



Project FireFly

Standards & Regulation | November 7 2022

Team:

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Main Stakeholders:

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Regulation: FAA Part 107

Small UAS Rule

What is it about?

The Federal Aviation Administration (FAA) dictates various air traffic control and operational regulations

- Part 107 defines the regulations for operating **civil small unmanned aircraft systems**
 - Includes documentation and reporting, remote piloting certification, procedures for operating over human beings, and waivers
- Exemption for air carrier operations, limited recreational operations, special authorization, and operation in the Grand Canyon National Park Special Flight Rules Area



Code of Federal Regulations

A point in time eCFR system



- To which products/markets does it apply?

- Small unmanned aircraft systems definition
 - Weigh less than 55 pounds on takeoff
 - Operated without the possibility of direct human intervention from within or on the aircraft
- Applies to any civil usage of sUAS
 - Monitoring and assessing infrastructure and construction
 - Surveying and mapping uncertain and risky environments
 - Delivery systems



- Registration



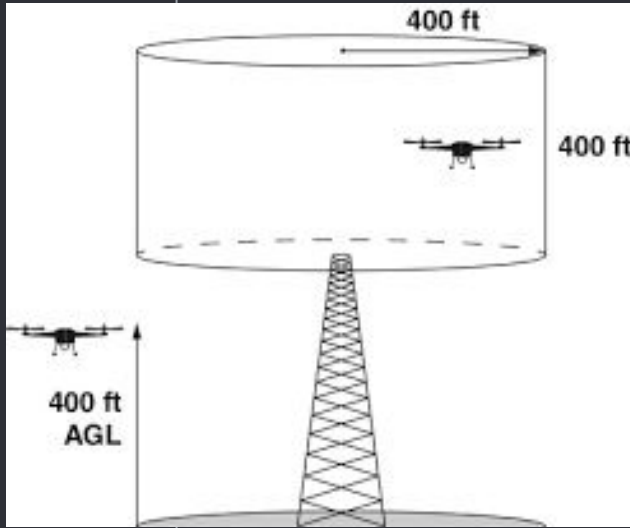
Remote Pilot Certificate
(Do recurrent training every two years)



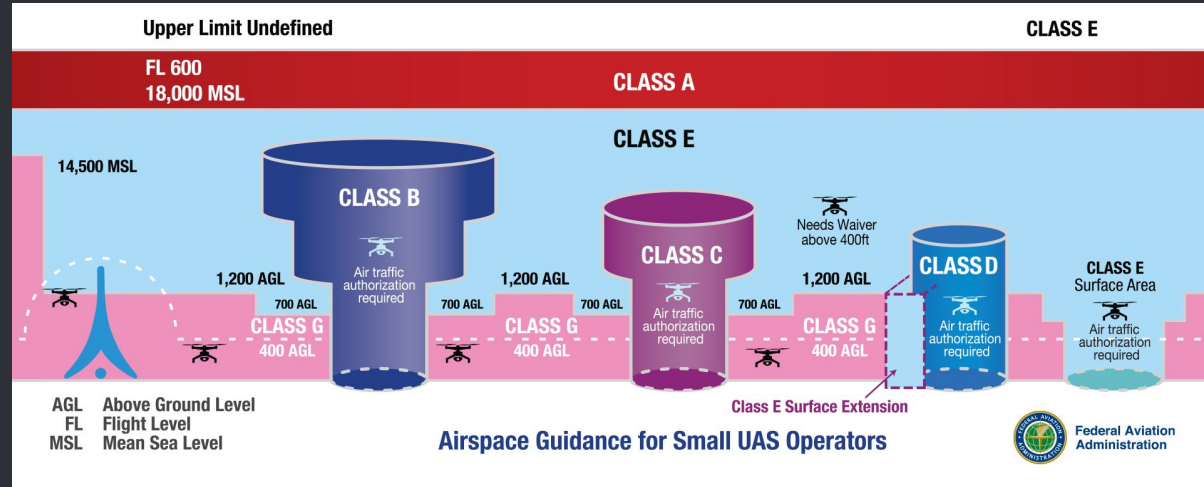
Certificate of Aircraft Registration
(Renew every three years)

Operation Conditions

- Maximum speed of 100 mph
- Maintain visual line of sight



Height Limits



Airspace Limits

- Restrictions



Don't fly at night,
unless you have the lumens



Don't fly directly over people (with many exceptions)

- How does it apply to the team's project?

