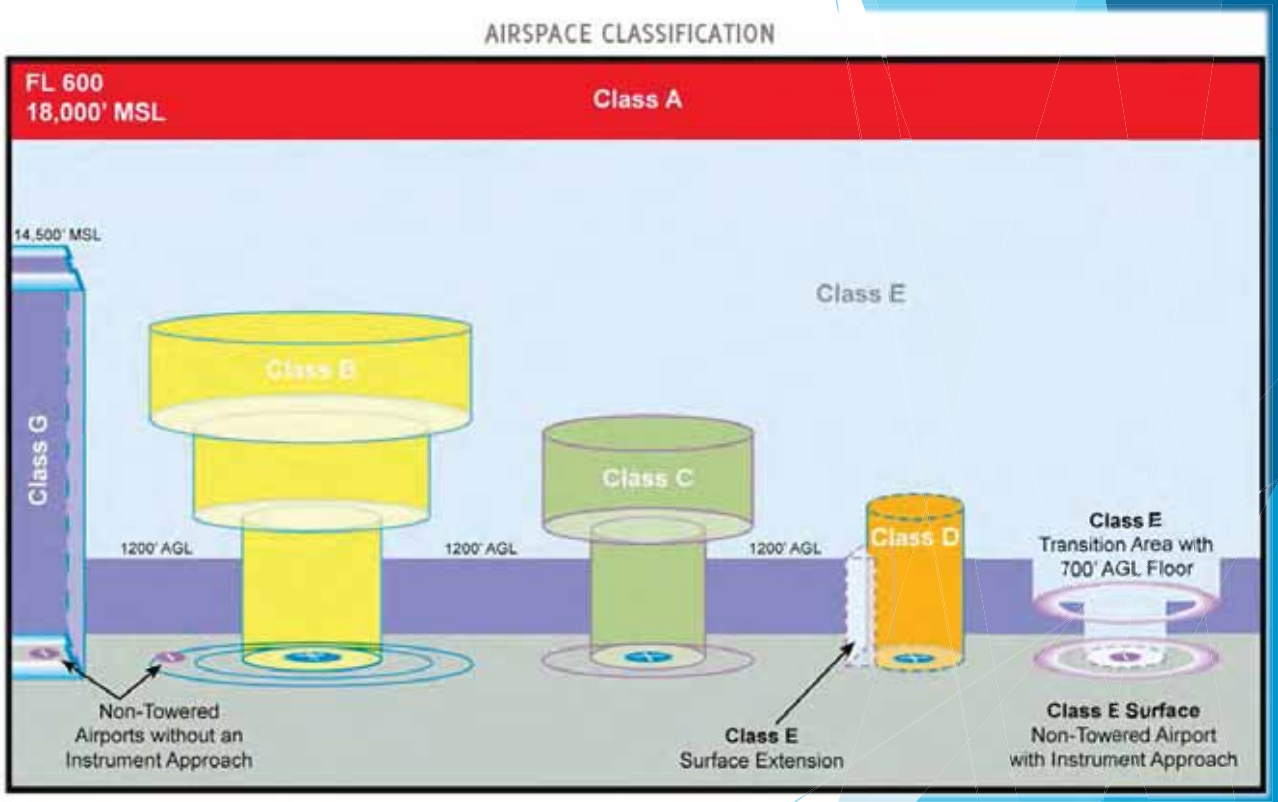
sUAS Registration

- Registration is now super simple!
- You must register if your sUAS is over 250 g or 0.55 lbs.
- Requires:
  - An “FAA Drone Zone” account.
  - The type/make/model of your sUAS.
  - Serial number of your sUAS, unless it is home built.
- $5 fee.
- Go to:
  - https://registermyuas.faa.gov/

