EMERGENCY PLANNING AND COMMUNICATIONS

AIRMAN CERTIFICATION STANDARDS: REMOTE PILOT SMALL: You will know and be able to explain in writing or oral form the below tasks regarding EMERGENCIES.

Task	Task C. Emergency Procedures
References	AC 107-2; FAA-H-8083-25; SAFO 15010, SAFO 10017, SAFO 09013
Objective	**To determine that the applicant is knowledgeable in sUAS emergency procedures.**
Knowledge	The applicant demonstrates understanding of:
UA.V.C.K1	1. Emergency planning and communication.
UA.V.C.K2	2. The characteristics and potential hazards of lithium batteries:
UA.V.C.K2a	a. Safe transportation, such as proper inspection and handling
UA.V.C.K2b	b. Safe charging
UA.V.C.K2c	c. Safe usage
UA.V.C.K2d	d. Risks of fires involving lithium batteries
UA.V.C.K3	3. Loss of aircraft control link and fly-aways.
UA.V.C.K4	4. Loss of Global Positioning System (GPS) signal during flight and potential consequences.
UA.V.C.K5	5.Frequency spectrums and associated limitations.

What would you consider an emergency regarding small unmanned aircraft systems?

THANKS TO UAVCOACH.COM FOR THE FOLLOWING INFORMATION
http://learn.uavcoach.com/courses/drone-pilot-ground-school/lectures/1284523#/questions/1

With a manned aircraft, there are often external cues that help you to recognize that you're in an emergency situation during flight. A strange vibration, smoke in the cockpit, an unusual noise--these are all things that alert an experienced aircraft pilot that there's trouble. *When we sense problems we have checklists and procedures to follow depending on the nature of the emergency* and actively communicate and receive assistance from air traffic control.

However, with an unmanned aircraft, none of these cues are available, and in addition, if the communication links are broken, the **unmanned aircraft system (UAS) must follow autonomous, pre-planned instructions if it is to recover and land**.

Packed into a UAS are hundreds of electronic components, all of which must withstand g-forces, vibrations and temperature changes, all within a short period of flight time. The fact that these complicated and delicate components must all work together at the same time is a feat in itself.

It is highly likely that if you haven't already experienced an inflight failure of some sort, *you will, probably sooner than later*.

The Safety Myth: "It Won’t Happen To Me" – is a dangerous perception in this business.

Jeff Cooper, a U.S. marine and an expert on the use and history of small arms, once said something you may have heard before: “Safety is something that happens between your ears, not something you hold in your hands.”

Safety is a mindset, and it’s a fundamental part of aviation.

Planning for an Emergency

As a remote PIC, you are ultimately responsible for briefing the participants--your clients, your crew members, other ground-based crew, etc.--about emergency procedures.

When it comes to emergency planning for your drone flight, there are many things to consider, like the different aircraft **points of failure** (propellers, motors, compass, etc.), but **also** the **approach of unmanned aircraft, and** the approach of **people on the ground**.

A key part of emergency operations planning is understanding everything that can go wrong during a flight in general and then planning for the specifics of a particular flight mission.

While it might not be easy, turning down a job because you don’t feel comfortable taking on the specific risks of that job in the context of potential emergency situations, that’s OK. That’s a common sense, prudent decision.

Conducting a Site Survey

Part of preparing for an emergency is conducting a site survey to understand the environment that you'll be operating in.

A good site survey might be done days in advance and could include:

- A look around for local hazards such as towers, power lines, trees, and other structures
- A check for radio interference that may compromise communication signals between the remote controller and the aircraft
- A check 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
- A look at the traffic patterns of vehicles that may be endangered by your operation
- A look at any non-participatory bystanders that may not be aware of what you are doing and be distracted or afraid of what you are doing
- A look at wind obstructions that can create turbulence.

Frequency Spectrums and Associated Limitations

An unmanned aircraft system typically uses radio frequencies (RF) for the communication link between the control station (CS), also referred to as the transmitter, and the unmanned aircraft.

