

Operational Risks and Mitigations questions

§ 107.25 Operation From a Moving Vehicle or Aircraft

- 1. Describe how you will ensure the dynamic (i.e., ever-changing) area of operation is evaluated for potential hazards and risks to non-participating persons and property. Include a description of how you will mitigate those risks so the hazards are controlled or eliminated.**
 - a. How will you identify potential hazards to other aircraft, people, and property before flying and during flight?
 - b. From what kind of vehicle will the Remote Pilot in Command (RPIC) be operating the small unmanned aircraft system (sUAS) or drone?
 - c. Where will the RPIC and Visual Observer(s) (VO), if used, be in the vehicle or along the route?

- 2. Describe how the RPIC and VO will be able to maintain visual line of sight (VLOS) with the small unmanned aircraft (sUA) or drone from the moving vehicle.**
 - a. How will the RPIC be able to see the sUA or drone when both are moving?
 - b. How will a VO who meets the requirements in Title 14, Code of Federal Regulations (14 CFR) § 107.33, be used for operations conducted under this waiver?
 - c. What will the VO's responsibilities and/or duties be during flight?
 - d. What will the RPIC or VO(s) do if they lose VLOS with the sUA or drone?

- 3. Describe how all persons involved in the operation will stay free of distractions that may prevent them from fulfilling their duties.**
 - a. How will the RPIC and VO(s) communicate during flight?
 - b. How will the RPIC and VO(s) remain free from distractions during flight?

4. **What are the procedures the RPIC will follow during a loss of data link with the sUA? How do these procedures account for the dynamic movement and positioning of the RPIC and ground control station?**
 - a. What will the RPIC do if he/she loses the command and control link with the sUA?
 - b. How will the RPIC and VO(s) maintain VLOS with the sUA or drone if the control link is lost?
 - c. How does this procedure account for all areas where the sUA or drone will be operated?
 - d. If the control link is lost, how will the RPIC ensure the sUA or drone will not fly over other people?

§ 107.29 Daylight Operation

1. **Describe how the Remote Pilot in Command (RPIC) will maintain visual line of sight (VLOS) during darkness.**
 - a. How will the RPIC be able to see the small unmanned aircraft (sUA) or drone in the dark, at the maximum planned flight distance from the RPIC and/or Visual Observer (VO)?
 - b. What procedures will the RPIC and/or VO follow in the event they lose sight of the sUA or drone in the dark?
2. **Describe how the RPIC will see and avoid other aircraft, people on the ground, and ground-based structures and obstacles during darkness.**
 - a. How will the RPIC and/or VO locate other persons, aircraft, obstacles, and structures in the dark?
 - b. What will they do if other persons/aircraft are located during flight?
 - c. How will they avoid hitting obstacles/structures during flight?
 - d. If flight operations occur in an area with lighting sufficient for the RPIC and VO to see the sUA or drone and other obstacles, persons, and aircraft, how will they determine the lighting is sufficient before flight?

3. **Describe how the RPIC will be able to continuously know and determine the position, altitude, attitude, and movement of the sUA or drone.**
 - a. How will the RPIC be able to tell which direction the sUA or drone is pointing or flying in the dark?
 - b. While keeping eyes on the sUA or drone, how will the RPIC continuously know the current real-time (1) geographic location, (2) altitude above the ground, (3) attitude (orientation, deck angle, pitch, bank), and (4) direction of flight of the sUA or drone?
4. **What procedures will be followed to ensure all the required persons participating in the operation have knowledge to recognize and overcome visual illusions caused by darkness and understand physiological conditions which may degrade night vision?**
 - a. How will the RPIC and any other participants in the operation demonstrate knowledge about night operation risks, such as overcoming night visual illusions, limitations to night vision, and conditions that can affect night vision?
 - b. How will this knowledge be obtained and who will document it?
 - c. How will the Responsible Person verify the knowledge has been obtained and documented?
5. **Describe how the visual conspicuity of the sUA or drone will be increased to be seen at a distance of at least 3 statute miles (mi).**
 - a. Will the sUA or drone be visible for at least 3 mi at night, in the location where the RPIC will operate?
 1. If yes, how will you accomplish this?
 2. If no, why do other aircraft not need to be able to see your sUA or drone from at least 3 mi?

