Safety Procedures

DroneScape, LLC

01/01/2017

14 CFR Part 107: Small Unmanned Aircraft Systems. The Federal Aviation Administration (FAA) has adopted specific rules to allow the operation of civil small unmanned aircraft systems (sUAS) in the National Airspace System (NAS). This is the DroneScape safety procedure for safe operations in accordance with FAA requirements. Reference Title 14 of the Code of Federal Regulations (14 CFR) part 107, Small Unmanned Aircraft Systems. Part 107 addresses sUAS classification, certification, and operational limitations.

Safety Procedures
January 1, 2017

1. Defined Crew Roles in a Team Environment

An sUAS operation may involve one individual or a team of crewmembers. Part 107 defines the following sUAS crew roles:

- **Remote Pilot in Command (Remote PIC):** A person who holds a current remote pilot certificate with an sUAS rating and has the final authority and responsibility for the operation and safety of the sUAS
- **Person manipulating the controls:** A person controlling the sUAS under direct supervision of the Remote PIC
- **Visual observer:** A person acting as a flight crewmember to help see and avoid air traffic or other objects in the sky, overhead, or on the ground

1.1. Remote Pilot in Command

The Remote PIC is directly responsible for and is the final authority as to the operation of the sUAS conducted under 14 CFR part 107.

He or she must:

1.1.1. Be designated before each flight (but can change during the flight)

1.1.2. Ensure that the operation:

- Poses no undue hazard to people, aircraft, or property in the event of a loss of control of the aircraft for any reason
- Complies with all applicable regulations of part 107

1.1.3. Operate the small unmanned aircraft to ensure compliance with all applicable provisions

1.1.4. Part 107 permits transfer of control of the sUAS between two or more certificated Remote PICs. The transfer of aircraft control (i.e. the Remote PIC designation) to each other must be accomplished while maintaining visual line of sight of the sUAS and without loss of control.

1.2. Supporting Crew Roles: Person Manipulating the Controls

A non-certificated person may operate the sUAS under Part 107 **only if:**

1.2.1. He or she is directly supervised by the Remote PIC
and

1.2.2. The Remote PIC has the ability to immediately take direct control of the sUAS

1.2.3. The Remote PIC is ultimately responsible for identifying hazardous conditions. The Remote PIC's ability to regain control of the sUAS is necessary to ensure that he or she can quickly intervene to ensure the safety of the flight and prevent a hazardous situation before an accident or incident occurs.

1.3. Supporting Crew Roles: Visual Observer

1.3.1. The role of visual observers (VOs) is to alert the rest of the crew about potential hazards during sUAS operations. The use of VOs is optional. However, the Remote PIC may use one or more VOs to supplement situational awareness and visual-line-of-sight responsibilities while the Remote PIC is conducting other mission-critical duties (such as checking displays).

1.3.2. The Remote PIC must make certain that all VOs:

1.3.3. Are positioned in a location where they are able to see the sUAS continuously and sufficiently to maintain visual line of sight

1.3.4. Possess a means to effectively communicate the sUAS position and the position of other aircraft to the Remote PIC and person manipulating the controls

1.4. Aircraft and Remote Pilot in Command Requirements: Remote Pilot in Command Responsibilities

1.4.1. Situational Awareness and Decision Making

1.4.1.1. The Remote PIC attains situational awareness by obtaining as much information as possible prior to a flight and becoming familiar with the performance capabilities of the sUAS, weather conditions, surrounding airspace, and Air Traffic Control (ATC) requirements. Sources of information include a weather briefing, ATC, FAA, local pilots, and landowners.

1.4.1.2. Technology, such as global positioning systems (GPS), mapping systems, and computer applications, can assist in collecting and

managing information to improve your situational awareness and risk-based aeronautical decision making (ADM).

1.4.2. Taking over controls

The ability for the Remote PIC to immediately take over the flight controls may be achieved by using a number of different methods.

For example, the Remote PIC could:

- Stand close enough to physically take over the control station
- Use a “buddy box” system with two control stations:
- One for the person manipulating the flight controls
- One that allows the Remote PIC to immediately override the other control station
- Use a preprogrammed safe-mode system with "home" or "hover" functions

1.5. Crew Resource Management

Crew resource management (CRM) is the effective use of all available resources—human, hardware, and information—prior to and during flight to ensure a successful outcome of the operation. The Remote PIC must integrate crew resource management techniques into all phases of the sUAS operation.

Many of the crew resource management techniques traditionally used in manned aircraft operations are also applicable for sUAS, such as the ability to:

- Delegate operational tasks and manage crewmembers
- Recognize and address hazardous attitudes
- Establish effective team communication procedures

Sources: AC 107, *Small UAS* (as amended); AC 60-22, Chapters 1 through 4; PHAK, page 17-4

1.5.1. Task Management

The Remote PIC identifies, delegates, and manages tasks for each sUAS operation.

Tasks can vary greatly depending on the complexity of the sUAS operation. Supporting crewmembers can help accomplish those tasks and ensure the safety of flight. For example, visual observers and other ground crew can provide valuable information about traffic, airspace, weather, equipment, and aircraft loading and performance.

1.5.1.1. Overall Responsibilities of the Remote PIC:

- Assesses the operating environment (airspace, surrounding terrain, weather, hazards, etc.)
- Determines the appropriate number of crewmembers that are needed to safely conduct a given operation. The Remote PIC must ensure sufficient crew support so that no one on the team becomes over-tasked, which increases the possibility of an incident or accident.
- Informs participants of delegated tasks and sets expectations
- Manages and supervises the crew to ensure that everyone completes their assigned tasks

1.5.1.2. Recognizing Hazardous Attitudes

1.5.1.2.1. Studies have identified five hazardous attitudes that can interfere with the ability to make sound decisions and properly exercise authority: anti-authority, impulsivity, invulnerability, machoism, and resignation. Each attitude is described in more detail on the next screen.

