Federal Aviation Administration

Waiver Safety Explanation Guidelines

When filling out the *Waiver Safety Explanation* field in the operational waiver application, applicants must:

1. Describe their proposed operation(s)
2. Describe the possible risks associated with their proposed operation(s) and methods to lessen or mitigate those risks

Use the following questions as a guide to address both sets of information. Answers to these questions may be entered into the Waiver Safety Explanation field on the waiver form (5,000 character limit), or submitted as attachments after receiving a waiver tracking number (see Step 4 – Submitting Additional Information).

Depending on how complex your proposed operation(s) is, you may need to provide information that is not addressed in this guide. It is an applicant's responsibility to identify operational risks and mitigations for those risks to ensure an acceptable level of safety. Information on operational risk assessments, risks, and mitigations can be located in Advisory Circular 107-2 (PDF) and the Preamble to Part 107.

Important: If hazard identification and risk mitigation strategies are not included in your application, the FAA will be unable to make a complete safety analysis and will disapprove your application based on insufficient information.

Describe your Proposed Operation

Provide a description of your proposed operation without the technical details, but with sufficient information for the FAA to understand it quickly and easily. This is the who, what, when, where, and how of your proposed operation, and is commonly called a Concept of Operations (CONOPS). All questions below relate to the operation(s) to be conducted under your requested waiver.

Operational Details

1. **Where do you plan to operate?**
   a. Consider providing latitude/longitude and a detailed map of your planned flight area

2. **How high will you fly your aircraft (maximum altitude above ground level)?**

3. **Do you want to fly in controlled airspace (Class B, C, D, surface E)?**
   a. *If yes, please see 14 CFR §107.41 and Airspace Authorization Request page*.

4. **Are there any other kinds of airspace within 5 miles of any planned flight area?**

5. **What kind of area(s) will you fly over?**
   a. *Ex: rural, sparsely populated, congested, populated, a neighborhood, within city limits, large outdoor gathering of people, a restricted access site, etc.*

Small UAS Details:

2. **What kind of UAS will you use to fly the operations requested in this application?**
   a. Ex: multi-rotor, fixed wing, hybrid (both multi-rotor and fixed wing), single rotor, lighter than air, etc.

2. **What is your UAS's power or energy source in flight?**

3. **What is your UAS's maximum flight time (in minutes), range (in feet), and speed (in miles per hour)?**

4. **How big is the aircraft (length/width/height in inches)?**

5. **How do you ensure the aircraft only flies where it is directed (i.e. ensure containment)?**
   a. Ex: geo-fencing, tether, etc.

6. **What kind of termination system, if any, does the UAS have?**
   a. Ex: immediate flight termination switch

7. **How much will the aircraft and its payload weigh when flying?**

8. **If the aircraft carries any external or internal load (or object), how is the load secured?**

9. **What, if any, external or internal load (or object) could be dropped from the aircraft when flying, and how will you assure the safety of people, or other people's property, if it is dropped or detached when flying?**

Pilot/Personnel Details:

1. **What minimum level of experience will the Remote Pilot in Command (Remote PIC) have to fly under this wavier?**

2. **How many personnel (including the Remote PIC) will you use for operations under this waiver (minimum needed)?**

3. **What kind of training, if any, will personnel (e.g. visual observer(s)) have prior to flying under the waiver?**

a. How will the personnel be trained?

b. How will the Responsible Person know the other personnel are competent and have operational knowledge to safely fly the UAS under the waiver conditions?

c. If personnel will be tested, what kind of testing will be performed, and how will evaluations be conducted and documented?

d. How will personnel maintain the knowledge/skill to fly under this waiver? Will recurrent training or testing be required?

Describe Operational Risks and Mitigations

Provide, to the greatest extent possible, how you propose to address or lessen the possible risks of your proposed operation. This could include using operating limitations, technology, additional training, equipment, personnel, restricted access areas, etc. When reviewing the questions for each section below, the FAA's primary concerns are:

1. **How you will ensure your operation(s) remains safe at all times, even in unusual circumstances?**

2. What kinds of circumstances could arise, and how you plan to handle each?

The following questions are associated with each waivable section of part 107.
Only answer the questions for the regulatory section applicable to the application you will submit:

107.25 Operations from a moving vehicle or aircraft
107.29 Daylight operation
107.31 Visual line of sight aircraft operation
107.33 Visual observer
107.35 Operation of multiple small unmanned aircraft
107.37 Operation near aircraft

107.39 Operation over people
107.51(a) Operating limitations: ground speed
107.51(b) Operating limitations: altitude
107.51(c) Operating limitations: minimum visibility
107.51(d) Operating limitations: minimum distance from clouds

NOTE: *The list of questions may not be all inclusive. You may need to provide additional information based on your specific operation*.

§ 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)?
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) from the moving vehicle.**

a. How will the RPIC be able to see the sUA 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?

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 if the control link is lost?
c. How does this procedure account for all areas where the sUA will be operated?
d. If the control link is lost, how will the RPIC ensure the sUA 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) 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 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 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.**

a. How will the RPIC be able to tell which direction the sUA is pointing or flying in the dark?