§ 107.31 Visual Line of Sight Aircraft Operation

1. **Describe how the Remote Pilot in Command (RPIC) will be able to continuously know and determine the position, altitude, attitude, and movement of his/her**

small unmanned aircraft (sUA) or drone and ensure the sUA or drone remains in the area of intended operation without exceeding the performance capabilities of the command and control link.

- a. When the RPIC or person operating the small unmanned aircraft system (sUAS) or drone cannot see the sUA or drone, how will they know, at all times, the current real-time (1) geographic location, (2) altitude above the ground, (3) attitude (orientation, deck angle, pitch, bank), and (4) direction of flight of the sUA or drone?
- b. If the primary method of maintaining this awareness fails, how will the RPIC maintain current and accurate knowledge of this information?
- c. How will the RPIC determine the operational limits of the command and control link in the flight environment and at the location of flight?

2. Describe how the RPIC will avoid other aircraft, flying over/into people on the ground, and ground-based structures and obstacles at all times.

- a. How will the RPIC see and avoid, or detect and avoid, all other aircraft when operating beyond visual line of sight (BVLOS)?
 - *For example, actions taken or procedures followed by the RPIC, use of a Visual Observer(s) (VO), or use of equipment/technology.*
- b. How will the RPIC know the location(s) of other aircraft that may be at risk of hitting the sUA or drone?
- c. How will the sUA or drone yield the right-of-way to all aircraft, airborne vehicles, and launch and reentry vehicles as required by Title 14, Code of Federal Regulations (14 CFR) § 107.37?
- d. When operating BVLOS, how will the RPIC identify and avoid flying over/into persons on the ground (as required by 14 CFR § 107.39)?
- e. If an equipment/technology method is used—

1. What kind equipment/technology?
2. How does it work?

3. How is it tested to determine system reliability and limitations?
 - *Consider providing data from the testing used to make those determinations.*

3. **Describe how the visual conspicuity of the sUA or drone will be increased to be seen at a distance of at least 3 statute miles (mi).**
 - a. Will the sUA or drone be visible for at least 3 mi in the location where the RPIC will operate?
0. If yes, how will you accomplish this?
1. If no, why do other aircraft not need to be able to see your sUA or drone from at least 3 mi?

4. **Describe how the RPIC is alerted of a degraded sUAS or drone function.**
 - a. When flying BVLOS, how will the RPIC be alerted if the sUAS or drone malfunctions or its capability degrades, and how will he/she respond?
 - b. Additional sUAS or drone Details:
If the sUAS or drone has a determined level of reliability, please provide the following information with your waiver application:
 0. Mean time between failure testing with results
 1. Reliability or maintenance program for the sUAS or drone
 2. Life limits on the sUAS or drone and its components
 3. System architecture
 4. Hardware reliability analysis
 5. Software design assurances and control
 6. Any operational restrictions or limitations associated with this reliability level
 - *For example, altitude limits or airspeed restrictions imposed by the manufacturer or self-imposed by the operator.*