The 2.4 GHz and 5.8 GHz systems are the unlicensed radio frequency bands that most UAS use for the connection between the control station and the unmanned aircraft. These frequencies are also used for computer wireless networks, and the interference 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 reported problems with sUAS frequency implications.

To avoid frequency interference, many modern sUAS operate using a 2.4 GHz system to control the small UA and a 5.8 GHz system to transmit video and photos to the ground. Consult the sUAS operating manual and manufacturer's recommended procedures before conducting sUAS operations. Consider an antenna parabolic directional signal concentrator.

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.

A final note about radio frequencies. 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). 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, which must be obtained from the FCC.

Lithium Batteries

Your unmanned aircraft has been in an accident, and during the accident your lithium battery was ejected from its compartment, and you noticed a small dent in the battery. What should you do before flying next?

You'll want to assess the extent of the damage before flying again!
Odds are you'll be flying an aircraft that uses lithium-ion polymer batteries, more commonly referred to as LiPo batteries. These guys are all rechargeable, come in a variety of power capacities and sizes, and are used to power other devices like mobile phones, notebook computers, and battery-powered electric vehicles.

Here's the thing. LiPo technology is great, but it's not perfect. In this section, I want to cover a few things that might surprise you but that are INCREDIBLY important not just to help you extend the life of your batteries but also to maintain your safety.

If you take proper care of your LiPo battery, you can get as many as 200-300 cycles out of it. If you're not taking care of your LiPo battery, you're looking at as few as 50 cycles. Quick side note: this is one reason it's important to log your flights and aircraft maintenance. You need to know at any given time how many cycles you've gone through on your different batteries So what does it mean to take care of your LiPo battery?

BEST PRACTICES

- Use a safety bag or fire-proof container like a metal ammo box for charging, discharging, and storage. Yes, LiPo batteries can cause fires. Just because your battery comes in a protective case doesn't mean it's safe.
- On that note, do not use your flight/travel case for long term LiPo storage. The foam and plastic in these cases can help spread a LiPo fire. Always use a fire-proof LiPo safety bag, metal ammo box, or other fire-proof container when you are charging, discharging, or storing your LiPo batteries. Your battery charging/discharging and storage area should be free from any materials that can catch fire, such as wood tables, carpet, or gasoline containers. The ideal surface for charging and storing LiPo batteries is concrete or ceramic.
- Speaking of travel, do NOT travel with a LiPo battery in your checked baggage. Use a carry-on. The U.S. Department of Transportation's Hazardous Materials Regulations (HMR), and equivalent International Civil Aviation Organization's Technical Instructions for the Safe Transport of Dangerous Goods (ICAO TI), prohibit spare lithium batteries from checked baggage (that includes baggage checked at the gate). Each spare lithium battery must be individually protected so as to prevent short circuits. Ways to do this are to (e.g., by placement it in original retail packaging, by insulating terminals by taping over exposed terminals, or to placing each battery in a separate plastic bag or protective pouch). Spare batteries must not come in contact with metal objects, such as coins, keys, or jewelry, and you should take steps to prevent crushing, puncturing, or pressure on the battery.

- If your battery is damaged or puffy / swollen, it’s done-zo. Make sure to follow proper disposal procedures and find a new battery ASAP.
- Don’t buy used batteries or batteries from unknown battery manufacturers. The potential issues you’ll have with cheap knock-offs aren’t worth the discounted rate you might be getting.
- Temperature matters. Always store your LiPo batteries in a cool, dry place. Shoot for room temperature. Do not store them in a hot garage, or in a cold refrigerator. Even though a cold battery has less chemical reaction taking place, and this fact which can prolong its lifespan, taking a battery out from a cold fridge can cause condensation to occur on the inside of the battery, which can be very dangerous. And while cold can be damaging, so can heat. The hotter your batteries get, the shorter their lifespan will be. Never charge a battery that is still warm from usage, and never use a battery that is still warm from charging.
- Related to this, LiPo batteries do not work well in cold weather. The colder it is, the shorter your battery life will be due to the slowing down of the chemical activity within the battery. You’ll start to see decreased performance at 59°F (15°C) or colder. If it is below 14°F (-10°C), LiPo usage is not recommended at all. Your battery could cause your drone to suddenly fail without warning in these temperatures.

