****

**Standard Operating Procedures**

**S500 V2 Quadcopter**

**Revision 2.1 November 5, 2019**

**CHANGE MANAGEMENT**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| REV # | DATE | CHANGED SECTIONS | REMARKS | INITIALS |
| 0 | 08.01.2019 | None | Initial WriteUp | MG |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

Contents

[1. General 5](#_Toc23868098)

[1.1 Introduction 5](#_Toc23868099)

[1.2 S500 UAS Overview 5](#_Toc23868100)

[2. Crewmembers 5](#_Toc23868101)

[2.1 Required Crewmembers 5](#_Toc23868102)

[2.2 Remote Pilot in Command (RPIC) Duties 6](#_Toc23868103)

[2.3 GCS Operator Duties 6](#_Toc23868104)

[2.4 Visual Observer (VO) Duties 6](#_Toc23868105)

[3. Qualification and Currency Requirements 6](#_Toc23868106)

[3.1 Piloting Privileges 6](#_Toc23868107)

[3.2 GCS Operator 7](#_Toc23868108)

[3.3 Visual Observer 7](#_Toc23868109)

[3.4 RPIC Currency 7](#_Toc23868110)

[3.5 Lapse in Currency 7](#_Toc23868111)

[4. Operations 8](#_Toc23868112)

[4.1 General 8](#_Toc23868113)

[4.2 Launch and Recovery Area 8](#_Toc23868114)

[4.3 Approach Sectors 8](#_Toc23868115)

[4.4 Home Location 8](#_Toc23868116)

[4.5 Flight Parameters 8](#_Toc23868117)

[4.5.1 Altitude 8](#_Toc23868118)

[4.5.2 Lateral Flight Limits/Flight Path 8](#_Toc23868119)

[4.6 Manual Control with Radio Controller 9](#_Toc23868120)

[4.7 Lost Communications Planning 9](#_Toc23868121)

[4.8 Onboard Camera/Sensor Usage 9](#_Toc23868122)

[4.9 Battery Reserve 9](#_Toc23868123)

[4.10 Multiple Aircraft Operations 9](#_Toc23868124)

[4.11 Emergency Procedures 9](#_Toc23868125)

[4.12 Checklist 10](#_Toc23868126)

[4.13 Operating Limitations 10](#_Toc23868127)

[5. Maintenance 10](#_Toc23868128)

[5.1 General 10](#_Toc23868129)

[5.2 Vehicle IDs 10](#_Toc23868130)

[5.3 Software Updates 11](#_Toc23868131)

[5.4 Hardware Fixes 11](#_Toc23868132)

[5.5 Mandatory Maintenance Schedule 11](#_Toc23868133)

# 1. General

## 1.1 Introduction

This SOP outlines information and procedures intended to ensure safe operations and reduce the level of risk associated with flight operations including the S500 V2 Quadcopter – here after referred as the S500.

Warnings, cautions, and notes may be found throughout the SOP. The following definitions apply:

**WARNING**

Operating procedures, techniques, etc., that, if not carefully followed, could result in personal injury or loss of life.

**CAUTION**

Operating procedures, techniques, etc., that if not carefully followed, could result in damage to equipment.

**NOTE** An operating procedure, technique, etc., that is considered essential to emphasize.

## 1.2 S500 UAS Overview

The S500 is a multirotor aircraft that is launched and recovered vertically.

This UAS incorporates a Pixhawk 4 Mini autopilot that has redundant control via a GCS (QGroundControl) and FrSky Taranis RC Transmitter. Autonomous flight planning and craft health visualization is accomplished using through the QGroundControl software. The GCS includes a laptop or tablet running QGroundControl and a 433MHz transmitter.

# 2. Crewmembers

## 2.1 Required Crewmembers

S500 operations require a minimum of two crew-members – a Pilot in Command (PIC) and GCS Operator. A third crewmember acting as a Visual Observer (VO) is optional. Crewmembers are expected to operate as a team and utilize principles of crew resource management (CRM) whenever applicable.