1.5.1.2.2. Remote PICs should be alert for hazardous attitudes (in themselves or in other crewmembers), label it as hazardous, and correct the behavior. See the

Five Hazardous Attitudes
Table 1

Attitude	Motto	Indicators
Anti-Authority	"Don't tell me what to do."	The person does not like or may resent anyone telling him or her what to do. The person may regard rules, regulations, and procedures as silly or unnecessary. (Note: it is always your prerogative to question authority if you feel it is in error.)
Impulsivity	"Do it quickly."	The person frequently feels the need to do something, anything, immediately. He or she does not stop to think about the best alternative and does the first thing that comes to mind.
Invulnerability	"It won't happen to me."	The person falsely believes that accidents happen to others, but never to him or her. The person knows accidents can happen and that anyone can be affected. However, the person never really feels or believes that he or she will be personally involved.

Attitude	Motto	Indicators
		Such people are more likely than others to take chances and increase risk.
Machoism	"I can do it—I'll show them."	The person tries to prove that he or she is better than anyone else. The person takes risks to impress others. (Note: While this pattern is thought to be a male characteristic, women are equally susceptible.)
Resignation	"What's the use?"	The person does not believe his or her actions make a difference in what happens. The person attributes outcomes to good or bad luck. He or she leaves the action to others, for better or worse. Sometimes, the person even goes along with unreasonable requests just to be a "nice guy."

1.5.2. Effective Communication

The FAA requires that the Remote PIC and other crewmembers coordinate to:

- Scan the airspace in the operational area for any potential collision hazard; and
- Maintain awareness of the position of the sUAS through direct visual observation.

2. Maintenance for UAS

Maintenance for sUAS includes scheduled and unscheduled overhaul, repair, inspection, modification, replacement, and system software upgrades for the unmanned aircraft itself and all components necessary for flight.

2.1. Records

2.1.1. Document any repair, modification, overhaul, or replacement of a system component resulting from normal flight operations

2.1.2. Record the time-in-service for that component at the time of the maintenance procedure

2.1.3. Assess these records over time to establish a reliable maintenance schedule for the sUAS and its components

2.2. Scheduled Maintenance

DroneScape utilizes the manufacturers recommendation for all UASs. The maintenance or replacement schedule for the unmanned aircraft and system components is based on time-in-service limits and other factors.

2.3. Unscheduled Maintenance

2.3.1. During the course of a preflight inspection, you may discover that an sUAS component requires some form of maintenance outside of the scheduled maintenance period.

2.3.2. For example, an sUAS component may require servicing (such as lubrication), repair, modification, overhaul, or replacement as a result of normal or abnormal flight operations. Or, the sUAS manufacturer or component manufacturer may require an unscheduled system software update to correct a problem.

In the event such a condition is found, do not conduct flight operations until the Performing Maintenance

2.4. Preflight Inspection

Before beginning any sUAS flight operation:

- Assess the operating environment
- Inform any supporting crewmembers about the operation and their roles
- Inspect the sUAS to ensure that it is in a condition for safe operation
- Maintain documents required in the event of an on-site FAA inspection

Sources: 14 CFR parts 107.15 and 107.49; AC 107, *Small UAS* (as amended)

3. Operating Environment

Before an sUAS operation, assess the operating environment.

The assessment must include, but is not limited to:

- Local weather conditions
- Local airspace and any flight restrictions
- The location of persons and property on the surface
- Other ground hazards

Source: AC 107, *Small UAS* (as amended)

4. **Information for the Crew**

Before any sUAS operation, at a minimum, ensure that all persons directly participating in the sUAS operation are informed about:

- Operating conditions
- Emergency procedures
- Contingency procedures
- Roles and responsibilities of each person involved in the operation
- Potential hazards

Source: AC 107, *Small UAS* (as amended)

5. **Condition of Aircraft**

Before any sUAS operation, inspect the aircraft for equipment damage or malfunctions.

For example, ensure that:

- All control links between the control station and the small unmanned aircraft are working properly
- There is sufficient power to continue controlled flight operations to a normal landing
- Any object attached or carried by the small unmanned aircraft is secure and does not adversely affect the flight characteristics or controllability of the aircraft
- The unique identifier is readily accessible and visible upon inspection of the small unmanned aircraft

See appendix A for the preflight planning checksheet

Sources: 14 CFR parts 107.15 and 107.49; AC 107, *Small UAS* (as amended)

6. **Recordkeeping**

6.1. Careful recordkeeping can be highly beneficial for sUAS owners and operators. For example, recordkeeping provides essential safety support for commercial operators who may experience rapidly accumulated flight operational hours/cycles.

6.2. Consider maintaining a hardcopy and/or electronic logbook of all periodic inspections, maintenance, preventative maintenance, repairs, and alterations performed on the sUAS.
6.3. Such records should include all components of the sUAS, including the:

- Small unmanned aircraft itself
- Control station
- Launch and recovery equipment
- Data link equipment
- Payload
- Any other components required to safely operate the sUAS

Source: AC 107, *Small UAS* (as amended)

6.4. You must make available to the FAA, upon request, the sUAS for inspection or testing.
6.5. In addition, you must verify before flight that all required documentation is physically or electronically available in the event of an on-site FAA inspection. Such documentation may include:

- Pilot certificate
- Aircraft registration
- Any necessary waiver or exemption
- Other documentation related to the operation

7. Loading and Performance

Prior to each flight, the Remote PIC must ensure that any object attached to or carried by the small unmanned aircraft is secure and does not adversely affect the flight characteristics or controllability of the aircraft.

7.1. Loading Considerations: General Weight and Balance

7.1.1. As with any aircraft, compliance with weight and balance limits is critical to the safety of flight for sUAS. An unmanned aircraft that is loaded out of balance may exhibit unexpected and unsafe flight characteristics.
7.1.2. Before any flight, verify that the unmanned aircraft is correctly loaded by determining the weight and balance condition.
7.1.3. Review any available manufacturer weight and balance data and follow all restrictions and limitations

7.1.4. If the manufacturer does not provide specific weight and balance data, apply general weight and balance principals to determine limits for a given flight. For example, add weight to the unmanned aircraft in a manner that does not adversely affect the aircraft's center of gravity (CG) location—a point at which the unmanned aircraft would balance if it were suspended at that point.