*Some quick tips for **beating the cold**:*

- *Make sure **batteries are fully charged** before each flight.*

- ***Warm batteries to about 75°F** (25°C) or more before flight. We recommend using a battery heater.*

- *Hover the aircraft for around 30-45 seconds to allow the battery to warm up.*

- When you're charging a LiPo battery that has more than one cell, always use a proper LiPo battery balance charger/discharger. It is crucial that all cells in a LiPo battery **maintain the same voltage**. If the voltages across the cells deviate too much from each other (like 5-10 millivolts) the battery can become unstable and dangerous. Also, never leave your LiPo batteries charging while unattended. If a battery starts to become puffy, get smoky, or catches fire, you need to be able to immediately handle the situation. *Having a small fire extinguisher ready to go isn't a bad idea.*

- Never over-charge a LiPo battery. Typically, a full charge is 4.2v per cell. Never “trickle” charge a LiPo battery. Trickle charging is when you charge a fully charged battery at a rate equal to its self-discharge rate, thus enabling the battery to remain at its fully charged level. You’ve got it plugged in 24/7. Avoid doing this.

- 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. 2.9v per cell and lower is causing permanent damage.

- Never leave your LiPo batteries sitting around on a full charge for more than a couple of days. If by, say, the end of day 2, you realize you are not going to use your battery today, you need to discharge your battery down to 3.6v-3.8v per cell for safe storage until you are ready to use the battery again.

Maintaining Your Aircraft Control

If you encounter an emergency situation while flying, rule #1 is to maintain your aircraft control. I'll repeat that again, because it's important. If you encounter an emergency situation while flying, rule #1 is to maintain your aircraft control. In aviation we say "Fly the airplane" or "Aviate, Navigate, Communicate". They both mean the same thing; first things first.

Just because your transmitter's video feed fails, that might not necessarily mean that your control communication has failed. You may be able to steer the aircraft back home safely.

Many UAS come equipped with autonomous failsafe systems where the drone will pause, auto-land or return home, depending on the situation and the emergency. Be familiar with these systems, as some are optional and must be set by you. Every model is a little different.

Using Emergency Maneuvers

Examples of situations that might trigger an emergency maneuver are:

- 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
- Bird

After an emergency has initially occurred, and after you've maintained control of your aircraft, you may need to conduct an emergency maneuver.

An example of an emergency maneuver might be switching from any kind of automated mode to a manual mode of flight. This could be helpful if you lose GPS signal, or if you see a manned aircraft enter your flight area and need to ascend or descend as quickly as possible.

Another emergency maneuver might be during landing, when a bystander or animal unknowingly encroaches into your landing zone. In this case, the maneuver would be to gain and hold a safe altitude, and then to find an alternate landing zone. Alternatively, with the help of other crew members, you could re-protect the landing zone and make it safe again.

One of the big things to know here is that you should always be prepared to switch to your aircraft's "manual" mode during an emergency. That's just a general best practice.

Another general best practice in an emergency is that, after you've regained control, you should land safely as soon as possible and turn off your aircraft. Let the adrenaline wear off, analyze the situation, and then only if it's appropriate to do so, get back in the air.

Aircraft wingtip vortices can cause an emergency if not detected and deserve mention.

Wingtip vortices are circular patterns of rotating air left behind the wing of a large aircraft as it generates lift.

Wingtip vortices are disturbances in the air created by large aircraft when they are producing lift. It is greatest when the aircraft is heavy, slow and developing full power, such as takeoff. In this case, the wingtip vortices tend to sink below the aircraft generating turbulence.

Additionally, another potential emergency is the scenario of two aircraft on a head on collision course. If everyone know what to do, it will not develop into an emergency or worse, a tragedy.

A Remote PIC has the responsibility to remain clear of and yield right-of-way to all manned aircraft.