faa.gov

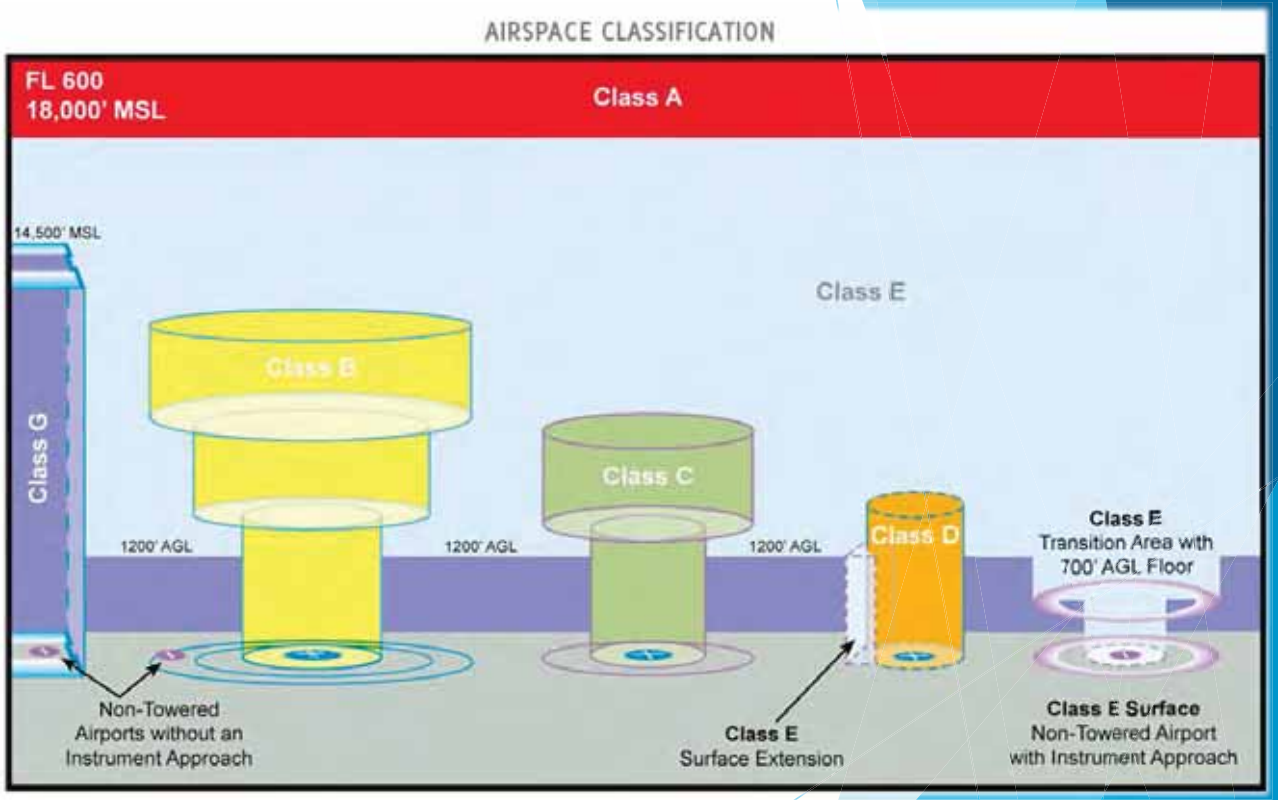
Airspace

- Different classifications.
- Controlled
  - Class A, B, C, D, and E.
  - More congested areas, i.e. around airports.
  - Monitored and controlled by ATC.
  - May have entry requirements such as 2 way communications or transponders.
  - Need a waiver to fly a UAS.
- Uncontrolled
  - Class G.
  - No entry or clearances requirements.
  - No communication or transponder requirements.
  - This is where most UAS ops. will happen.



Class G Airspace – UAS Friendly

- Purple area in the diagram.
- Basically this is all airspace that is not class A, B, C, D, or E.
- Only uncontrolled airspace.
- Not marked on aviation charts.
- This is where you can fly sUAS without a waiver under Part 107.
- Normally starts that the surface and goes up to 1,200 ft. AGL.
- Under class E transition areas it starts at the surface and goes to 700 ft. AGL.
- In some exceptional areas (Rocky Mts.) it may go higher.