## Remote Pilot in Command (RPIC) Duties

The RPIC is responsible for controlling and navigating the S500, and for ensuring overall safe operation of the UAS. Prior to initiating a flight, the PIC shall:

1. Obtain all necessary information regarding the flight and make a determination that the flight can be made safely and legally.
2. Operate the UAS according to the crewmember checklist and within the limits specified in the ADDA Flight Operations Manual.
3. Communicate with the air traffic controlling authority (if necessary) and participating personnel.

## GCS Operator Duties

The GCS Operator is responsible for monitoring the S500 and communicating all necessary warnings or errors that are outputted by QGroundControl. If the GCS Operator deems the PIC unable to continue flight, they may command an autonomous takeover, return and landing sequence (RTL).

## 2.4 Visual Observer (VO) Duties

The Visual Observer is optional but recommended. The VO is responsible for keeping eyes on the aircraft and detecting any potential threats, such as air traffic conflicts, obstacles in the flight path, ground traffic during approach to landing, or anything that may affect the safety of the UAS, ground crew, or non-participating personnel (observers, spectators, etc.).

During landing or recovery, the VO (if used) shall stand near the intended touchdown point and observe the S500’s approach path and glide slope, effectively communicating to the PIC any need to abort the approach or landing.

# 3. Qualification and Currency Requirements

## 3.1 Piloting Privileges

To become an authorized pilot of the S500, an individual must meet the following criteria:

1. Be enrolled in the ADDA training program as a student pilot, or possess a remote pilot license (Pt. 107 or equivalent).
2. Perform initial qualification training.
3. Perform an evaluation flight that demonstrates the individual’s ability to safely and proficiently operate the S500.
4. Receive a written RPIC qualification signoff (logged in the ADDA*Tracking* pilot credentialing system - PCS)

## 3.2 GCS Operator

To become an authorized GCS Operator of the S500, an individual must meet the following criteria:

1. Receive training within an accepted flight training curriculum.
2. Participate as a GCS Operator in a supervised training activity.
3. Demonstrate usability of QGroundControl to a Remote Pilot Instructor (RPI).

Pass any applicable knowledge and/or practical tests, as required.

## 3.3 Visual Observer

Visual Observers must be thoroughly briefed on their duties and responsibilities prior to each flight by the RPIC.

The qualifications requirements for a visual observer are to:

1. Understand the duties and responsibilities of a VO.
2. Pass the VO knowledge test.

## 3.4 RPIC Currency

Each remote pilot in command (RPIC) must complete at least one S500 launch and recovery and achieve 15 minutes of flight time within the preceding 30 days to remain current. If currency has lapsed for more than 30 days but less than 60 days, then the operator enters a probationary period in which they must perform two launch and recovery events along with 30 minutes of logged flight time.

Each operation may consist of an actual or simulated flight that includes a successful launch and recovery. All operations counting toward currency must consist of launch procedures, landing procedures, flight planning, and flight monitoring.

## 3.5 Lapse in Currency

RPICs who fail to complete the probationary requirements or allow more than 60 days since their currency had lapsed will enter suspension and must complete a proficiency flight evaluation that is consistent with the TOP Level 2 maneuvers. Annual PIC Standardization Checkout

Within the preceding 12 calendar months, an authorized PIC must have completed an annual standardization checkout consisting of an oral evaluation and a flight evaluation. Both portions of the checkout may involve training of deficient areas without resulting in an unsatisfactory checkout. Reviews that are deemed unsatisfactory, however, require additional remedial training of the deficient areas before the checkout is reattempted.

# 4. Operations

## 4.1 General

Ground operations for the S500 consist of the RPIC and GCS Operator conducting checklist procedures throughout all stages of flight.

During ground operations, non-essential personnel shall remain clear of the ground control station and of the immediate aircraft area (within a 10 ft. or 3m radius of the aircraft). These sterile operating areas are necessary for safety and allow the flight crew to maintain focus and situational awareness.

## 4.2 Launch and Recovery Area

This area requires a minimum radius of 10 feet (3m) from the aircraft’s launch and recovery location that remain clear of equipment, obstructions, and all personnel during launch and recovery procedures.

## 4.3 Approach Sectors

The sectors from which the S500 will approach for landing must be clear of obstacles and equipment for a distance of 10 feet (3m).