After An Emergency

Aside from any immediate first aid or site safety considerations, the first thing you'll want to do following an emergency is to document everything that happened. What was the date and time? Who was flying, and what were they flying? What was the circumstance or cause of failure, if known?

According to Part 107, you may also need to notify the proper authorities. The remote PIC of the sUAS is required to report an accident to the FAA within 10 days if it meets either of these thresholds:

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

The accident report must be made within 10 calendar days of the operation that created the injury or damage. 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/...).

The report should include the following information:

- sUAS remote PIC's name and contact information;
- sUAS remote PIC's FAA airman certificate number;
- sUAS registration number issued to the aircraft;
- Location of the accident;
- Date of the accident;
- Time of the accident;
- Person(s) injured and extent of injury, if any or known;
- Property damaged and extent of damage, if any or known; and
- Description of what happened

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Tampa FSDO-Contact the Office

Address:

5601 Mariner Street
Suite 310
Tampa, FL 33609-3416

Phone: (813) 287-4900
Email the Office
Fax: (813) 287-4940

Office Hours: 7:30 a.m. to 4:00 p.m., Monday - Friday
Office visits by appointment only

- Tampa FSDO Service Area Map (PDF)
- Feedback Form

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If the remote pilot-in-command needed to deviate from any of the Part 107 rules during flight to respond to the emergency, he or she must also send a written report, only upon the FAA's request, that explains the deviation. For example, if you had to go up to 600 ft. altitude to avoid a manned aircraft, you'd be violating the Part 107 maximum altitude provision, and that's something for which the FAA might want an explanation.

Other Considerations for Emergency Response and Prevention

Consider using ***checklists*** in both normal and emergency operations. Don't leave critical items up to memory. All other type of pilots do this as a necessity and best practice!

Consider the practice of Safety Management for LARGE multiplatform operations. It is a dynamic and ongoing process of identifying safety risks, its level of danger, and how you can mitigate those identified risks. It is frequently reviewed/updated.

SAFETY MANAGEMENT SYSTEM

"The purpose of a safety management system is to provide a systematic way to control risk and to provide assurance that those risks are controlled effectively. Safety Management will combine systems of safety and quality management in the form of *Safety Risk Management and Safety Assurance*. An accepted safety management system shall clearly define lines of safety accountability including direct accountability for safety on the part of senior management."1

Effective SMS management will help balance safety to prevent injury and damage, quality to prevent delivery of defective products and services, and efficiency to prevent waste.

The requirements for protective (risk management) systems must be based on *objective determination of risk*. Risk is inherent in aviation operations. Careful consideration of **personnel**, **environmental** and **operational** activities will be assessed, monitored and mitigated.

1 FAA, Introduction to Safety Management Systems

Safety Risk Assessment

Risk assessment is a dynamic process which will require constant feedback and setting of initial parameters to insure risks of any safety issue are mitigated. Every person in or supporting operations must participate, without exception.

Elements of SMS Policy and Implementation

1. Identify safety Hazards
2. Ensure that remedial action necessary to maintain an acceptable level of safety implemented
3. Provide continuous monitoring and regular assessment of the safety is achieved
4. Continuous improvement and management of the overall level of safety

Below are ***SAMPLE*** risk identification items. The operations, persons involved, potential risks, method of mitigation and who is responsible to manage that risk are identified. The final oversight management of all SMS risk mitigation rest with the Director of Operations.