Sources: PHAK; FAA-H-8083-1, Weight & Balance Handbook, 4-4-5

7.2. Factors that Affect Maximum Gross Takeoff Weight

Although a maximum gross takeoff weight is normally specified for a given unmanned aircraft, the aircraft may not be able to launch with this load under all conditions. Or if it does become airborne, the unmanned aircraft may exhibit unexpected and unusually poor flight characteristics.

Factors that may require a reduction in weight prior to flight include:

- High density altitude conditions
  - High elevations
  - High air temperatures
  - High humidity
- Runway/launch area length
- Surface
- Slope
- Surface wind
- Presence of obstacles

Sources: AC 107, *Small UAS* (as amended); PHAK

7.3. Common Performance Deficiencies of Overloaded Aircraft

Excessive weight reduces the flight performance in almost every respect. In addition, operating above the maximum weight limitation can compromise the structural integrity of an unmanned aircraft.

The most common performance deficiencies of an overloaded aircraft are:

- Reduced rate of climb
- Lower maximum altitude

- Shorter endurance
- Reduced maneuverability

Source: PHAK

7.4. **Loading Considerations: Effects of Weight Changes**

7.4.1. Weight changes have a direct effect on aircraft performance.

7.4.2. Fuel burn is the most common weight change that takes place during flight.

7.4.3. For battery-powered unmanned aircraft, weight change during flight may occur when expendable items are used on board (e.g., agricultural use). Changes of mounted equipment between flights, such as the installation of cameras, battery packs, or other instruments, may also affect the weight and balance and performance of an sUAS.

Sources: AC 107, *Small UAS* (as amended); PHAK

7.5. **Loading Considerations: Effects of Load Factor**

7.5.1. Unmanned airplane performance can be decreased due to an increase in load factor when the airplane is operated in maneuvers other than straight and level flight.

7.5.2. 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. The Remote PIC should be mindful of the increased load factor and its possible effects on the aircraft's structural integrity and the results of an increase in stall speed.

7.5.3. As with manned aircraft, an unmanned airplane will stall when critical angle of attack is exceeded. Due to the low altitude operating environment, consideration should be given to ensure aircraft control is maintained and the aircraft isn't operated outside its performance limits.

Source: PHAK

7.6. Carriage of Hazardous Material

A small unmanned aircraft may not carry hazardous material as defined in 49 CFR part 171.8:

"Hazardous material means a substance or material that the Secretary of Transportation has determined is capable of posing an unreasonable risk to health, safety, and property when transported in commerce, and has designated as hazardous under section 5103 of Federal hazardous materials transportation law (49 U.S.C. 5103). The term includes hazardous substances, hazardous wastes, marine pollutants, elevated temperature materials, materials designated

as hazardous in the Hazardous Materials Table (see 49 CFR 172.101), and materials that meet the defining criteria for hazard classes and divisions in part 173 of subchapter C of this chapter."

Sources: 14 CFR part 107.36; 49 CFR part 171.8

7.6.1. Carriage of Lithium Batteries

7.6.1.1. Lithium batteries that are installed in an sUAS for power during the operation are not considered a hazardous material under part 107.

7.6.1.2. However, spare (uninstalled) lithium batteries would meet the definition of hazardous material and may not be carried on the sUAS.

7.7. Determining Performance: Sources of Performance Data

Performance or operational information may be provided by the manufacturer in the form of an Aircraft Flight Manual, Pilot's Operating Handbook, or owner's manual. Follow all manufacturer recommendations for evaluating performance to ensure safe and efficient operation.

Even when specific performance data is not provided, the Remote PIC should be familiar with:

- The operating environment
- All available information regarding the safe and recommended operation of the sUAS

Source: PHAK

7.8. Remote PIC Responsibilities for Determining Performance

7.8.1. The Remote PIC is responsible for ensuring that every flight can be accomplished safely, does not pose an undue hazard, and does not increase the likelihood of a loss of positive control.

7.8.2. Consider how your decisions affect the safety of flight. For example:

7.8.3. If you attempt flight in windy conditions, the unmanned aircraft may require an unusually high power setting to ascend. This action may cause a rapid depletion of battery power and result in a failure mode.

7.8.4. If you attempt flight in wintery weather conditions, ice may accumulate on the unmanned aircraft's surface. Ice increases the weight and adversely affects performance characteristics of the small unmanned aircraft.

7.8.5. Due to the diversity and rapidly-evolving nature of sUAS operations, individual Remote PICs have flexibility to determine what equipage methods, if any, mitigate risk sufficiently to meet performance-based

requirements, such as the prohibition on creating an undue hazard if there is a loss of aircraft control

7.9. Determining Performance: Operational Data

7.9.1. The FAA acknowledges that some manufacturers provide comprehensive operational data and manuals, such as Aircraft Flight Manuals or Pilot's Operating Handbooks, and others do not. When operational data is provided, follow the manufacturer's instructions and recommendations.

7.9.2. Even when operational data is not supplied by the manufacturer, the Remote PIC can better understand the unmanned aircraft's capabilities and limitations by establishing a process for tracking malfunctions, defects, and flight characteristics in various environments and conditions. Use this operational data to establish a baseline for determining performance, reliability, and risk assessment for your particular system.

Source: PHAK

7.10. Effects of Weather on Performance

7.10.1. General

Even though sUAS operations are often conducted at very low altitudes, weather factors can greatly influence performance and safety of flight.

Specifically, factors that affect sUAS performance and risk management include:

- Atmospheric pressure and stability
- Wind and currents
- Uneven surface heating
- Visibility and cloud clearance
- As with any flight, the Remote PIC should check and consider the weather conditions prior to and during every sUAS flight.

