

Appendix F – Condensed Visual Observer Training Slides

Appendix F provides the condensed version of the Visual Observer (VO) Training PowerPoint presented by the Air Boss to the VO participants during the A46 flight test campaign. Each slide is presented individually with any of the Air Boss's notes provided underneath the slide.

Slide 1



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A46 – Validation of Visual Operation Standards for Small UAS (sUAS)

Ground Based Visual Observer Training

November 3, 2023

Version 1.1

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A46 – Visual Observer Training

Purpose

- To train you to be a second set of eyes and ears to monitor airspace in which the UAS is flying for any potential collision hazard, and to maintain awareness of the position of the UAS at all times, in order to support the RPIC. The VO is a key component in airspace safety.

VO Training Goals

- Flight safety is paramount
- Understand the Federal Aviation Rules and Requirements for small UAS flight operations
- What to look for as a VO
- How to look – techniques for observation and being a good VO
- How to properly communicate information as a VO

Approach

- Provide an overview of the responsibilities of the VO
- Step by step walk through of the baseline knowledge needed
- Practice practical skills required

Focus is on Flight Safety!

Slide 3

A46 – Visual Observer Training

Training Outline

- Federal Aviation Requirements (General Knowledge and FAR § 107)
- Airspace Knowledge
- UAS Part 107 Operating Limitations
- Team Composition and Reporting
- Responsibilities for Primary Observer
- VO Placement
- Communications (call signs, people, phraseology, standards, and emergency terminology)
- Situational Awareness
- UAS Observer Challenges
- Spatial Disorientation
- VO Scanning and Observation Techniques

Understanding, Techniques, and Communication

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Stay high level on this slide.






Big ticket items include-

- FAA requirements
- Responsibilities for Visual Observers
- Communications
- VO scanning and observation techniques

Federal Aviation Requirements

General Knowledge

- All UAS flights have to follow the rules. For small UAS (sUAS), FAA rules are found in Federal Acquisition Regulation (FAR) Part 107 “Small Unmanned Aircraft Systems” (sometimes just called “Part 107” or “FAR § 107”)
- Some of the rules are general and some are specific
- As a VO, the general information one needs to know
 - FAR § 107.3 – Definitions
 - FAR § 107.31 – Visual Line of Sight Aircraft Operation
 - FAR § 107.37 – Operation Near Aircraft; Right of Way Rules
 - FAR § 107.39 – Operation Over Human Beings
 - FAR § 107.51 – UAS Operating Limits
 - FAR § 107.33 – Visual Observer






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Additional points to mention on this slide: The FAA oversees all of aviation in the United States, including drones. Part 107 outlines the regulations for commercial use of an Unmanned Aircraft System (UAS).

Federal Aviation Requirements

FAR § 107.3 – Definitions

- **Control station** – means an interface used by the remote pilot to control the flight path of the small unmanned aircraft.
- **Corrective lenses** – means spectacles or contact lenses.
- **Declaration of compliance** – means a record submitted to the FAA that certifies the small unmanned aircraft conforms to the Category 2 or Category 3 requirements under subpart D of this part.
- **Small unmanned aircraft** – means an unmanned aircraft weighing less than 55 pounds on takeoff, including everything that is on board or otherwise attached to the aircraft.
- **Small unmanned aircraft system (small UAS)** – means a small unmanned aircraft and its associated elements (including communication links and the components that control the small unmanned aircraft) that are required for the safe and efficient operation of the small unmanned aircraft in the national airspace system.
- **Unmanned aircraft** – means an aircraft operated without the possibility of direct human intervention from within or on the aircraft.
- **Visual observer** – means a person who is designated by the remote pilot in command to assist the remote pilot in command and the person manipulating the flight controls of the small UAS to see and avoid other air traffic or objects aloft or on the ground.

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High level here. Main items are small unmanned aircraft system (what is UAS) and Visual Observer.