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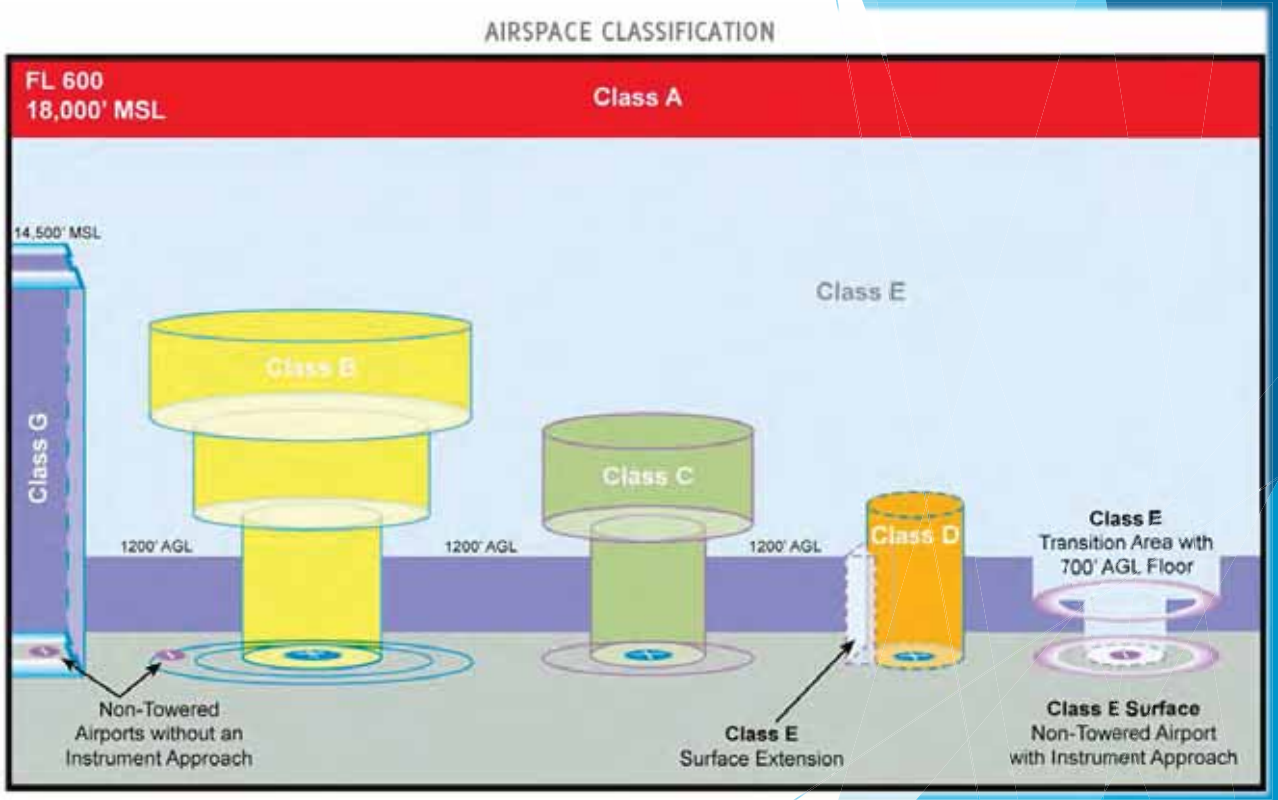
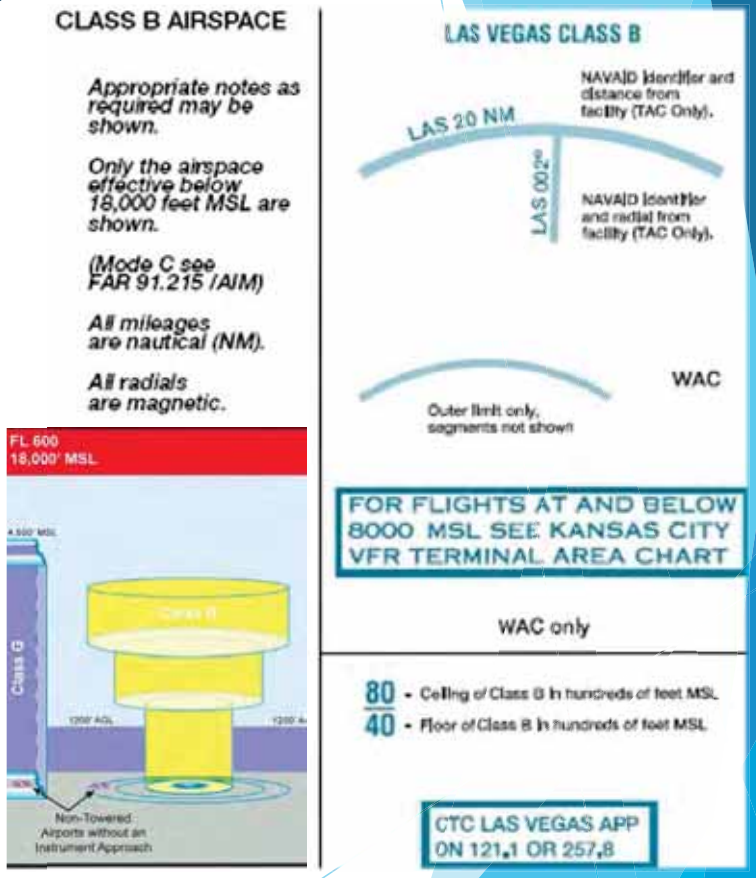
Class A Airspace – Way Up There

