UAS Standards, Reg, Law & Exam

FAA Regulations: Part 107

Lesson 5c – Operations: Emergency Procedures

Emergency Procedures

- References – AC 107-2A; FAA-H-8083-25B; SAFO 15010, SAFO 10017, SAFO 09013
- Objective – to determine that the applicant is knowledgeable in sUAS emergency procedures.

The Applicant Demonstrates Understanding Of

- UA.V.C.K1 Emergency planning and communication
- UA.V.C.K2 Characteristics and potential hazards of lithium batteries
  - UA.V.C.K2a – Safe transportation, such as proper inspection and handling
  - UA.V.C.K2b – Safe charging
  - UA.V.C.K2c – Safe usage
  - UA.V.C.K2d – Risks of fires involving lithium batteries
- UA.V.C.K3 Loss of aircraft control link and fly-away
- UA.V.C.K4 Loss of Global Positioning System (GPS) signal during flight and potential consequences
- UA.V.C.K5 Frequency spectrums and associated limitations

Safety is Job #1

- This lecture is about safety and what to do when, not if, you encounter an emergency situation
- If you fly UAVs long enough you will face an emergency situation of some kind. It is inevitable
- UAS have many points of failure and one of these days something will fail and you as the RPIC will have to deal with it and its consequences
- Safety is an Attitude
- Safety is a Mindset that is a fundamental part of aviation.
- Who is responsible? – RPIC

Introduction

- An inflight emergency is usually an unexpected and unforeseen event that can have serious consequences for an unprepared remote pilot
- During an emergency, a remote pilot is permitted to deviate from any part of 14 CFR part 107 to respond to the emergency
- When a remote pilot does deviate from a rule due to an emergency, the remote will report the emergency if asked to do so by the FAA (also referred to as "the Administrator")

Inflight Emergency

- A remote pilot is responsible for the safe operation of the small UA at all times.
- A remote pilot must ensure that the aircraft is in a safe operating condition before flight, that there is not any hazard to persons or property, and that all required crew members are properly briefed on the operation and emergency procedures.

Inflight Emergency

- Before every flight, a remote pilot will conduct a preflight inspection of the aircraft.
- If any irregularities are found in the inspection, they must be corrected before the small UA is operated.
- Some small UA manufacturers will provide the remote pilot with preflight inspection items.
- For those small UAs that do not have a manufacturer checklist, the remote should develop a checklist that will provide enough information that the aircraft will be operated in a safe condition.

Inflight Emergency

- When a remote pilot does experience an inflight emergency, the pilot may take any action to ensure that there is not a hazard to other people or property.
- For example, if during a flight the small UA experiences as battery fire, the remote pilot may need to climb the small UA above 400’ AGL to maneuver to a safe landing area. In this instance, a report will need to be made only if asked to do so by the FAA.

Inflight Emergency

- When other crew members are used during a flight, all of those crew members must be briefed on the flight and the planned emergency procedures for the flight. The briefing will be given to any visual observers (VO) that might be used and any non-certificated person who is allowed to manipulate the flight controls of the small UA.

Emergency Planning – What To Consider

5.11 – Preflight Familiarization, Inspection, and Actions for Aircraft Operation.

- The remote PIC must complete a preflight familiarization, inspection, and other actions, such as crewmember briefings, prior to beginning flight operations (§ 107.49).
- The FAA has produced many publications providing in-depth information on topics such as aviation weather, aircraft loading and performance, emergency procedures, risk mitigation, ADM, and airspace, which should all be considered prior to operations (see Appendix E, Sample Preflight Assessment and Inspection Checklist).
- Additionally, all remote pilots are encouraged to review FAA publications (see paragraph 2.3).

Emergency Planning – What To Consider

Prior to flight, the RPIC must conduct an assessment of the operating environment. The assessment must include at least the following:

- Local weather conditions;
- Local airspace and any flight restrictions;
- The location of persons and moving vehicles not directly participating in the operation, and property on the surface;
- If conducting operations over people or moving vehicles, ensure their small unmanned aircraft is eligible for the category or categories of operations (see Chapter 8);
- Consider the potential for persons and moving vehicles not directly participating in operations entering the operational area for the duration of the operation;
- Consider whether the operation will be conducted over an open-air assembly of persons; and
- Other ground hazards.

Emergency Planning and Communication

The RPIC is responsible for briefing all the participants in every mission.

- Who should you brief on emergency safety procedures:
  - Your clients
  - Your crew members
  - All ground-based crew
  - In short, everyone who is involved in the mission
- What should the briefing cover:
  - Operating conditions;
  - Emergency procedures;
  - Contingency procedures, including those for persons or moving vehicles not directly participating in the operation that enter the operational area;
  - Roles and responsibilities of each person participating in the operation; and
  - Potential hazards.