Source: PHAK

7.10.2. Wind

Wind and currents can affect sUAS performance and maneuverability during all phases of flight. Be vigilant when operating sUAS at low altitudes, in

confined areas, near buildings or other manmade structures, and near natural obstructions (such as mountains, bluffs, or canyons). Consider the following effects of wind on performance:

- Obstructions on the ground affect the flow of wind, may create rapidly changing wind gusts, and can be an unseen danger
- The intensity of the turbulence associated with ground obstructions depends on the size of the obstacle and the primary velocity of the wind
- Even when operating in an open field, wind blowing against surrounding trees can create significant low level turbulence
- High winds may make it difficult to maintain a geographical position in flight and may consume more battery power

7.10.3. Example: Operations Near Buildings

- Remember that local conditions, geological features, and other anomalies can change the wind direction and speed close to the Earth's surface.
- For example, when operating close to a building, winds blowing against the building could cause strong updrafts that can result in ballooning or a loss of positive control. On the other hand, winds blowing over the building from the opposite side can cause significant downdrafts that can have a dramatic sinking effect on the unmanned aircraft.

7.10.4. Currents

Different surfaces radiate heat in varying amounts.

The resulting uneven heating of the air creates small areas of local circulation called convective currents. Convective currents can cause bumpy, turbulent air that can dramatically affect the Remote PIC's ability to control unmanned aircraft at lower altitudes.

For example:

- Plowed ground, rocks, sand, and barren land give off a large amount of heat and are likely to result in updrafts

- Water, trees, and other areas of vegetation tend to absorb and retain heat and are likely to result in downdrafts

7.10.5. Visibility and Clouds

- As in manned aircraft operations, good visibility and safe distance from clouds enhances the Remote PIC's ability to see and avoid other aircraft. Similarly, good visibility and cloud clearance may be the only means for other aircraft to see and avoid the unmanned aircraft.
- The regulatory requirements for visibility and cloud clearance are discussed in a later module. But it should be noted here that adherence to the regulatory requirements in conjunction with good airmanship and effective scanning techniques can preclude in-flight collisions. And collision avoidance is an essential aspect to the safe integration of sUAS into the NAS.

8. Daylight Only Operations

14 CFR part 107 prohibits operation of a small UAS at night, defined in 14 CFR part 1 as the time between the end of evening civil twilight and the beginning of morning civil twilight, as published in the Federal Air Almanac, and converted to local time.

The Federal Air Almanac provides tables to determine sunrise and sunset at various latitudes. For example:

- In the contiguous United States, evening civil twilight is the period of sunset until 30 minutes after sunset and morning civil twilight is the period of 30 minutes prior to sunrise until sunrise
- In Alaska, the definition of civil twilight differs and is described in the Federal Air Almanac

Visit the Resources page to access the Naval Observatory website where you can download these tables and customize them for your location.

Source: 14 CFR part 107.29; AC 107, *Small UAS* (as amended)

9. Daylight: Operations in Civil Twilight

When sUAS operations are conducted during civil twilight, the sUAS must be equipped with anti-collision lights that are capable of being visible for at least 3 statute miles.

However, the Remote PIC may reduce the intensity of the lighting if he or she has determined that it would be in the interest of operational safety to do so. For example, the Remote PIC may momentarily reduce the lighting intensity if it impacts his or her night-vision.

Source: 14 CFR part 107.29; AC 107, *Small UAS* (as amended)

10. **Visual Line of Sight**

10.1. The small unmanned aircraft must remain within visual line-of-sight (VLOS) of flight crewmembers. Visual line of sight means any flight crewmember (i.e. the Remote PIC; person manipulating the controls; and visual observers, if used) is capable of seeing the aircraft with vision unaided by any device other than corrective lenses (spectacles or contact lenses).

10.2. Crewmembers must operate within the following limitations.

10.3. Minimum visibility, as observed from the location of the control station, must be no less than 3 statute miles

10.4. Minimum distance from clouds must be no less than 500 feet below a cloud and 2000 feet horizontally from the cloud

10.5. Crewmembers must be able to see the small unmanned aircraft at all times during flight. Therefore, the small unmanned aircraft must be operated closely enough to the control station to ensure visibility requirements are met during small unmanned aircraft operations.

Sources: 14 CFR parts 107.31 and 107.51; AC 107, *Small UAS* (as amended)

11. Restrictions on Vision Aids

- Visual line of sight must be accomplished and maintained by unaided vision, except vision that is corrected by the use of eyeglasses (spectacles) or contact lenses.
- Vision aids, such as binoculars, may be used only momentarily to enhance situational awareness. For example, the Remote PIC, person manipulating the controls, or visual observer may use vision aids briefly to avoid flying over persons or to avoid conflicting with other aircraft.

Sources: 14 CFR part 107.3; AC 107, *Small UAS* (as amended)

12. **Regaining Visual Line of Sight**

12.1. The Remote PIC or person manipulating the controls may have brief moments in which he or she is not looking directly at or cannot see the small unmanned aircraft, but still retains the capability to see it or quickly maneuver it back to line of sight.

12.2. These moments should be for:

12.2.1. **The safety of the operation,** such as briefly looking down at the control station or scanning the airspace. To scan for traffic, the crew should systematically focus on different segments of the sky for short intervals.

12.2.2. **Operational necessity,** such as intentionally maneuvering the aircraft for a brief period behind an obstruction

12.2.3. There is no specific time interval for which interruption of visual contact is permissible. Such parameters could potentially allow a hazardous interruption or prohibit a reasonable one.

12.2.4. The Remote PIC or person manipulating the controls must attempt to regain visual line of sight:

- **Immediately,** if he or she unintentionally loses sight of the aircraft
- **As soon as practicable,** if he or she loses sight of the aircraft for operational necessity

Source: AC 107, *Small UAS* (as amended)

13. Operating Limitations for Small Unmanned Aircraft

The small unmanned aircraft must be operated in accordance with the following limitations:

- Cannot be flown faster than a groundspeed of 87 knots (100 miles per hour)
- Cannot be flown higher than 400 feet above ground level (AGL) unless flown within a 400-foot radius of a structure and is not flown higher than 400 feet above the structure's immediate uppermost limit

Sources: 14 CFR part 107.51; AC 107, *Small UAS* (as amended)

14. Operation near Aircraft: Right of Way Rules

14.1. No person may operate a small unmanned aircraft in a manner that interferes with operations and traffic patterns at any airport, heliport, or seaplane base. The Remote PIC also has a responsibility to remain clear of and yield right-of-way to all other aircraft, manned or unmanned, and avoid other potential hazards that may affect the Remote PIC's operation of the aircraft. This is traditionally referred to as "see and avoid".