    1) While keeping eyes on the sUA, how will the RPIC continuously know the current real-time geographic location, altitude above the ground,
    2) attitude (orientation, deck angle, pitch, bank), and
    3) direction of flight of the sUA?

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 will be increased to be seen at a distance of at least 3 statute miles (mi).**

a. Will the sUA 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 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) and ensure the sUA 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) cannot see the sUA, 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?
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?

c. How will the sUA 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.

❖ Describe how the visual conspicuity of the sUA will be increased to be seen at a distance of at least 3 statute miles (mi).

a. Will the sUA 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 from at least 3 mi?

❖ Describe how the RPIC is alerted of a degraded sUAS function.

➢ **When flying BVLOS, how will the RPIC be alerted if the sUAS malfunctions or its capability degrades, and how will he/she respond?**

➢ **Additional sUAS Details:**
If the sUAS has a determined level of reliability, please provide the following information with your waiver application:

1) Mean time between failure testing with results
2) Reliability or maintenance program for the sUAS
3) Life limits on the sUAS and its components
4) System architecture
5) Hardware reliability analysis
6) Software design assurances and control
7) 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.*

- What procedure will be followed to ensure the required persons participating in the operation have relevant knowledge of all aspects of operating an sUA that is not in visual line of sight of the RPIC?
- **If the sUA 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?**
- **If the sUA 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?**

- Describe how the RPIC will operate the sUA within the weather requirements while en route.
- **When flying BVLOS, how will the RPIC meet the requirements for visibility and cloud clearance specified in 14 CFR § 107.51?**

- Describe the emitters and command and control link used in the sUAS.
- **Include the Federal Communications Commission (FCC) grant of equipment authorization and FCC ID number for each emitter on the sUA or at the pilot station.**
- **Include the frequency licenses used by the sUA or at the pilot station.**

    1) If the equipment is licensed by rule, indicate the FCC rule that applies (e.g., Title 47, CFR § 87.18).
    2) If the frequency is leased, provide a copy of the leasing agreement.

- **Include a complete description of the emitters.**

    1) Frequency or frequencies used to transmit
    2) Antenna type, antenna mainbeam gain, and antenna pattern
    3) Maximum range
    4) Transmission power in watts and Decibel-milliwatts (dBm)
    5) Emission modulation
    6) Receiver sensitivity
    7) System losses
    8) 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) 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. 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 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) simultaneously.**

a. How does the system simultaneously control multiple participating sUA and prevent them from colliding with each other?
b. How will the system ensure individual participating sUA 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?
d. Will the proposed operations use a Visual Observer(s) (VO)?
e. How will the RPIC safely stop all participating sUA in the event of a hazard?
f. How will the RPIC know when a single sUA has failed, and how will he/she respond?
g. How will the RPIC respond to multiple sUA 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 communicate with each other? If so, what path do the communications follow?
k. How do the system and/or individual sUA 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) and know they must yield the right-of-way to the sUA.**

a. How will other operators of other aircraft know they need to give way to your sUA in flight?

2. **What procedure will you use to ensure the operator of the manned aircraft is aware the sUA does not need to yield the right-of-way?**

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

§ 107.39 Operation over Human Beings

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

a. Has the sUA been tested to determine what injury level may occur if the sUA 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 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 design.**

a. If your sUA 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 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 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 has a determined level of reliability (if you assume the sUA will not fail or crash), please provide the following information:

1) Mean time between failure testing
2) Reliability or maintenance program
3) Life limits on parts
4) System architecture
5) Hardware reliability analysis
6) Software design assurances and control
7) 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–

1) What hazard is the restriction designed to reduce?
2) How does each operational restriction reduce each hazard?
3) 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?

§ 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) 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, flying at over 87 knots/100 mph, will not increase the likelihood of the sUA hitting another aircraft, person, or property?
b. How will the RPIC maintain sight of the sUA when it is traveling at over 87 knots/100 mph?

2. **Describe how the visual conspicuity of the sUA will be increased to be seen at a distance of at least 3 statute miles (mi).**

a. Will the sUA 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 from at least 3 mi?

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

1. **Describe how the small unmanned aircraft (sUA) 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 will be increased to be seen at a distance of at least 3 statute miles (mi).**

a. Will the sUA 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 from at least 3 mi?

3. **Describe how the RPIC will be able to accurately determine the sUA altitude, attitude, and direction of flight.**

a. How will the RPIC know, while keeping eyes on the sUA, 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?
b. How will the RPIC maintain visual line of sight with the sUA (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) when operating with visibility less than 3 statute miles (mi).**

a. How will the RPIC maintain VLOS of the sUA when visibility is reduced?
b. What is maximum distance the sUA 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 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 will be increased to be seen at a distance of at least 3 mi.

a. Will the sUA 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 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) 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 is flying too close to the clouds and prevent accidental flight into the clouds?

b. What is the maximum vertical distance the sUA 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).

c. 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?

d. Describe how the visual conspicuity of the sUA will be increased to be seen at a distance of at least 3 statute miles (mi).

    Will the sUA 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 from at least 3 mi?