Is The Mission Safe?

- If you are not comfortable with your ability to mitigate the potential safety concerns of a particular job, DON'T TAKE IT!
- The consequences of a mission failure are probably far more significant than the lost revenue.

How DO I Know If A Mission Is Safe?

- Identify the hazards before you fly – conduct a site survey
  - By looking around your project area for local hazards such as towers, power lines, trees, and other structures.
  - Checking for radio interference that may compromise communication signals between the remote controller and the aircraft.
  - Checking for magnetic interference, which could be an issue if there are steel structures close by. Metal can sometimes be tough to spot, like steel rebar in concrete or underground metal pipes.
  - Looking at the traffic patterns of vehicles that may be endangered by your operation.
  - A look at any bystanders who may not be aware of what you are doing and who might be distracted or afraid of what you are doing.
  - A look at wind obstructions that can create turbulence.
- This can take place well before you will be flying your mission.

Handling An Emergency

- Rule #1 – Maintain Control of your aircraft!
- A failed video connection does not necessarily mean you have lost the ability to control the aircraft. Remember Control and Video RF are different.
- Many systems have failsafe systems built in that will hover the UAV or cause it to "Return to Home" in the event of a hardware failure.
- Know your UAS. Does it have these failsafe systems?

Situations That Might Trigger An Emergency Maneuver

- Loss of orientation
- Loss of GPS signal
- Compass error
- Loss of direct line-of-sight
- Loss of video feed
- Fly-away
- Erratic movement
- Structures in line of flight
- Birds

Emergency Maneuvers

- Example – maneuvering to avoid manned aircraft or birds in the project area may require:
  - Switching from autonomous mode to manual control
  - Ascending or Descend as quickly as possible
- Avoidance of person, animal or vehicle encroaching into the landing zone may require:
  - Switch to manual mode when flying in autonomous mode.
  - Holding altitude and not landing until the area is clear.
  - Use of an alternate landing area that you identified during pre-flight.
  - Clearing the intruder from the landing area.
  - Land the aircraft as soon as it is possible to do so safely.

Emergency Situations

- Don’t take off again immediately.
- Take time to assess what happened, why it happened, and how it can be avoided on any subsequent flights.
- Relax and remember – IMSAFE!

IMSAFE

- Illness – Am I suffering from any illness or symptom of an illness which might affect me in flight?
- Medication – Am I currently taking any drugs (prescription or over-the-counter)?
- Stress – Am I experiencing any psychological or emotional factors which might affect my performance?
- Alcohol – Have I consumed alcohol within the last 8 to 24 hours?
- Fatigue – Have I received sufficient sleep and rest in the recent past?
- Emotion or Eating – Have I fully recovered from any recent upsetting events? Am I sufficiently nourished?

Close Calls and Uh-ohs

- Document, Document, Document
- Record
  - sUAS remote PIC's name, contact information & FAA airman certificate number;
  - sUAS registration number issued to the aircraft;
  - Location, Date and Time of the incident;
  - 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
- This information will be required if it is necessary to submit an incident report to the FAA.

Do I Report the Incident to the FAA?

- 107.9 Accident Reporting
  - No later than 10 calendar days after an operation that meets the criteria of either paragraph (a) or (b) of this section, a remote pilot in command must report to the FAA, in a manner acceptable to the Administrator, any operation of the small unmanned aircraft involving at least:
  - (a) Serious injury to any person or any loss of consciousness; or
  - (b) Damage to any property, other than the small unmanned aircraft, unless one of the following conditions is satisfied:
  - (1) The cost of repair (including materials and labor) does not exceed $500; or
  - (2) The fair market value of the property does not exceed $500 in the event of total loss.
- Source – https://www.ecfr.gov/current/title-14/chapter-I/subchapter-F/part-107#107.9

Where To File An Incident Report

- The report can be submitted to the appropriate FAA Regional Operations Center (ROC) electronically (http://www.faa.gov/uas) or by phone.
- Reports can also be made to the nearest jurisdictional Flight Standards District Office (FSDO) http://www.faa.gov/about/office_org/field_offices/fsdo/

Lithium Batteries

- Lithium–ion Polymer (LiPo) batteries are the most commonly used power source for UAVs.
- A properly charged and maintained LiPo battery can provide as many as 200-300 recharge/discharge cycles.
- An improperly maintained battery may provide as few as 50 cycles. This is why you want to maintain logs of all battery charges and use.
- Note: always follow the manufacturers recommendations for battery care.