14.2. To satisfy this responsibility, the Remote PIC must:

14.3. Know the location and flight path of his or her small unmanned aircraft at all times

14.4. Be aware of other aircraft, persons, and property in the vicinity of the operating area

14.5. Be able to maneuver the small unmanned aircraft to:

- Avoid a collision

- Prevent other aircraft from having to take evasive action

14.6. Avoid operating anywhere where the presence of his or her unmanned aircraft may interfere with operations at the airport, such as approach corridors, taxiways, runways, or helipads

14.7. Yield right-of-way to all other aircraft, including aircraft operating on the surface of the airport

14.8. First-person view camera cannot satisfy ‘‘see-and-avoid’’ requirement. However, such cameras can be used as long as the “see-and-avoid” requirement is satisfied in other ways.

Sources: 14 CFR parts 107.37 and 43; AC 107, *Small UAS* (as amended)

15. Operation in Certain Airspace

Many sUAS operations can be conducted in uncontrolled, Class G airspace without further permission or authorization. However, operations require prior authorization from Air Traffic Control (ATC) in Class B, C, and D airspace and within the lateral boundaries of the surface area of Class E airspace designated for an airport.

It is incumbent on the Remote PIC to be aware of the type of airspace in which they will be operating their sUAS. As with other flight operations, the Remote PIC should refer to current aeronautical charts and other navigation tools to determine position and related airspace.

Sources: 14 CFR part 107.41; AC 107, *Small UAS* (as amended)

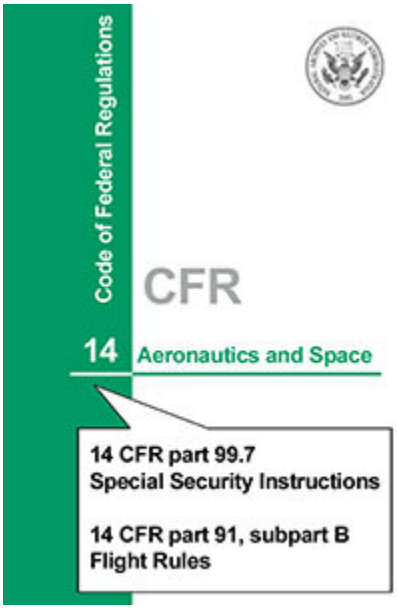
16. Notices to Airmen (NOTAMs)

16.1. Temporary Flight Restrictions (TFRs) are inclusive of sUAS operations. For that reason, it is necessary for the Remote PIC to check for Notices to Airmen (NOTAMs) before each flight to determine if there are any applicable airspace restrictions.

16.2. Common TFRs that relate to sUAS operations include, but are not limited to:

- Presidential TFRs and NOTAMs
- Emergency response TFRs and NOTAMs
- Standing TFRs that go into and out of effect (e.g., stadiums for sporting events)

17. Operation in Prohibited or Restricted Areas or Areas Designated in NOTAMs



No person may operate a small unmanned aircraft in prohibited or restricted areas unless that person has permission from the using or controlling agency, as appropriate.

The Remote PIC must comply with the following provisions:

- The provisions of 14 CFR part 99.7, *Special Security Instructions*
- The following provisions of 14 CFR part 91 subpart B, *Flight Rules*:
  - 14 CFR part 91.137 Temporary flight restrictions in the vicinity of disaster/hazard areas
  - 14 CFR part 91.138 Temporary flight restrictions in national disaster areas in the State of Hawaii
  - 14 CFR part 91.139 Emergency air traffic rules
  - 14 CFR part 91.141 Flight restrictions in the proximity of the Presidential and other parties
  - 14 CFR part 91.143 Flight limitation in the proximity of space flight operations
  - 14 CFR part 91.144 Temporary restriction on flight operations during abnormally high barometric pressure conditions
  - 14 CFR part 91.145 Management of aircraft operations in the vicinity of aerial demonstrations and major sporting events

Sources: 14 CFR parts 107.45 and 107.47; AC 107, *Small UAS* (as amended)

18. Obtaining Airspace Authorizations

ATC has the authority to approve or deny aircraft operations based on traffic density, controller workload, communication issues, or any other type of operations that could potentially impact the safe and expeditious flow of air traffic in that airspace.

When ATC authorization is required, it must be requested and granted before any operation in that airspace. There is currently no established timeline for approval after ATC permission has been requested because the time required for approval will vary based on the resources available at the ATC facility and the complexity and safety issues raised by each specific request.

For this reason, Remote PICs should contact the appropriate ATC facility as soon as possible prior to any operation in Class B, C and D airspace and within the lateral boundaries of the surface area of Class E airspace designated for an airport.

Source: AC 107, *Small UAS* (as amended)

19. Frequency

19.1. Frequency Spectrum

Most sUAS use radio frequencies to establish the data link between the control station and the small unmanned aircraft.

Considerations for radio frequencies used in sUAS operations include:

- Frequency interference
- Line of sight/obstructions

This section of the lesson describes each topic in more detail on the next screens.

Source: AC 107, *Small UAS* (as amended)

19.2. Frequency Interference

The most commonly used sUAS frequencies are 2.4GHz and 5.8GHz.

These unlicensed radio frequency bands are regulated by the Federal Communications Commission (FCC).

These frequencies are also used for computer wireless networks. Therefore, frequency interference can cause problems when operating an unmanned aircraft in areas with many wireless signals (e.g., near dense housing or office buildings).

- Lost links and flyaways are some of the reported problems with sUAS frequency implications
- To avoid frequency interference many modern sUAS operate using a 5.8GHz system to control the small unmanned aircraft and a 2.4GHz system to transmit video and photos to the ground
- Consult the sUAS operating manual and manufacturers recommended procedures before conducting sUAS operations

Source: AC 107, *Small UAS* (as amended)

19.3. Line of Sight and Frequency Obstructions

Both sUAS radio frequency bands (2.4GHz and 5.8GHz) are considered line of sight.

