Sooryauday Aerial Vehicles Private Limited.

Plot No. 40, Sector 68, IMT Faridabad, Haryana - 121004
India.

SprayCoptor

Maintenance Manual V1.0

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Amendments to this Maintenance Manual shall be promulgated by means of revisions issued whenever necessary to cover corrections and to add or modify the contents. The page number and the revision number of the affected page must be changed accordingly. The list of effective pages must be amended accordingly.

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1. SprayCoptor UAV Details

SprayCoptor is an advanced Unmanned Aerial Vehicle (UAV) that is designed to perform a variety of tasks with various payloads. Its main applications include spraying fungicides, herbicides, weedicides, and pesticides. The UAV has a maximum take-off weight of up to 30.7 kg, making it suitable for both small-scale and large-scale operations.

SprayCoptor's maximum attainable height above ground level is 40 m, and it has a range of 1000 m, allowing it to cover a large area with ease. The UAV is flown within the Line of Sight (LOS) to ensure maximum control and safety during operation. Additionally, the drone has various controls for Return to Launch (RTL) in case of unforeseen circumstances.

The RTL feature comes into play in case of battery failsafe, smart range failsafe, radio failsafe in case of communication failure, and flight mode specified for Return to Launch. These features ensure that the drone can safely return to its launch position, avoiding any potential risks or hazards.

“SprayCoptor” drone is built from a variety of electrical and electronic components, including motors, batteries, sensors, and communication modules. As a result, regular inspection and maintenance of the drone are necessary for its long-term, uninterrupted operation. This includes checking the drone's battery and motor performance, conducting a thorough visual inspection of the UAV, and updating the software and firmware as required.

In conclusion, “SprayCoptor” drone is a versatile and reliable UAV that can perform a variety of tasks with ease. Its advanced features and controls ensure safe and efficient operation, while regular maintenance guarantees uninterrupted performance over time.

Figure 1: SprayCoptor UAV

1.1 Purpose of Maintenance Manual

Maintaining a drone is a crucial process that is often neglected or overlooked, with many adopting the "FIX-IT-WHEN-IT'S BROKEN" mentality. However, this approach can be detrimental as it turns a blind eye to underlying faults that may already exist within the system, waiting to manifest themselves at the worst possible time.

To ensure the safety and optimal performance of your drone, it is essential to have a proper maintenance procedure in place. This checklist is designed to be run after every 20 flights or two weeks, whichever comes first. This robust approach ensures that any errors are caught before they can become critical and cause damage.

The checklist involves a full component inspection, with proper battery handling and control software updates. It covers everything you need to keep your drone in tip-top shape, including the airframe, propellers, motor, battery, controller, and camera.

Regular maintenance is required after every flight to keep your drone in good condition. Running this checklist ensures that all systems are in working order and that any necessary repairs or replacements can be carried out before the next flight.

It is important to note that drone maintenance is not only about checking for damages or malfunctions but also about keeping the drone in compliance with regulations and guidelines. This includes checking the drone's weight, registration, and ensuring that the drone is flown within permitted airspace.

In conclusion, a proper drone maintenance procedure is crucial for the safe and optimal performance of your drone. By running this checklist regularly, you can catch any errors and carry out repairs or replacements before they turn critical. Remember to also comply with regulations and guidelines to ensure a safe and enjoyable flying experience.

2. UAV System Details

A “SprayCoptor” UAV system comprises various components that work together to ensure a safe and efficient flight. It is essential to conduct regular inspections and sanity checks before every flight to detect any faults and ensure that all components are in good working condition.

The components that require inspection and checks include:

1. **Drone:** This includes the motor, propeller, GPS, and other essential components. The motor and propeller should be checked for damage, wear and tear, or any signs of malfunction. The GPS system should be tested for accuracy and signal strength to ensure it is functioning correctly. Other components such as the camera, sensors, and flight controller should also be inspected for any defects or malfunctions.
2. **Radio Devices:** These include the remote control and any other communication devices used to control the drone. The communication system should be checked for any interference or signal loss. The remote control should be tested to ensure all buttons and functions are working correctly.
3. **Ground Control Station**: The smartphone used to control the drone should be checked for battery life and functionality. The smartphone should also have the necessary software installed and updated to ensure smooth communication between the drone and the ground control station.
4. **Battery**: The battery is a critical component of the UAV system and should be checked for damage, swelling, and proper charging levels. The battery should be charged fully before every flight and should not be used if it shows any signs of damage or swelling.