5. **What procedure will be followed to ensure the required persons participating in the operation have relevant knowledge of all aspects of operating a sUA or drone that is not in visual line of sight of the RPIC?**
 - a. If the sUA or drone uses Global Positioning System (GPS) functionality, how will the RPIC determine the GPS signal availability for the flight time and location, before and during each intended flight?
 - b. If the sUA or drone uses GPS location to safely operate, what will the RPIC do if the GPS fails to provide location information, or provides reduced GPS position accuracy?
6. **Describe how the RPIC will operate the sUA or drone within the weather requirements while en route.**
 - a. When flying BVLOS, how will the RPIC meet the requirements for visibility and cloud clearance specified in 14 CFR § 107.51?
7. **Describe the emitters and command and control link used in the sUAS or drone.**
 - a. Include the Federal Communications Commission (FCC) grant of equipment authorization and FCC ID number for each emitter on the sUA or drone or at the pilot station.
 - b. Include the frequency licenses used by the sUA or drone or at the pilot station.
 - c. If the equipment is licensed by rule, indicate the FCC rule that applies (e.g., Title 47, CFR § 87.18).
 - d. If the frequency is leased, provide a copy of the leasing agreement.
 - e. Include a complete description of the emitters.
 - f. Frequency or frequencies used to transmit
 - g. Antenna type, antenna mainbeam gain, and antenna pattern
 - h. Maximum range
 - i. Transmission power in watts and Decibel-milliwatts (dBm)

- j. Emission modulation
- k. Receiver sensitivity
- l. System losses
- m. Acceptable bit error rate

§ 107.33 Visual Observer

1. **Describe how you will account for the communication latency between the visual observer(s) (VO) and the Remote Pilot in Command (RPIC).**
 - a. How will the RPIC and VO(s) communicate with each other if they are not near each other?
 - b. If this communication method fails, how will the RPIC and VO(s) be alerted to the failure?
 - c. What will the RPIC and VO(s) do if a communication failure occurs?

Note: A VO may not be required for certain part 107 operations. If a VO is part of your operation, Title 14, Code of Federal Regulations (14 CFR) § 107.31 requires the VO(s) to all be able to see the small unmanned aircraft (sUA) or drone throughout the duration of the flight. You may need a waiver to certain portions of § 107.33 (specifically § 107.33(b) and § 107.33(c)(2)) if your operation requires the use of multiple VOs, not all of which will be able to maintain visual line of sight with your sUA or drone. An example of operations where this may apply is when using a daisy-chain of VOs (where VO(s) maintain direct visual contact with the sUA or drone throughout the entire flight in place of the RPIC doing so).

§ 107.35 Operation of Multiple Small Unmanned Aircraft

1. **Describe how the operation will remain safe during a failure of single and multiple small unmanned aircraft (sUA) or drone simultaneously.**
 - a. How does the system simultaneously control multiple participating sUA or drone and prevent them from colliding with each other?
 - b. How will the system ensure individual participating sUA or drone remain contained in the pre-determined operational area?

- c. How will the Remote Pilot in Command (RPIC) see and avoid, or detect and avoid, all other aircraft when operating multiple sUA or drone?
- d. Will the proposed operations use a Visual Observer(s) (VO)?
- e. How will the RPIC safely stop all participating sUA or drone in the event of a hazard?
- f. How will the RPIC know when a single sUA or drone has failed, and how will he/she respond?
- g. How will the RPIC respond to multiple sUA or drone failing at the same time?
- h. What additional preflight safety procedures would the RPIC undergo to ensure safe operation?
 - *For example, preflight computer simulations, personnel training.*
- i. How many command and control links and procedures does the system use?
- j. Do the sUA or drone communicate with each other? If so, what path do the communications follow?
- k. How do the system and/or individual sUA or drone respond when communications fail?
- l. How will the RPIC maintain a stand-off distance (buffer zone) from non participating people or property?

§ 107.37 Operation Near Aircraft; Right-of-Way Rules – Guiding Questions

- 1. Describe how all manned aircraft pilots are able to detect and avoid the small unmanned aircraft (sUA) or drone and know they must yield the right-of-way to the sUA or drone.**
 - a. How will other operators of other aircraft know they need to give way to your sUA or drone in flight?
- 2. What procedure will you use to ensure the operator of the manned aircraft is aware the sUA or drone does not need to yield the right-of-way?**

- a. How will operators of other aircraft visually locate your sUA or drone in flight?