Federal Aviation Requirements

FAR § 107.31 – Visual Line of Sight Aircraft Operation

(a) With vision that is unaided by any device other than corrective lenses, the remote pilot in command, the visual observer (if one is used), and the person manipulating the flight control of the small unmanned aircraft system must be able to see the unmanned aircraft throughout the entire flight in order to:

- 1) Know the unmanned aircraft's location;
- 2) Determine the unmanned aircraft's attitude, altitude, and direction of flight;
- 3) Observe the airspace for other air traffic or hazards; and
- 4) Determine that the unmanned aircraft does not endanger the life or property of another.

(b) Throughout the entire flight of the small unmanned aircraft, the ability described in paragraph (a) of this section must be exercised by either:

- 1) The remote pilot in command and the person manipulating the flight controls of the small unmanned aircraft system; or
- 2) A visual observer.

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Script on slide. Additional notes- While this is somewhat confusing language, the key elements come from the verbiage in Part A, “RPIC, VO, and person manipulating controls must be *able* to see the UAS.” Part B specifies that *someone* in the crew must be looking at the UAS. For instance, the RPIC may be looking down at their screen while the VO maintains visual on the UAS, which would satisfy Part B. However, the RPIC must be *able* to look up and see their aircraft, which would satisfy Part A.

KSU: Inform participants that their operations will be conducted under a BVLOS waiver with no VO requirement.

Federal Aviation Requirements

FAR § 107.37 – Operation Near Aircraft; Right of Way Rules

- a) Each small unmanned aircraft must yield the right of way to all aircraft, airborne vehicles, and launch and reentry vehicles. Yielding the right of way means that the small unmanned aircraft must give way to the aircraft or vehicle and may not pass over, under, or ahead of it unless well clear.
- b) No person may operate a small unmanned aircraft so close to another aircraft as to create a collision hazard.


In summary, the UAS must give the right of way to all other air traffic and must not operate in a way that creates a collision hazard with aircraft





Federal Aviation Requirements

FAR § 107.39 – Operation Over Human Beings

No person may operate a small unmanned aircraft over a human being unless –

- a) **That human being is directly participating in the operation of the small unmanned aircraft;**
- b) **That human being is located under a covered structure or inside a stationary vehicle that can provide reasonable protection from a falling small unmanned aircraft; or**
- c) **The operation meets the requirements of at least one of the operational categories specified in subpart D of this part.**

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Part A- Someone participating in the operation of the UAS would be the RPIC, the VO(s), or the person manipulating the controls (flying the UAS). Just because someone has knowledge of the UAS flight (spectators at an event), doesn't make them a participant in the operation.


Part C- Falls within one of four categories described by the FAA.

After reading the 3 subpoints of Part 107.39, summarize it with the following: The UAS may not fly over people who are not directly participating in the UAS operation and have a direct impact on the flight, unless those people are under a covered structure or within a stationary vehicle, or the aircraft being operated falls within one of four categories as outlined by the FAA.

Federal Aviation Requirements




Important Specific Elements to Safely Perform the Job as VO

- FAR § 107.33 – Visual Observer
- FAR § 107.33a – Effective Communication
- FAR § 107.33b – See the aircraft throughout the flight and accurately determine UAS altitude and direction
- FAR § 107.33c – Coordination



The image shows two men in purple shirts standing in a grassy field under a blue sky with clouds. One man is pointing upwards with his right hand, while the other is looking at a small device in his hands. They appear to be engaged in a discussion or training exercise related to drone operations.

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Part 107 even has its own regulation pertaining to Visual Observers. We will take a closer look at 107.33 in the next slide.