Be aware that the command and control link between the control station and the small unmanned aircraft may not work properly when barriers are between the control station and the unmanned aircraft.

Source: AC 107, *Small UAS* (as amended)

19.4. Spectrum Authorization

Radio transmissions, such as those used to control an unmanned aircraft and to downlink real-time video, must use frequency bands that are approved for use by the operating agency. Operations on licensed band frequencies require a user-specific license for all civil users, except federal agencies, to be obtained from the FCC.

Visit the Resources page to access the FCC Licensing website that provides information about spectrum authorization.

Source: AC 107, *Small UAS* (as amended)

20. No Operation Over People

You may not operate a small unmanned aircraft directly over another person **unless** that person is:

- Directly involved in the operation (such as a visual observer or other crewmember)
  OR
- Within a safe cover, such as inside a stationary vehicle or a protective structure that would protect a person from harm if the small unmanned aircraft were to crash into that structure

Sources: 14 CFR part 107.39; AC 107, *Small UAS* (as amended)

20.1. Protecting Non-Participants

To comply with limitations on sUAS operations near persons not participating in the operation, the Remote PIC should employ the strategies described below.

- Select an appropriate operational area for the sUAS flight
  - Ideally, select an operational area (site) that is sparsely populated
  - If operating in populated/inhabited areas, make a plan to keep non-participants clear, indoors, or under cover
  - If operating from a moving vehicle, choose a sparsely populated (or unpopulated) area and make a plan to keep sUAS clear of anyone who may approach
- Adopt an appropriate operating distance from non-participants
- Take reasonable precautions to keep the operational area free of non-participants

Sources: 14 CFR part 107.39; AC 107, *Small UAS* (as amended)

21. Operation from Moving Vehicles or Aircraft

14 CFR part 107 permits operation of an sUAS from a moving land or water-borne vehicle over a sparsely populated (or unpopulated) area. However, operation from a moving aircraft is prohibited.

Additionally, small unmanned aircraft that are transporting another person's property for compensation or hire may not be operated from any moving vehicle.

Source: 14 CFR part 107.25; AC 107, *Small UAS* (as amended)

22. Transporting Another Person's Property

The sUAS may be used to transport another person's property (cargo) for compensation or hire provided you comply with the additional requirements described below.

- The total weight of the sUAS (including the cargo) must remain below 55lbs
- The sUAS operation must be within the boundaries of a State (intrastate)
- No items may be dropped from the small unmanned aircraft in a manner that creates an undue hazard to persons or property
- You may not operate the sUAS from a moving land vehicle or water-born vessel

23. Moving Vehicles

23.1. Moving Vehicles: Part 107 Restrictions

Operations from moving vehicles are subject to the same restrictions that apply to all other part 107 sUAS operations.

Examples include:

- **Visual Line of Sight:** The Remote PIC (and the person manipulating the controls, if applicable) operating from a moving vehicle or watercraft is still required to maintain visual line of sight for the sUAS
- **Operations over People:** Operations are still prohibited over persons not directly involved in the operation of the sUAS, unless under safe cover. The Remote PIC is also responsible for ensuring that no person is subject to undue risk as a result of loss of control of the small unmanned aircraft for any reason.
- **Communication:** The visual observer and Remote PIC must still maintain effective communication
- **No Reckless Operation:** Part 107 also prohibits careless or reckless operation of an sUAS. Operating an sUAS while driving a moving vehicle is considered to be careless or reckless because the driver's attention would be hazardously divided. Therefore, the driver of a land vehicle or the operator of a water-borne vehicle must not serve as the Remote PIC, person manipulating the controls, or visual observer.

Source: 14 CFR part 107.25

23.2. Moving Vehicles: State and Local Traffic Laws

Other laws, such as State and local traffic laws, may also apply to the conduct of a person driving a vehicle.

Many states currently prohibit distracted driving and state or local laws may also be amended in the future to impose restrictions on how cars and public roads may be used with regard to an sUAS operation. The FAA emphasizes that people involved in an sUAS operation are responsible for complying with all applicable laws and not just the FAA's regulations.

24. No Operations While Impaired

Part 107 does not allow operation of an sUAS if the Remote PIC, person manipulating the controls, or visual observer is unable to safely carry out his or her duties and responsibilities.

While drug and alcohol use are known to impair judgment, certain over-the-counter medications and medical conditions could also affect the ability to safely operate a small unmanned aircraft. For example, certain antihistamines and decongestants may cause drowsiness.

You may not directly participate in the operation of an sUAS if you know or have reason to know that you have a physical or mental condition that would interfere with the safe operation of the sUAS.

Sources: 14 CFR part 107.17; AC 107, *Small UAS* (as amended)

24.1. Impaired Judgement: Prohibition Thresholds

Part 107 prohibits a person from serving as any sUAS crewmember if he or she:

- Consumed any alcoholic beverage within the preceding 8 hours
- Is under the influence of alcohol
- Has a blood alcohol concentration of .04% or greater
- Is using a drug that affects the person's mental or physical capabilities

Sources: 14 CFR part 107.27; AC 107, *Small UAS* (as amended)

25. No Hazardous Operation

No person may operate an sUAS in a careless or reckless manner so as to endanger another person's life or property. Part 107 also prohibits allowing an

object to be dropped from an sUAS in a manner that creates an undue hazard to persons or property.

Examples of hazardous operation include, but are not limited to:

- Operations that interfere with manned aircraft operations
- Operating an sUAS over persons not directly participating in the operation
- Loading the sUAS beyond its capabilities to the point of losing control

Source: 14 CFR part 107.23

26. Privacy and Other Considerations

Other laws, such as State and local privacy laws, may apply to sUAS operations. The Remote PIC is responsible for reviewing and complying with such laws prior to operation.

In addition, Remote PICs are encouraged to review the Department of Commerce National Telecommunications and Information Administration (NTIA) best practices that address privacy, transparency and accountability issues related to private and commercial use of sUAS.

Visit the Resources page to access the NTIA Voluntary Best Practices for UAS Privacy, Transparency, and Accountability.