- Red area in the diagram.
- This is where airliners fly.
- Starts at 18,000 ft. MSL and goes to FL 600.
- Above that is Class E “air” space, but mostly just space.
- Can only IFR.
- Probably too high up for any UAS we will every fly.



Class B Airspace – “B” is for Big.

- Class B airspace surrounds the busiest of airports like JFK.
- Denoted on charts by blue concentric rings.
- Each ring marks where the upper and lower limit of the airspace changes.
  - This is marked on the chart – 80/40 = Upper limit of 8,000 ft. and a lower limit of 4000 ft. MSL.
- The center ring is normally from the surface to 10,000 ft. MSL.
- From the side the airspace looks like a up-side down wedding cake.
- You must have ATC clearance to enter class B airspace.
- Unless otherwise authorized, you must have 2-way radio communications with ATC.
- Mode C Veil – An area 30 NM from the airport where a altitude reporting transponder is required.



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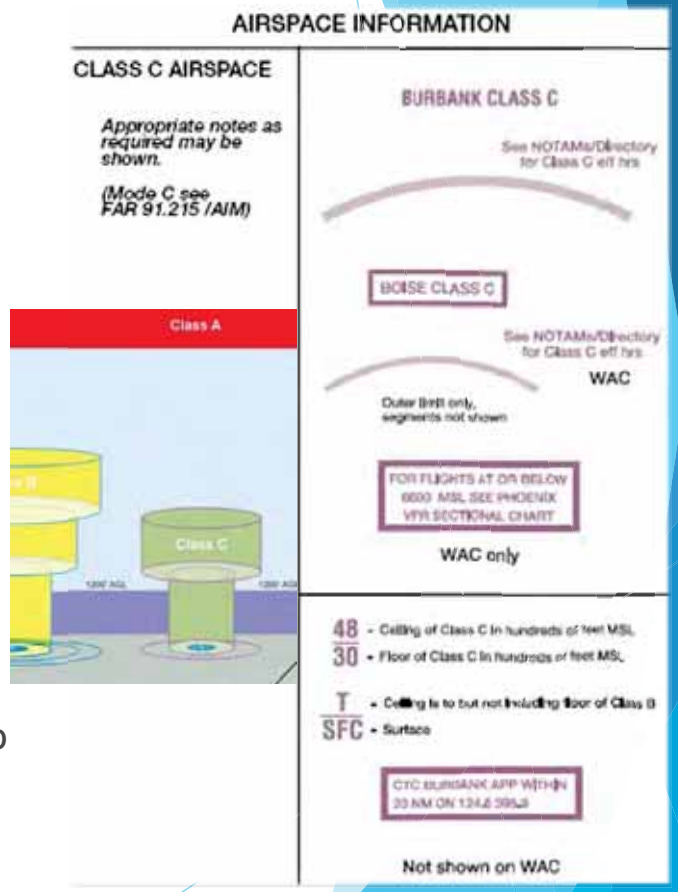
Class C Airspace – Like B, but Smaller

- Class C airspace surrounds airports which have operational control towers, such as Roanoke, but are not large enough to warrant class B airspace.
- Denoted on charts by magenta concentric rings.
- Each ring marks where the upper and lower limit of the airspace changes.
  - This is marked on the chart – 48/30 = Upper limit of 4,800 ft. and a lower limit of 3,000 ft. MSL.
- The center ring is normally from the surface to 4,000 ft. MSL.
- The middle and outer rings upper and lower limits are marked on sectional charts.
- From the side the airspace looks like smaller up-side down wedding cake.
- You must contact ATC before entering class C airspace. But you do not need permission.
- Mode C Veil – An area 30 NM from the airport where a altitude reporting transponder is required.