Federal Aviation Requirements

FAR § 107.33 – Visual Observer

If a visual observer is used during the aircraft operation, all of the following requirements must be met:

- a) **The remote pilot in command, the person manipulating the flight controls of the small unmanned aircraft system, and the visual observer must maintain effective communication with each other at all times.**
- b) **The remote pilot in command must ensure that the visual observer is able to see the unmanned aircraft in the manner specified in § 107.31.**
- c) **The remote pilot in command, the person manipulating the flight controls of the small unmanned aircraft system, and the visual observer must coordinate to do the following:**
 - 1) Scan the airspace where the small unmanned aircraft is operating for any potential collision hazard; and
 - 2) Maintain awareness of the position of the small unmanned aircraft through direct visual observation.

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Part B: KSU will announce that their operations are being conducted under a BVLOS waiver where the VO is not able to see the UAS.

Part 107 Highlights

Notable Part 107 Regulations

- Maximum groundspeed of 100 mph (87 knots)
- Maximum altitude of 400' AGL
- Minimum weather visibility of 3 miles from control station, 500' below clouds, 2000' horizontally from clouds
- No person may act as a remote pilot in command or VO for more than one unmanned aircraft operation at one time
- No operations from a moving vehicle unless the operation is over a sparsely populated area
- No careless or reckless operations
- Requires preflight inspection by RPIC
- RPIC may not operate a sUAS if he or she knows or has reason to know of any physical or mental condition that would interfere with safe operations

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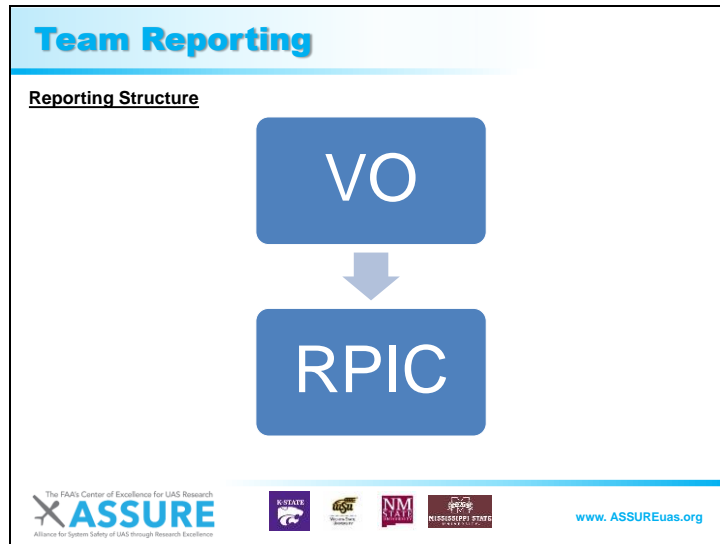
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Additional notes: There are times when the UAS may climb above 400'. When operating within 400' of a structure, the UAS can fly 400' above that structure's uppermost limit. Additionally, when the RPIC deems it necessary in the event of an emergency, the UAS may climb above 400'.

Team Composition

Roles and Responsibilities

- Remote Pilot in Command (RPIC)
 - Mission commander with on-site authority for the UAS
 - Solely responsible for the overall flight operations for a specific mission.
 - May only operate one UAS at a time
 - Each UAS shall have its own RPIC assigned
- Flight Team
 - Any combination of the RPIC and/or Visual Observers.
 - ONLY the RPIC meets the FAA definition of crewmember
- Visual Observer (VO)
 - Individual trained to maintain line of sight and 360 degree hazard awareness around the UAS at all times.
 - May be formally trained and certified for special operations or chosen ad hoc and properly briefed by the RPIC.



Any hazards or observations should be reported directly to the RPIC.