27. Certificates of Waiver

If the Remote PIC determines that the operation cannot be conducted within the regulatory structure of part 107, he or she is responsible for applying for a Certificate of Waiver in accordance with 14 CFR part 107.200 and proposing a safe alternative to the operation.

This Certificate of Waiver will allow an sUAS operation to deviate from certain provisions of part 107 as long as the FAA finds that the proposed operation can be safely conducted under the terms of that Certificate of Waiver.

Visit the Resources page to access the online application for a UAS Certificate of Waiver.

Sources: 14 CFR part 107.200; AC 107, *Small UAS* (as amended)

27.1. Waivable Sections of Part 107

A request for a waiver may be granted if the FAA finds that the proposed operation can be safely conducted under the terms of that Certificate of Waiver.

A list of the waivable sections of part 107 can be found in 14 CFR part 107.205 and are listed below:

- § 107.25 Operation from a moving vehicle or aircraft. However, no waiver of this provision will be issued to allow the carriage of property of another by aircraft for compensation or hire
- § 107.29 Daylight operation
- § 107.31 Visual line of sight aircraft operation. However, no waiver of this provision will be issued to allow the carriage of property of another by aircraft for compensation or hire
- § 107.33 Visual observer
- § 107.35 Operation of multiple small unmanned aircraft systems
- § 107.37(a) Yielding the right of way
- § 107.39 Operation over people
- § 107.41 Operation in certain airspace
- § 107.51 Operating limitations for small unmanned aircraft

Sources: 14 CFR parts 107.200 and 107.205; AC 107, *Small UAS* (as amended)

28. Emergency

28.1. Emergency Planning and Communication

In case of an in-flight emergency, the Remote PIC is permitted to deviate from any rule of part 107 to the extent necessary to meet that emergency. Upon FAA request, you must send a written report to the FAA explaining the deviation.

Become familiar with any manufacturer suggested emergency procedures prior to flight. Review emergency actions during preflight planning and inform crew members of their responsibilities.

Sources: 14 CFR part 107.21; AC 107, *Small UAS* (as amended)

28.2. Common Abnormal and Emergency Situations

The Remote PIC must be prepared to respond to abnormal and emergency situations during sUAS operations.

Refer to the manufacturer's guidance for appropriate procedures in the following situations:

- Abnormal situations, such as lost link, alternate landing/recovery sites, and flight termination (controlled flight to the ground)
- Emergency situations, such as flyaways, loss of Global Positioning System (GPS), and battery fires

Each situation is described in more detail on the next screens.

29. Lost Link

Without an onboard pilot, sUAS crewmembers rely on the command and control link to operate the aircraft. For example, an uplink transmits command instructions to the aircraft and a downlink transmits the status of the aircraft and provides situational awareness to the Remote PIC or person manipulating the controls.

Lost link is an interruption or loss of the control link between the control station and the unmanned aircraft, preventing control of the aircraft. As a result, the unmanned aircraft performs pre-set lost link procedures. Such procedures ensure that the unmanned aircraft:

- Remains airborne in a predictable or planned maneuver, allowing time to re-establish the communication link
- Autolands, if available, after a predetermined length of time or terminates the flight when the power source is depleted

A lost link is an abnormal situation, but not an emergency. A lost link is not considered a flyaway, which is defined in the next section of this lesson.

Source: AC 107, *Small UAS* (as amended)

29.1. Lost Link: Pre-Flight Preparations

Follow the manufacturer's recommendations for programming lost link procedures prior to the flight.

Examples of lost link procedures may include, when applicable:

- A lost link route of flight that avoids flight over populated areas
- Communications procedures

Plan contingency measures in the event recovery of the sUAS is not feasible. More information about this topic is provided on the next screens.

30. Contingency Planning

Contingency planning should include an alternate landing/recovery site to be used in the event of an abnormal condition that requires a precautionary landing away from the original launch location.

Incorporate the means of communication with ATC throughout the descent and landing (if required for the flight operation) as well as a plan for ground operations and securing/parking the aircraft on the ground. This includes the availability of control stations capable of launch/recovery, communication equipment, and an adequate power source to operate all required equipment.

Take into consideration all airspace constructs and minimize risk to other aircraft by avoiding congested areas to the maximum extent possible.

31. Flight Termination

Flight termination is the intentional and deliberate process of performing controlled flight to the ground. Flight termination may be part of lost link procedures, or it may be a contingency that you elect to use if further flight of the aircraft cannot be safely achieved, or if other potential hazards exist that require immediate discontinuation of flight.

Execute flight termination procedures if you have exhausted all other contingencies.

Flight termination points (FTPs), if used, or alternative contingency planning measures must:

- Be located within power-off glide distance of the aircraft during all phases of flight
- Be based on the assumption of an unrecoverable system failure
- Take into consideration altitude, winds, and other factors
- Flyaways: A flyaway begins as a lost link—an interruption or loss of the control link prevents control of the aircraft. As a result, the unmanned aircraft is not operating in a predicable or planned manner. However in a flyaway, the pre-set lost link procedures are not established or are not being executed by the unmanned aircraft, creating an emergency situation.
- If a flyaway occurs while operating in airspace that requires authorization, notify ATC as outlined in the authorization.

32. Loss of Global Positioning System (GPS)

Global positioning system (GPS) tools can be a valuable resource for flight planning and situational awareness during sUAS operation.

However, as with manned aviation, Remote PICs in sUAS operations must avoid overreliance on automation and must be prepared to operate the unmanned aircraft manually, if necessary.

- Prior to flight, check NOTAMs for any known GPS service disruptions in the planned location of the sUAS operation
- Make a plan of action to prevent or minimize damage in the event of equipment malfunction or failure

Sources: AC 107, *Small UAS* (as amended)

33. Battery

33.1. Risk of Battery Fires

Battery fires pose a significant hazard to sUAS.

Both Lithium metal and lithium-ion batteries are:

- Highly flammable
- Capable of self-ignition when a battery short circuits or is overcharged, heated to extreme temperatures, mishandled, or otherwise defective
- Subject to thermal runaway

During thermal runaway, lithium metal batteries generate sufficient heat to cause adjacent cells to go into thermal runaway. As a result, the lithium metal cell releases an explosive combination of a flammable electrolyte and molten lithium metal, accompanied by a large pressure pulse.