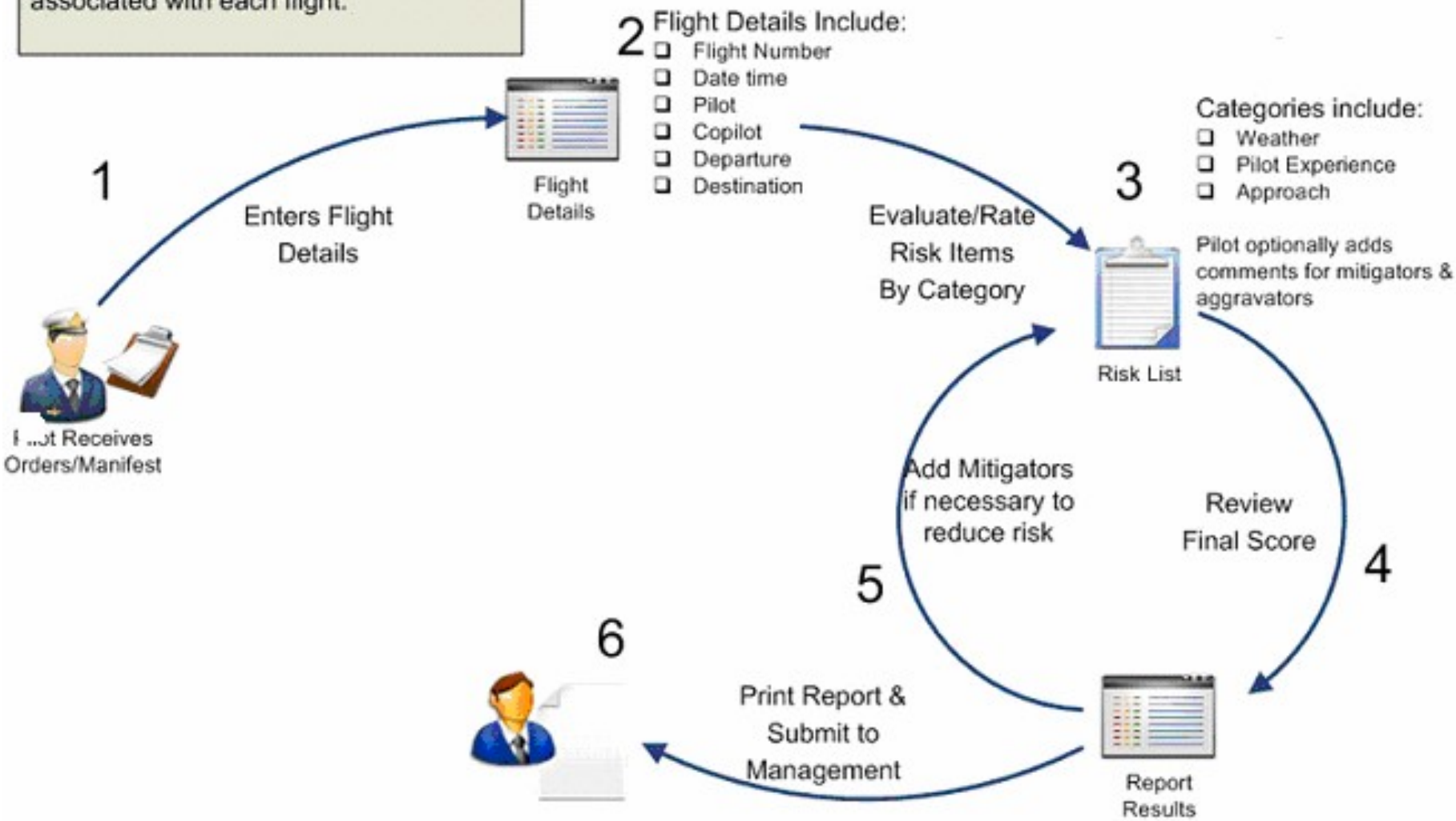
This is a "living document" that you maintain and review prior to flight.

Operation	Personnel	Risk	Mitigation	Responsibility
Charging batteries	Office	Failure to fully charge	Verify charge before flight	PIC
sUAS office inspection	PIC	Damage	Careful handling	PIC
Preflight weather	PIC	Instability or precipitation	Cannot mitigate only verify safe	PIC
Preflight location	PIC	Obstacles, airspace, people	Verify location, assess location prior to flight	PIC
etc	etc	etc	etc	etc

Flight Risk Assessment Tool

(FRAT)

Note: Flight Risk Assessment Tool (FRAT) allows pilots to evaluate risks associated with each flight.



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Maintenance and Inspections