## 4.4 Home Location

The S500’s home location is depicted on the QGroundControl software as a small pointer with the letter “H” labeled within it. Unless manually modified by the GCS Operator, this location will not change throughout flight. Prior to launch, the GCS Operator must confirm that the home location and aircraft location are within 5’ of each other.

## 4.5 Flight Parameters

### 4.5.1 Altitude

During flight, the S500 must maintain an AGL altitude between 5’ and 400’. Navigating outside of this altitude will result in an immediate autonomous takeover and landing. The aircraft may only fly below the 5’ AGL when commencing a takeoff or landing sequence.

### Lateral Flight Limits/Flight Path

The S500 shall remain within unaided line-of-site of the RPIC and VO. If either personnel are to lose visualization of the aircraft, the S500 must be commanded to autonomously RTL. Operations may be planned and conducted only over permissible property.

The flight path shall be planned with care to avoid direct overflight of people.

## Manual Control with Radio Controller

Manually flying the S500 with the radio controller is authorized during normal flight operations and/or during proficiency training with the manual controller.

## Lost Communications Planning

If the S500 loses communication with either the GCS or radio controller for more than 5 seconds – the aircraft must have an inbuilt failsafe to autonomously RTL. This must be setup via the failsafe’s menu in QGroundControl. Shorter times, such as an instant RTL, may be used at the discretion of the PIC.

## Onboard Camera/Sensor Usage

When equipped with an onboard camera, all data acquisition shall be used in accordance with privacy best practices.

## Battery Reserve

The minimum battery reserve after landing is 20%. All flights should be planned to land with at least 20% battery life. The absolute minimum battery reserve after landing is 10%. If any in-flight indications are suggestive of a higher than expected battery drain, the PIC shall terminate the flight early at his/her discretion.

## Multiple Aircraft Operations

For flights consisting of more than one aircraft, a minimum shortest distance separation of 50 feet must be uploaded to the aircraft’s flight plans and verified by both crews prior to launch. When any two aircraft are approaching laterally, the trailing aircraft shall “Hold Position” in order to prevent crossing flight paths, in event of inaccurate vertical separation.

Operations with multiple aircraft require an additional RPIC and GCS Operator per aircraft.

## Emergency Procedures

The procedures outlined in the checklist are to be followed in the event the following emergency situations:

1. Low Endurance
   1. Immediate Landing in Controlled Area
2. Loss of GCS or Radio Communications
   1. Immediate RTL at Communication Regain
3. Loss of Flight Control
   1. Immediate Change to Stabilize and Landing (if possible).
4. Loss of Visual Line of Sight
   1. Regain LOS and Navigate Back to Home

## Checklist

Checklist usage is mandatory for operations. A tailored S500 checklist may be used as a substitute to the manufacturer’s S500 checklist for conducting flight operations.

## Operating Limitations

The limitations listed below are aircraft-specific limitations. Operator limitations may be applied that are more restrictive than what is listed below.

1. Flight in any type of precipitation is prohibited.
2. Surface wind limit – 15 knots.
3. Winds aloft limit – 15 knots.
4. The flight must be conducted in VFR conditions (surface visibility must be 1 SM and the cloud ceiling must be at least 1,000 ft.).
5. The S500 must remain within VLOS of the RPIC.
6. Flights must occur within the altitude specifications set form in this document.

# 5. Maintenance

## General

All aircrafts must be maintained to the same standard using the requirements below. Each time maintenance is carried out (hardware or software) it shall be recorded in the designated maintenance form.

## Vehicle IDs

All S500’s will have a unique vehicle ID associated with them. It is crucial that this ID is recorded at all stages of maintenance.

## Software Updates

Software updates must be carried out to the entire S500 fleet at the same time. It is crucial that all autopilot and GCS software’s are updated to the same version – regardless of their current standing. Vehicles that have not updated to the current version will not be cleared for flight.

## Hardware Fixes

All hardware fixes must be carried out in accordance to the User Manual and S500 Build/Setup Guide. Any deviations must be cleared by the Head of Maintenance and be amended to the respective guide.

## Mandatory Maintenance Schedule

Regardless of their current standing and flight operations, all vehicles must go through a mandatory maintenance review every two weeks. This is to ensure no undocumented changes were made to the aircraft.