Source: Safety Alert for Operators (SAFO) 10017, *Risks in Transporting Lithium Batteries in Cargo by Aircraft*

33.2. Preventing Battery Fires: Storage

Ensure careful storage of spare (uninstalled) lithium batteries.

Take the following precautions to prevent a battery fire:

- Prevent short circuits by placing each individual battery in the original retail packaging, a separate plastic bag, or a protective pouch or by insulating exposed terminals with tape
- Do not allow spare batteries to come in contact with metal objects, such as coins, keys, or jewelry
- Take steps to prevent objects from crushing, puncturing, or applying pressure on the battery

Source: SAFO 15010, *Carriage of Spare Lithium Batteries in Carry-On and Checked Baggage*

33.3. Preventing Battery Fires: Preflight

When preparing to conduct sUAS operations, do not use any battery with signs of damage or defect. For example, check carefully for small nicks in the battery casing and be alert for signs of bubbling or warping during charging.

Once the battery is installed and the sUAS takes flight, the Remote PIC or ground crew may not observe a battery fire until it is too late to land the aircraft safely.

If a battery fire occurs, follow any manufacturer guidance for response procedures.

34. Accident Reporting

The Remote PIC must report any sUAS accident to the FAA, within 10 days of the operation, if any of the following thresholds are met:

- **Serious injury** to any person or any loss of consciousness
- **Damage** to any property, other than the small unmanned aircraft, if the cost is greater than $500 to repair or replace the property (whichever is lower)

File the report:

- **Electronically,** via the FAA online sUAS accident reporting website
- **By phone** to:
  - The appropriate FAA Regional Operations Center

- The nearest Flight Standards District Office (FSDO)

Visit the Resources page to access the accident reporting website or contact information for the FSDOs and Regional Operations Centers (listed in AC 107, *Small UAS* (as amended))

Sources: 14 CFR part 107.9; AC 107, *Small UAS* (as amended)

34.1. Accident Reporting: Serious Injury Threshold

Under 14 CFR part 107, a serious injury qualifies as Level 3 or higher on the Abbreviated Injury Scale (AIS) of the Association for the Advancement of Automotive Medicine. This scale is an anatomical scoring system that is widely used by emergency medical personnel.

It would be considered a serious injury **if a person requires hospitalization, but the injury is fully reversible** including, but not limited to:

- Head trauma
- Broken bone(s)
- Laceration(s) to the skin that requires suturing

Sources: 14 CFR part 107(III)(I)(2); AC 107, *Small UAS* (as amended)

34.2. Accident Reporting: Required Information

If the accident meets the previously described thresholds, report the following key information to FAA.

Category	Required Information
Remote PIC Information	• Name • Contact Information • FAA Airman Certificate Number
Aircraft Information	• Registration Number (N-number or unique identifier issued in accordance with 14 CFR part 48)
Accident Information	• Location of the Accident • Date and Time of the Accident

Category	Required Information
	• Person(s) Injured and Extent of Injury (if any or known) • Property Damaged and Extent of Damage (if any or known) • Description of What Happened

In addition to this FAA report, and in accordance with the criteria established by the National Transportation Safety Board (NTSB), certain sUAS accidents must also be reported to the NTSB.

Source: AC 107, *Small UAS* (as amended)

35. **References**

Regulations and policy documents, such as 14 CFR part 107 and Advisory Circular (AC) 107, *Small UAS* (as amended)

- The FAA Airman Testing Standards Branch (AFS-630) Website that provides:
  - Reference Handbooks, such as the Aircraft Weight and Balance Handbook, Pilot's Handbook of Aeronautical Knowledge (PHAK), Aeronautical Information Manual (AIM), and Risk Management Handbook
  - UAS Airman Certification Standards (ACS)

Appendix A
Preflight Inspection Checklist

Even if the small unmanned aircraft system (sUAS) manufacturer has a written preflight inspection procedure, it is recommended that the Remote Pilot in Command (Remote PIC) ensure that the following inspection items are incorporated into the preflight inspection procedure required by part 107 to help the Remote PIC determine that the sUAS is in a condition for safe operation.
Conduct a preflight visual or functional check of the aircraft, including (but not limited to) the steps below.

- ❑ Visually inspect the condition of the unmanned aircraft system components
- ❑ Inspect the airframe structure, including undercarriage, all flight control surfaces and linkages
- ❑ Inspect registration markings for proper display and legibility
- ❑ Inspect moveable control surface(s), including airframe attachment point(s)
- ❑ Inspect servo motor(s), including attachment point(s)
- ❑ Inspect the propulsion system, including powerplant(s), propeller(s), rotor(s), ducted fan(s), etc.
- ❑ Verify all systems (e.g. aircraft, control unit) have an adequate energy supply for the intended operation and are functioning properly
- ❑ Inspect the avionics, including control link transceiver, communication/navigation equipment and antenna(s)
- ❑ Calibrate UAS compass prior to any flight
- ❑ Inspect the control link transceiver, communication/navigation data link transceiver, and antenna(s)
- ❑ Check that the display panel, if used, is functioning properly
- ❑ Check ground support equipment, including takeoff and landing systems, for proper operation
- ❑ Check that control link correct functionality is established between the aircraft and the control station
- ❑ Check for correct movement of control surfaces using the control station
- ❑ Check on board navigation and communication data links
- ❑ Check flight termination system, if installed
- ❑ Check fuel for correct type and quantity
- ❑ Check battery levels for the aircraft and control station
- ❑ Check that any equipment, such as a camera, is securely attached
- ❑ Verify communication with UAS and that the UAS has acquired GPS location from at least 4 satellites
- ❑ Start the UAS propellers to inspect for any imbalance or irregular operation
- ❑ Verify all controller operation for heading and altitude
- ❑ If required by flight path walk through, verify any noted obstructions that may interfere with the UAS
- ❑ At a controlled low altitude, fly within range of any interference and recheck all controls and stability

Adapted from: Advisory Circular 107, *Small Unmanned Aircraft Systems* (as amended)