Responsibilities for Primary Observer

- Deployed at launch/landing site
 - You are located to watch the ops and the skies to ensure safe flights
- UAS Tracking
 - You will track the UAS in flight and scan the skies for intruder aircraft and any other potential hazards of flight (covered on next slide)
- Late-game collision avoidance
 - If it looks like the vehicles in flight will be close – call it out!
- External pilot assistance
 - You will help the UAS pilot when needed for any operational aspect
- Interface between VO's and other personnel
 - Communication among the team is required
- Interference with non-participants and ground vehicles
 - Pilot should concentrate on flying and you may need to assist with other coordination as needed

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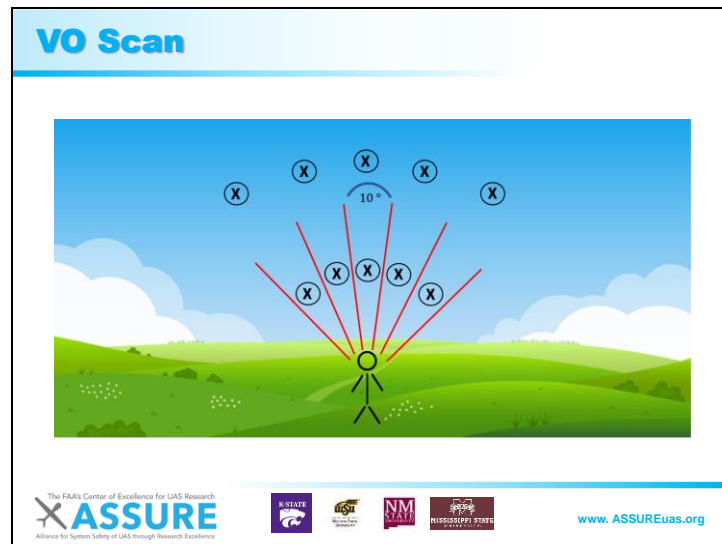
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UAS Tracking- We'll discuss this in the next two slides.

Late-game collision avoidance- The worst thing a VO could do, is doing nothing at all! Even if you are unsure whether or not something is a potential hazard, call it out.

VO Scanning Techniques

- Various scanning techniques can be used
- Some have different applicability to the particular mission
- For these missions, you will use a sector scan approach
- Scanning Technique
 - 10-degree sectors through the area of responsibility
 - Horizon to operating altitude
 - Work step by step through assigned sector and repeat
 - If VO hears a potential intruder, the visual scan should cease and VO should look in the direction of the sound
 - If aircraft cannot be acquired, visual scan may commence again
- Image on next slide



- 10-degree sectors through the area of responsibility
- Horizon to operating altitude (follow the x's)
- Work step by step through assigned sector and repeat
- If VO hears a potential intruder, the visual scan should cease and VO should look in the direction of the sound.
- If aircraft cannot be acquired, visual scan may commence again.

Communications – Intruder Aircraft

- **When an intruder aircraft is spotted, it is vital the information is passed to the RPIC quickly and correctly**
- **When communicating the intruder aircraft information, the following is required:**
 - Announce the intruder sighting
 - Provide the intruders location
 - Provide intruders path relative to the UA
 - Provide altitude of intruder aircraft
 - Provide suggested maneuver, if required

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Example of this flow is on the next slide.

Communications - Script

<ol style="list-style-type: none">1. Announce “intruder aircraft”2. Intruder aircraft location relative to UA:<ul style="list-style-type: none">• “Cardinal direction”3. Path relative to UA:<ul style="list-style-type: none">• “Headed toward UA”• “Headed away from UA”• “No factor”4. General altitude of intruder:<ul style="list-style-type: none">• “High”• “Low”• “Co-altitude”5. Specific altitude of intruder:<ul style="list-style-type: none">• “Altitude in feet above ground”6. Suggested maneuver:<ul style="list-style-type: none">• “recommend maintain course”• “recommend climb”• “recommend descend”	<ul style="list-style-type: none">• Notes<ul style="list-style-type: none">• The suggested maneuver does not need to be called out right away. Calls 1-5 are in succession while 6 can be called out as the intruder gets closer, so long as it does not endanger the operation.• Modify recommendations as appropriate• You will be provided a script while in the field with these communication options
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Script on slide. Start on the left side and go through the six steps. For step 3, describe a “No factor.” What happens when you see an aircraft that appears to be at several thousand feet? Often times a callout is not necessary in these conditions. However, if you believe the RPIC may hear the aircraft but it is still well outside of the operating area or well above the operating area, a “traffic no factor” call would be reasonable.