§ 107.39 Operation over Human Beings

- 1. Provide data specific to the small unmanned aircraft (sUA) or drone you plan to operate that demonstrates when the sUA or drone impacts a human for any reason –whether because of an accident, incident, sUA or drone failure or malfunction, or Remote Pilot in Command (RPIC) error–the sUA or drone will not cause a serious injury or worse.**

- a. Has the sUA or drone been tested to determine what injury level may occur if the sUA or drone were to hit a human?
 1. If so, provide information that supports the injury level, including how and when the testing was performed, as well as data from the testing.
 2. If not, provide information that demonstrates the sUA or drone would not hit a human.

- 2. Ensure the data provided addresses not only blunt trauma injuries, but also laceration injuries caused by contact with an exposed rotating part and any other type of serious injury that could be caused by a potentially hazardous characteristic of the sUA or drone design.**

- a. If your sUA or drone has design features (other than rotating parts) that could injure a person during a collision, what are they and how could they injure a human?
 - *For example, sharp edges or protrusions, flammable liquids, batteries, payloads, and/or sUA or drone construction from composite or metallic materials*

- 3. Describe any operating conditions, operating limitations, or procedures that must be followed to safely operate over humans.**

- a. If the sUA or drone incorporates any safety-related features that reduce the severity of impact to a person, what are they and how do they reduce the injury to a human if hit?

- *For example, a deployable device (such as a parachute or airbag) designed to reduce impact, construction from energy-absorbing or frangible materials.*
- b. Alternatively, if the sUA or drone has a determined level of reliability (if you assume the sUA or drone will not fail or crash), please provide the following information:
0. Mean time between failure testing
 1. Reliability or maintenance program
 2. Life limits on parts
 3. System architecture
 4. Hardware reliability analysis
 5. Software design assurances and control
 6. Any operational restrictions or limitations associated with this reliability level
 - *For example, altitude limits, offset distances (buffer zones), or airspeed restrictions imposed by the manufacturer or self-imposed by the operator.*
4. **Describe any unique qualifications of the RPIC or person manipulating the controls, including any knowledge, experience, or skills necessary to safely operate over humans.**
- a. If the RPIC will use operational restrictions to enhance safety, please describe each restriction, including–
0. What hazard is the restriction designed to reduce?
 1. How does each operational restriction reduce each hazard?
 2. How did the Applicant/Responsible Person determine the restriction(s) reduces the likelihood or severity of the hazard to prevent a serious injury or greater, if a human were hit by the sUA or drone?

§ 107.51(a) Operating Limitations for Small Unmanned Aircraft: Groundspeed – Guiding Questions

1. **Describe how you will ensure a loss of control of the small unmanned aircraft (sUA) or drone at higher speed poses no additional hazard or explain how any additional hazard to other aircraft, people, or property on the ground will be controlled or eliminated.**
 - a. How will the Remote Pilot in Command (RPIC) ensure the sUA or drone, flying at over 87 knots/100 mph, will not increase the likelihood of the sUA or drone hitting another aircraft, person, or property?
 - b. How will the RPIC maintain sight of the sUA or drone when it is traveling at over 87 knots/100 mph?
2. **Describe how the visual conspicuity of the sUA or drone will be increased to be seen at a distance of at least 3 statute miles (mi).**
 - a. Will the sUA or drone be visible for at least 3 mi in the location where the RPIC will operate?
 1. If yes, how will you accomplish this?
 2. If no, why do other aircraft not need to be able to see your sUA or drone from at least 3 mi?