Lithium Batteries

- Lithium-based (LiPo) batteries are highly flammable and capable of ignition or thermal runaway.
- A battery fire could cause an in-flight emergency by causing a loss of control (LOC) of the small UA.
- Lithium battery fires can be caused when a battery short circuits, is improperly charged, is heated to extreme temperatures, is damaged as a result of a crash, is mishandled, or is simply defective.
- The Remote PIC should consider following the manufacturer's recommendations, when available, to help ensure safe battery handling and usage.

Lithium Batteries

- Thermal runaway occurs in situations where an increase in temperature changes the conditions in a way that causes a further increase in temperature.
- In the case of lithium batteries if a battery cell overheats and begins to meltdown or catch on fire it can cause the other cells to do the same causing a chain reaction.
- The procedures to control a lithium battery fire consist of two phases: extinguishing the fire utilizing halon (beside 'Halon 1301') or a halon replacement, extinguishing the fire utilizing a water extinguisher, cooling the remaining cells to stop additional thermal runaway by dousing with other appropriate non-flammable and non-alcohol-based liquids.
- A note about Halon 1301: This particular Halon is ineffective in controlling lithium battery fires, furthermore Halon 1301 is a threat to the ozone layer.

Lithium Batteries

- Proper care for lithium batteries is a must: follow the manufacturer's instructions regarding proper transportation and disposal.
- This includes proper identification and special designed cargo containers for lithium batteries.
- Damaged or retired lithium batteries should not be disposed in routine household or office trash.

Lithium Batteries

- Lithium-based batteries are highly flammable and capable of ignition even in-flight creating a loss of control (LOC) or after a UA crash.
- Again, lithium battery fires can be caused when a battery short circuits, is improperly charged, is heated to extreme temperatures, is damaged as a result of a crash, is mishandled, or is simply defective.
- Again, for the purpose of the exam and repetition: The Remote PIC should consider following the manufacturer's recommendations, when available, to help ensure safe battery handling, safe charging and usage.

Traveling With Lithium Batteries

- DO NOT travel with a LiPo battery in your checked baggage.
- DO carry-on any LiPo batteries when traveling.
- The U.S. and International Regulations prohibit lithium batteries in checked baggage, including any baggage checked at the gate.
- Each lithium battery must be individually protected so as to prevent short circuits. This can be accomplished by:
  - Placing each battery in the original retail packaging
  - Insulating terminals by taping over exposed terminals,
  - Placing each battery in a separate plastic bag or protective pouch such as a charging bag.
  - LiPo batteries must not come in contact with metal objects, such as coins, keys, or jewelry
  - Taking steps to prevent crushing, puncturing, or pressure on the battery

Lithium Batteries

- Temperature matters.
- Always store LiPo batteries in a cool, dry place, preferably at room temperature.
- Do not store them in a hot garage, or in a cold refrigerator.
  - Taking a battery out from a cold fridge can cause condensation to occur on the inside of the battery, which can be very dangerous.
  - Heat damages batteries. The hotter your batteries get, the shorter their life.
- Charge batteries at room temperature. Never charge a battery that is still warm from usage, and never use a battery that is still warm from charging.

Lithium Batteries

- LiPo batteries do not work well when cold. The colder it is, the shorter your battery life due to the slowing down of the chemical activity within the battery.
- Performance degrades at 59°F (15°C) or colder.
- It is not recommended that you fly if it is below 14°F (-10°C). At these low temperatures the battery could cause your drone to suddenly fail without warning.

Lithium Batteries

- When Flying in Cold Weather
  - Make sure batteries are fully charged before each flight.
  - Warm batteries to about 75°F (25°C) or more before flight. You may want to consider using a battery heater if you routinely fly under cold conditions.
  - Hover the aircraft for around 30-45 seconds to allow the battery to warm up.

Charging Lithium Batteries

- Never leave LiPo batteries charging while unattended.
- If a battery becomes puffy, starts to smoke, or catches fire, immediately disconnect the power to the charger.
- Never discharge a LiPo battery below 3.0v per cell. Ideally, you never want to go below 3.2v per cell to maintain a healthy battery.
- Discharging a battery to 2.9v per cell or lower can permanently damage the battery.
- Never leave your LiPo batteries sitting around on a full charge for more than a couple of days.
- If you are not going to use the battery for more than two days, you need to discharge your battery down to 3.6v - 3.8v per cell for safe storage.
- Recharge the battery before the next use.
- Record the charge / discharge cycle in the UAS log book.