2.1 SprayCoptor UAV Application

One of the main applications of UAVs in agriculture is spraying activities for vegetation. Agricultural UAVs, such as the "SprayCoptor" UAV, can be equipped with various payloads, to spray fungicides, herbicides, weedicides, and pesticides.

Another application of “SprayCoptor” UAVs is precision agriculture. Precision agriculture involves the use of technology to optimize crop production and reduce waste. Agricultural UAVs can be equipped with GPS and mapping software to precisely target specific areas of a crop field for spraying or monitoring, reducing the amount of chemicals and resources used and increasing efficiency.

3. UAV Support Environment

The operating and support environment for an agricultural UAV system requires regular inspection and maintenance of equipment, support software, and databases. Skilled personnel must be available to manage the system and its programs, including trained technicians and software engineers. The database must be reliable, secure, and able to handle large volumes of data. Overall, a robust operating and support environment is essential for the effective and uninterrupted operation of the UAV system.

3.1 UAV operating Environment

Regular inspection and testing are essential for a UAV system operating in harsh field environments, which are characterized by high levels of dust and moisture. These conditions can negatively impact the system's components and overall performance, making it imperative to conduct routine checks to ensure optimal functioning.

3.2 UAV Hardware

Sr. No.	Hardware Description	Hardware Specifications	Hardware Type
1	Flight Controller	Tempered and isolated IMU **3 x Accelerometers:** **3 x Gyroscopes** **1 x Compass** **2 x Barometers**	Active component
2	Battery	GENX 25000 mAh	Active component
3	Ground Control Station and RC controller	SkyDroid T12	Active Component
4	Motors	Hobbywing X6 Plus Propulsion System Average thrust: 3-5 KG Max. Thrust: 10-12 KG Operating Temp.: -20 to 50 Waterproof rating: IPX7 Maximum Current: 60 A	Active Component
5	Propellers	Hobbywing 2480 Propellers Propeller Diameter: 24 inches Propeller pitch: 8.0 inch	Passive Component
6	Radio Communication	2.4 GHZ and 30 dBm output power can transmit telemetry data and video feed.	Active Component
7	Airframe Structure	The main frame is built using Polyamide 66 plastic The vertical and horizontal landing gears are made of Aluminium 6061 T6 metal. The outer arms are made of carbon fiber composites.	Passive Component
8	Connectors and connections	All the wire connections are fitted properly and routed well through the frame.	Passive Component

		Proper precautions are taken for vibrations by adding silicon rubber pads. Strong rubber pads are used in horizontal landing gears.	
9	GPS	U-blox **high precision GNSS modules** Satellite constellation: GPS L1C/A, GLONASS L1OF, BeiDou B1I	Active Component
10	Detection and Avoidance System	Microwave RADAR with 20-meter range is used in the front and back direction. Altimeter RADAR is used for accurate terrain following and landing.	Active Component

Active Components: Active components in a drone refer to the electronic components that actively control and manipulate the electrical signals and power flowing through the drone's system. These components are responsible for the overall operation and control of the drone, including the drone's flight, navigation, and communication.

Passive components: Passive components in a drone refer to the components that do not actively control or manipulate the electrical signals and power flowing through the drone's system. Hence the passive components need time to time inspections.

3.3 Life Cycle of Component

The components and devices used in UAVs have an associated life cycle, as outlined in the table below:

Sr. No.	Component Description	Life Cycle
1	Propellers	500 Hours
2	Lithium Polymer Battery	300 Cycles
3	Landing Gear	10000 Landings
4	Airframe	7000 Hours
5	Motor	500 Hours

The life cycle of drone components refers to the stages of a component's existence, from design and development to disposal or retirement. The life cycle can be broken down into several stages of its development and application/usage.