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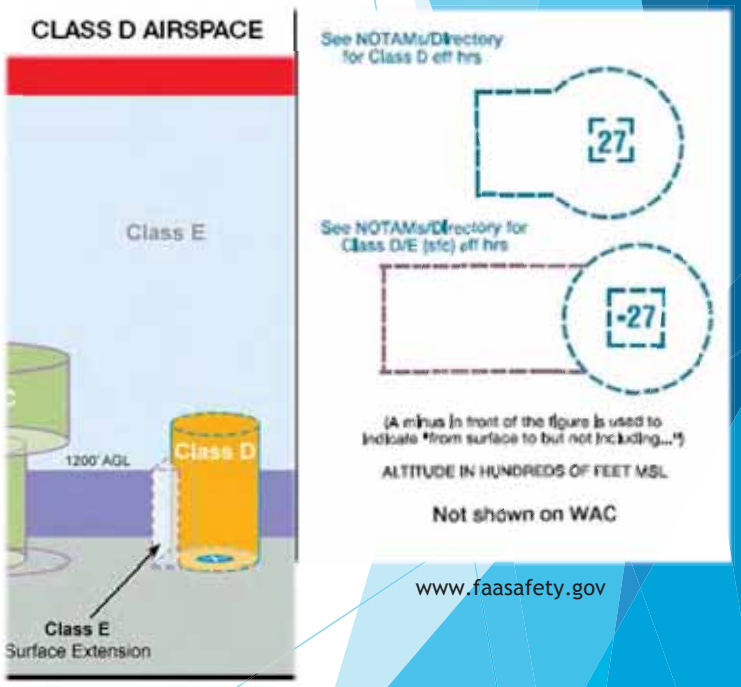
Class D Airspace – For Little Airports

- Class D airspace surrounds the smaller airports which have operational control towers.
- Denoted on charts by hashed blue lines.
- Class D airspace starts at the surface and goes up to the altitude, MSL, on the chart.
  - 27 = 2,700 ft. MSL.
  - A minus (-) sign indicates that the marked altitude is from the surface up to, but not including…
- 2-way radio communications must be established before entering class D airspace, but permission is not required.
- Many airports do not have full time towers, these are only class D airspace when the tower is in operation. When the tower is closed the airspace reverts to class G or a mixture of class E/G airspace.



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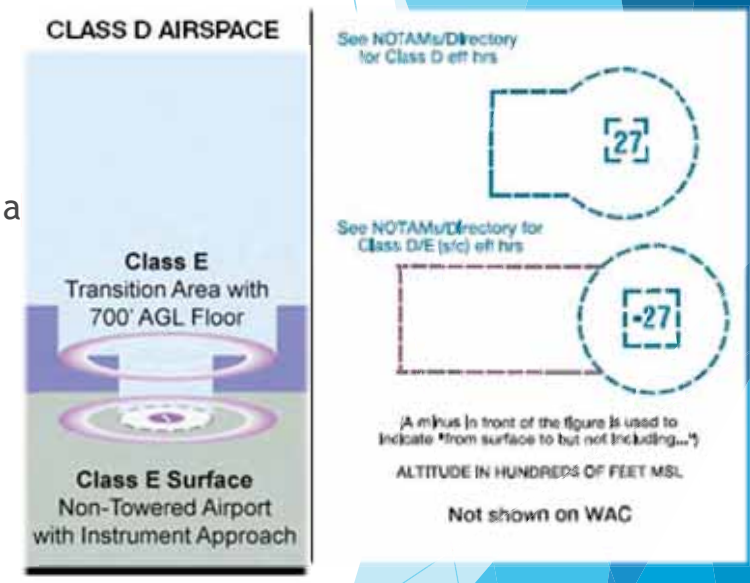
Class E Airspace – "E" is for Everywhere

- Class E is above class G and around other controlled airspace.
- Denoted on charts by blue or magenta lines which fade out on the inside.
  - Blue – Normal Class E. Starts at 1,200 ft. AGL.
  - Magenta – Class E Transition Area. Starts at 700 ft. AGL.
  - Magenta Hashes – Starts at the surface and if often in place to add a layer of protection of instrument approaches or places where aircraft will be abnormally low.
- Less controlled.
- Do not need to establish communications or get permission to enter.
- Still need a waiver to fly a UAS.



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