For the last “note,” inform the participants that the script will follow this same order to assist them with callouts and decisions.


Communications - Examples

- “Intruder aircraft, south, headed toward UA, high, 1000’, recommend maintain course.”
- “Intruder aircraft, northwest, headed toward UA, low, 500’, recommend descent.”
- “Intruder aircraft, west, headed away from UA, low, 500’, recommend maintain course.”
- “Intruder aircraft, southeast, headed toward UA, low, 300’, recommend climb.”




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Communications – Practice



Alt: 400'





Script:

1. Announce the Intruder:	"Intruder Aircraft"
2. Location relative to UA:	"West"
3. Path relative to UA:	"Headed toward UA"
4. General altitude relative to UA:	"Co-altitude"
5. Specific altitude relative to UA:	"400 feet"
6. Suggested maneuver:	"Recommend descent"

"Intruder aircraft west headed toward UA, co-altitude, 400 feet...recommend descent."


RPIC/VO






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Communications – Practice



Alt: 400'


Recommend descent could be appropriate as well 


Script:

1. Announce the Intruder:	“Intruder Aircraft”
2. Location relative to UA:	“Southeast”
3. Path relative to UA:	“Headed toward UA”
4. General altitude relative to UA:	“High”
5. Specific altitude relative to UA:	“1000 feet”
6. Suggested maneuver:	“Maintain course”

“Intruder aircraft southeast headed toward UA, high, 1000 feet...recommend maintain course.”


RPIC/VO






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Communications – Practice








Script:

1. Announce the Intruder:	“Intruder Aircraft”	
2. Location relative to UA:	“North”	
3. Path relative to UA:	“No factor”	
4. General altitude relative to UA:	“Co-altitude”	Alt: 400’
5. Specific altitude relative to UA:	“400 feet”	
6. Suggested maneuver:	“Maintain course”	

“Intruder aircraft north heading away, no factor, recommend maintain course.”

RPIC/VO



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Emergency Terminology

Required Under Specific Circumstances

- All flight and mission operations have a plan
- Sometimes there are in-flight emergencies that require immediate action
- The remote pilot in command may have to deviate from normal operations to address the emergency
- All flight team members including the VO's should not provide any distractions if the RPIC (or other lead) calls an emergency unless for a safety concern, and as a VO should also be prepared to support as requested

COMMON EXAMPLES OF EMERGENCY TERMINOLOGY

- "Mayday Mayday Mayday" – terminology used to declare an emergency
- "STOP STOP STOP" – stop current activity
- "ABORT ABORT ABORT" – cease current activity and return to a safe state


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In the event of a non-simulated emergency, the RPIC will inform the crew and proceed with emergency procedures.

UAS Observer Issues

- Size and orientation of the UAS
 - Different aircraft are different sizes, and the approach/orientation can make the vehicle harder to see
- Paint schemes and lights
 - Be aware that different colors of paint or lights on the UAS can make it easier or harder to see. You will need to assess this real time in the operations environment.
- Engine noise (or lack of)
 - Some piloted aircraft and UAS generate engine (and/or rotor) noise that can help locate the vehicle. Some do not. This may or may not be an aid in locating the aircraft. You will need to assess this real time in the operations environment.

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For KSU, simulated UAS will be BVLOS so this slide may be covered quickly.

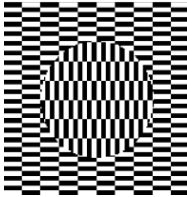
UAS Observer Issues

- Environmental and terrain effects
 - Sun, clouds, haze, dust – these can impact assessment within all or portions of your fields of view. Understand what is present when starting VO operations and be aware of how this may impact ability to see aircraft
 - Mountains, trees, or objects in the background - these can impact the ability to see the aircraft as well as how far out for initial detection
- Accurate altitude and distance estimates for non-participating aircraft
 - An aircraft may seem closer or further away depending on the environment and visual clues. It is difficult to estimate both altitude and distance.