Lost link Lost GPS

- Autonomous Operations
  - An autonomous operation is generally considered an operation in which the remote pilot inputs a flight plan into the CS, which sends it to the autopilot onboard the small UA.
  - During automated flight, flight control inputs are made by components onboard the aircraft, not from a CS.
  - Thus, the remote PIC could lose the control link to the small UA and the aircraft would still continue to fly the programmed mission/return home to land.
  - During automated flight, the remote PIC also must have the ability to change routing/altitude or command the aircraft to land immediately.
  - The ability to direct the small UA may be through manual manipulation of the flight controls or through commands using automation.

Lost link Lost GPS

- 5.2.3.1 The remote PIC must retain the ability to direct the small UA to ensure compliance with the requirements of part 107.
  - There are a number of different methods that a remote PIC may utilize to direct the small UA to ensure compliance with part 107.
  - For example, the remote pilot may transmit a command for the autonomous aircraft to climb, descend, land now, proceed to a new waypoint, enter an orbit pattern, or return to home.
  - Any of these methods may be used to satisfactorily avoid a hazard or give right of way.
- 5.2.3.2 The use of automation does not allow a person to simultaneously operate more than one small UA.

Frequency Spectrums And Associated Limitations

- B.6 sUAS Frequency Utilization.
- An sUAS typically uses radio frequencies (RF) for the communication link between the CS and the small UA.

Frequency Spectrums And Associated Limitations

- B.6.1 Frequency spectrum (RF) Basics.
- The 2.4 GHz and 5.8 GHz systems are the unlicensed band RFs that most sUAS use for the connection between the CS and the small UA.

Frequency Spectrums And Associated Limitations

- Note the frequencies are also used for computer wireless networks and the interference can cause problems when operating a UA in an area (e.g., dense housing and office buildings) that has many wireless signals.
- LOC and fly-aways are some of the reported problems with sUAS frequency implications.
- To avoid frequency interference, many modern sUAS operate using a 5.8 GHz system to control the small UA and a 2.4 GHz system to transmit video and photos to the ground. Consult the sUAS operating manual and manufacturers recommended procedures before conducting sUAS operations.
- It should be noted that both RF bands (2.4 GHz and 5.8 GHz) are considered line of sight and the command and control link between the CS and the small UA will not work properly when barriers are between the CS and the UA. Part 107 requires the remote PIC or person manipulating the controls to be able to see the UA at all times, which should also help prevent obstructions from interfering with the line of sight frequency spectrum.

Frequency Spectrums And Associated Limitations

- B.6.2 Spectrum Authorization.
- Frequency spectrum used for small UA operations are regulated by the Federal Communications Commission (FCC).
- Radio transmissions, such as those used to control a UA and to downlink real-time video, must use frequency bands that are approved for use by the operating agency.
- The FCC authorizes civil operations. Some operating frequencies are unlicensed and can be used freely (e.g., 900 MHz, 2.4 GHz, and 5.8 GHz) without FCC approval.
- All other frequencies require a user-specific license for all civil users, except federal agencies, to be obtained from the FCC.
- For further information, visit https://www.fcc.gov/licensing-databases/licensing.

Frequency Spectrums And Associated Limitations

- Unmanned aircraft systems typically use radio frequencies (RF) for the communication link between the control station (CS), also referred to as the transmitter, and the unmanned aircraft.
- The unlicensed radio frequency bands used by most UAS are: 2.4 GHz and 5.8 GHz systems. These frequencies are used for the connection between the control station and the unmanned aircraft.
- They are also used for computer wireless networks.
- Interference from other 2.4 GHz and 5.8GHz systems can cause problems when operating an UA in an area that has many wireless signals, such as dense housing and office buildings.
- Loss-of-control (LOC) and fly-aways are some of the problems with sUAS frequency implications.

Frequency Spectrums And Associated Limitations

- To avoid frequency interference, many sUAS operate using a 2.4 GHz system to control the aircraft and a 5.8 GHz system to transmit video and photos to the ground.
- Both of these RF bands (2.4 GHz and 5.8 GHz) are considered line-of-sight. Meaning that the command and control link between the CS and the small UA will not work properly when barriers are between the Control Station and the UAV.
- Consult the sUAS operating manual and manufacturer's recommended procedures before conducting sUAS operations.

Frequency Spectrums And Associated Limitations

- Radio transmissions, such as those used to control a UA and to transmit real-time video, must use frequency bands that are approved for use by the Federal Communications Commission (FCC).
- Some operating frequencies are unlicensed and can be used freely (e.g., 900 MHz, 2.4 GHz, and 5.8 GHz) without FCC approval. All other frequencies require a user-specific license for all civil users, except federal agencies, which must be obtained from the FCC.