§ 107.51(b) Operating Limitations for Small Unmanned Aircraft: Altitude

1. **Describe how the small unmanned aircraft (sUA) or drone will be able to avoid non participating aircraft and structures when operating at altitudes other than those prescribed in Title 14, Code of Federal Regulations (14 CFR) § 107.51(b).**
 - a. How will the Remote Pilot in Command (RPIC) and Visual Observer(s) (VO), if used, see and avoid other aircraft when flying over 400 feet above ground level (AGL)?
2. **Describe how the visual conspicuity of the sUA or drone will be increased to be seen at a distance of at least 3 statute miles (mi).**
 - a. Will the sUA or drone be visible for at least 3 mi in the location where the RPIC will operate?

- b. If yes, how will you accomplish this?
 - c. If no, why do other aircraft not need to be able to see your sUA or drone from at least 3 mi?
3. **Describe how the RPIC will be able to accurately determine the sUA or drone altitude, attitude, and direction of flight.**
- a. How will the RPIC know, while keeping eyes on the sUA or drone, the current real-time (1) geographic location, (2) altitude AGL, (3) attitude (orientation, deck angle, pitch, bank), and (4) direction of flight of the sUA or drone?
 - b. How will the RPIC maintain visual line of sight with the sUA or drone (i.e., meet the requirements of 14 CFR § 107.31) at the maximum altitude and distance requested in the waiver application?
4. **Describe the area of operations using latitude/longitude, street address, identifiable landmarks, or other maps to include the distance from and direction to the nearest airport, (e.g., 4.8 miles SE of XYZ Airport).**
5. **Describe how the RPIC will be able to be contacted by Air Traffic Control (ATC) in case the operation needs to be terminated, as well as a procedure to notify ATC when the operation begins and ends.**

§ 107.51(c) Operating Limitations for Small Unmanned Aircraft: Minimum Flight Visibility

1. **Describe how the Remote Pilot in Command (RPIC) will be able to maintain visual line of sight (VLOS) with the small unmanned aircraft (sUA) or drone when operating with visibility less than 3 statute miles (mi).**
- a. How will the RPIC maintain VLOS of the sUA or drone when visibility is reduced?
 - b. What is maximum distance the sUA or drone will be visible to the RPIC, Visual Observer(s), and other aircraft?
 - 1. How was that visibility determined?

2. **Describe how, and what procedures will be used to ensure, the sUA or drone will be able to avoid non-participating aircraft when operating with visibility less than 3 mi.**
 - a. How will the RPIC see and avoid, or detect and avoid, non-participating aircraft when the ground or flight visibility is less than 3 mi?
3. **Describe how the visual conspicuity of the sUA or drone will be increased to be seen at a distance of at least 3 mi.**
 - a. Will the sUA or drone be visible for at least 3 mi in the location where the RPIC will operate?
 1. If yes, how will you accomplish this?
 2. If no, why do other aircraft not need to be able to see your sUA or drone from at least 3 mi?

§ 107.51(d) Operating Limitations for Small Unmanned Aircraft: Cloud Clearance

1. **Describe how the Remote Pilot in Command (RPIC) will be able to maintain visual line of sight with the small unmanned aircraft (sUA) or drone when operating closer to clouds than the distances prescribed in Title 14, Code of Federal Regulations (14 CFR) § 107.51(d).**
 - a. How will the RPIC know when the sUA or drone is flying too close to the clouds and prevent accidental flight into the clouds?
 - b. What is the maximum vertical distance the sUA or drone will be visible to the RPIC, Visual Observer(s), and other aircraft?
 1. How was that visibility determined?
2. **Describe how the RPIC will be able to locate and avoid non participating aircraft when operating closer to clouds than the distances prescribed in § 107.51(d).**
 - a. How will the RPIC see and avoid other aircraft that may be flying in the clouds or be hidden from view because of the clouds?

3. **Describe how the visual conspicuity of the sUA or drone will be increased to be seen at a distance of at least 3 statute miles (mi).**
 - a. Will the sUA or drone be visible for at least 3 mi in the location where the RPIC will operate?
 1. If yes, how will you accomplish this?
 2. If no, why do other aircraft not need to be able to see your sUA or drone from at least 3 mi?