- 1. Team had to get a remote pilot certificate and register our drone
 2. Imposes restrictions on operating conditions
 - Stay below 400 ft AGL
 - Stay within line of sight
 3. Team needs to ensure drone does not fly directly over firefighters
 - Teleop override if autonomy is headed towards firefighters
 - Future research may need waivers or automated people avoidance systems

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Standard/Regulation: ASTM F2411-04

Design and Performance of an Airborne Sense-and-Avoid

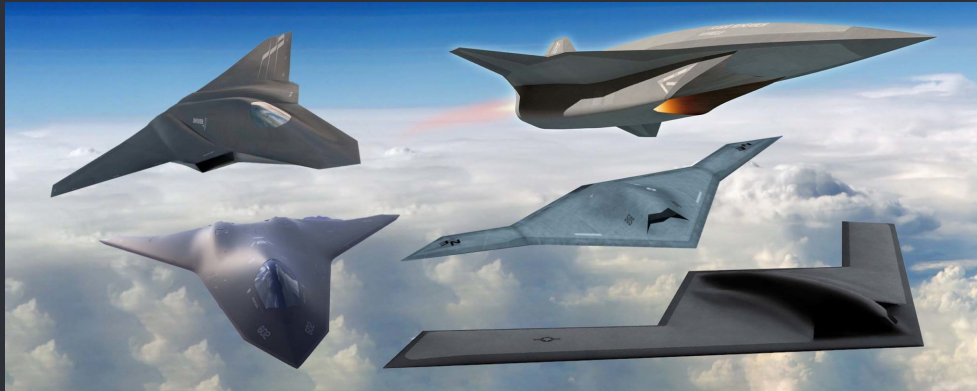
- What is it about?

The American Society of Testing and Materials (ASTM) develops and delivers various consensus standards designed to improve the quality of products, improve safety, enforce uniform standards and facilitate trade

F2411-04 defines the regulations for **designing and implementing airborne sense-and-avoid (S&A) systems**

- Supports detection of airborne objects (manned and unmanned aerial vehicles) thus ensuring safe operation
- This specification includes requirements to support detection of, and safe separation from, airborne objects such as manned or unmanned aircraft and air vehicles.
- This specification is not intended to apply to cooperative S&A systems along with formation flying

- To which products/markets does it apply?
 - Applicable to all flying objects seeking approval from the Civil Aviation Authority (flight certification, flight permits)
 - The regulation is applicable to
 - Commercial/Civil Planes
 - Military Planes
 - Unmanned Aerial Vehicles (Drones)
 - Autonomous Systems



- What are its main prescriptions?

- - Performance
 - Design and Construction
 - Reliability and Maintenance

● Main Prescriptions: Performance

◦ Sensing

- Detection distance, field-of-regard, latency sources

◦ Avoidance

- Traffic sources, nature of corrective maneuvers

◦ Proof of Compliance

- Basically says this can be simulation, analysis or flight testing

◦ Proof of Performance

- Stipulates field-of-regard for obstacle awareness in multiple cases, and range of operating conditions (closing velocities, cruise speeds)

● Main Prescriptions: Design and Construction

- **Power:** Can be powered by main/auxiliary power without compromising other subsystems
- **Communication:** Robust to loss in direct C&C
- **Loads:** In line with system spec even during S&A maneuvers
- **Subsystem Integration:**
 - S & A can be single subsystem
 - Retro-fit systems allowed

● Main Prescriptions: Design and Construction (continued)

- **Data:** All data elements needed for executing S&A to be documented and provided to end user
- **Human Interface**
 - Must not increase pilot workload
 - Must not require more crew to be pulled in
 - Must not compromise primary mission in non-emergency
 - Detection of collision threat & engaging of S&A maneuver **shall** be accompanied by an audio/visual alarm to the pilot
- **Sensor Configuration**
 - S&A sensor shall be onboard the aircraft

● Main Prescriptions: Reliability and Maintenance

- **Accessibility:** S&A components to be accessible for repair and maintenance
- **Environment:** S&A should operate in all conditions (weather, altitude, etc) that the craft is specified to
- **Operating Limitations:** To be made available to pilot and ATC
- **Failure Rate:** Overall critical failure rate of no more than 0.51 per million flight hours
- **Proof of Compliance:** Proven by conservative analysis, test, or a combination of both, and done in coordination with the cognizant certification authorities

- How does it apply to the team's project?

- Unmanned Aerial Vehicle monitoring wildfires over uneven terrain and forests
- This specification will be necessary to get our system approved
- Metrics and requirements mentioned in the specification can be used as validation criteria
 - Minimum detection distance
 - Azimuth and elevation field of regard

- How does it apply to the team's project?
- - Current obstacle avoidance system tested only in simulation
 - Need to refine it and test it further
 - LiDAR mounted under the drone
 - We plan to fly along the viewing plane of the LiDAR since no data for the orthogonal direction
 - No data for any obstacles above the drone
 - Does not conform to the azimuth field of view requirements

Thank you!

○ ANY QUESTIONS?