Spatial Disorientation (cont.)

Spatial Disorientation

- When the brain misinterprets its reference, spatial disorientation can occur.
- You need to recognize where these misinterpretations are most likely to occur and to be prepared for such instances.



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Spatial Disorientation can be summarized by “visual illusions”. Picture represents an example of spatial disorientation / visual illusions.

Spatial Disorientation (cont.)





Spatial Disorientation Definitions – Visual Illusions

- **Autokinesis**
 - The movement of a single light when stared at for a period of time caused by the brain attempting to isolate the light within the visual field. The eye and brain are turning on and off bipolar and ganglion cells in an attempt to establish reference and edges. Mitigate by focusing your eyes at varying distances, and increasing the speed of visual scanning.
- **Flicker Vertigo**
 - This is more a condition than an illusion. It is caused by flicker lights at a steady rhythm and can induce nausea or dizziness. Mitigate with continual scanning.
- **False Horizons**
 - Believing a line of sight (lights along a road, lights along a coastline, or clouds) is the actual horizon when it is not. This leads to spatial disorientation.

Definitions from the PSURT UAS Visual Observer Course



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High level only. Many of these will not be experienced by the VO.

Autokinesis should be covered in it's entirety.

Summary

- Part 107 regulations
 - How far away can the RPIC fly the UAS?
 - How high can the UAS fly?
 - Who has the right of way- a UAS or a helicopter flying into the area?
- Visual Observer roles/responsibilities
 - What is one of the primary responsibilities of the VO?
- VO communication
 - What do you do first when you spot an intruder aircraft?
 - Describe an instance when an aircraft is “no factor”
 - How should you report intruder aircraft location?
- Non-simulated emergencies
 - In the event of a non-simulated emergency, who has the ultimate authority during the operation?

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Regulations-

- Visual line of sight (KSU operating under BVLOS waiver).
- 400' AGL unless flown within 400' of a structure and then not more than 400' above the uppermost limit of the structure.
- All aircraft have right of way over the UAS.

Visual Observer responsibilities (potential answers)-

- Scan the airspace for any intruders..
- Communicate with the RPIC any hazards to the flight.
- Maintain visual with the UAS.
- Interference with non-participants and ground vehicles.

Communications-

- Announce the intruder to the RPIC/crew.
- An aircraft that is in the vicinity of the operation, but does not require maneuvering by the UAS.
- Cardinal direction, movement direction relative to the UAS.

Non-simulated emergencies-

- RPIC will use emergency procedures and direct crew as needed.

Questions



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Operations

- UAS flights will take place 1.2 – 1.6 miles away from your RPIC/VO station
- You will not be able to see the UAS at these distances
 - The research being conducted is to determine if the airspace surrounding the UAS can be cleared while not necessarily being able to see the UAS itself
- It is okay if you see the UAS but most of the time you will likely not
- Three UAS will be flown simultaneously and have known separation at all times
- When you arrive at your station, the RPIC will show you the UAS he/she is flying around the box pattern
- Although the RPIC is stationed with you and in control of the UAS, secondary external pilots are co-located with the UAS and can take control in case of an emergency
- When suggesting a descent, the UAS will be commanded by the RPIC to 200' AGL
- When suggesting a climb, the UAS will be commanded by the RPIC to 700' AGL
 - Waiver approved

Operations


FOXTECH GREAT SHARK 330 VTOL



Specifications:

- Wingspan: 10' 10"
- Max take-off weight: 44 lbs.
- Payload capacity: 11 lbs.
- Endurance: 4 hours
- Cruising speed: 50 mph
- Fuselage material: Kevlar
- Batteries: VTOL – 2 6S 10000 mAh LiPo
Fixed-wing – 4 6S 12500 mAh LiPo

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Questions



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