3.3.1 Battery Disposal SOP

Dispose of the battery by following local regulations for hazardous materials. The battery should be properly packaged, labeled, and transported to a certified disposal facility.

Precautions: Safety to be taken care of

- Only authorized and trained personnel should handle the battery
- Personnel should wear appropriate protective gear, including gloves and eye protection when handling the battery.
- Personnel involved in the process should take precautions to avoid damaging the environment.
- Hazards that may be encountered during the disposal process may include flammable materials and hazardous chemicals. Personnel involved in the process should be trained to identify and mitigate these hazards.

Record-Keeping

- Records of the disposal should be kept for a minimum of five years.
- Any associated hazardous materials should be properly documented.
- Keep a record of the disposal, including the date and location.

This SOP outlines the steps to be taken for the safe and compliant disposal of the Battery of the drone that has reached its designated life of 300 cycles. By following these procedures, the disposal process can be completed in a manner that is safe for personnel and the environment.

Once the battery life is over (300 cycles) or the battery gets damaged, it will be considered as battery waste. Collect such all the batteries and hand it over to Sooryauday Aerial Vehicles Private Limited..

3.4 Components of Drone

There are several critical components of a drone that require frequent wear and tear checks during their service life to ensure their proper functioning and safe operation. These components include:

Sr. No.	Component Description	Reason for Damage
1	Tank Connector	Drone crash, uneven vibrations due to lose props
2	Propeller	Bearing issues, excess RPM, 500 Hours of Operation
3	Hardware Safety Switch	Frequent or hard push by user
4	Landing Gears	10000 Landings, Multiple Hard landings
5	Water Tank	Not maintaining the tank, harsh and concentrated chemicals
6	Water Pump	If pump is not maintained/cleaned properly

3.5 Tools Required for Maintenance

Drone maintenance requires specific tools to properly maintain and repair the various components of the UAV. Some essential tools for drone maintenance include:

- **Screwdrivers set:** To access and remove various components of the drone, screwdrivers of different sizes and types are necessary.
- **Pliers:** Pliers are useful for gripping and twisting wires and connectors, especially in tight spaces.
- **Wrenches:** Wrenches are necessary for tightening and loosening nuts and bolts in the drone's mechanical components.
- **Digital Multimeter:** A multimeter is an essential tool for measuring electrical properties such as voltage, current, and resistance. It is useful for troubleshooting electrical problems in the drone.
- **Cleaning tools:** Dust, debris, and other contaminants can accumulate in the drone's various components, and cleaning tools such as compressed air, brushes, and cleaning solutions are necessary for maintaining the drone's performance and reliability.
- **Prop balancer:** A prop balancer is used to balance the drone's propellers, which is essential for smooth and stable flight.
- **Battery checker:** A battery checker is used to check the status of the drone's battery, including its charge level and voltage.
- **Allen wrenches:** Allen wrenches are necessary for accessing and tightening various components of the drone's mechanical system.

- **Spirit level**: Spirit level required for leveling the motors on the motor mount and to check the level of the airframe.
- **Nuts and bolts:** Need some M3, M3.5 Allen screws to replace damaged ones.

4. UAV Maintenance

4.1 Visual Errors in UAV

Some visual recognizable defects in drones include:

- **Physical damage:** Physical damage to the drone's body or components such as propellers, landing gear, and camera can affect the drone's flight performance and lead to safety risks.
- **Corrosion:** Corrosion of the drone's metal components can weaken the structure and affect the drone's flight performance.
- **Loose or missing components**: Loose or missing screws, bolts, or other mechanical components can cause the drone to vibrate and affect its flight performance.
- **Cracks or deformation:** Cracks or deformation in the drone's body or components can indicate structural weakness and lead to safety risks during flight.
- **Electrical damage:** Damage to the drone's electrical system can cause issues such as power failure or uncontrolled flight, leading to potential safety risks.
- **Unusual noise:** Unusual noise during drone operation can indicate mechanical or electrical issues that can affect the drone's flight performance.
- **Overheating:** Overheating of the drone's battery or components can indicate a malfunction or damage and lead to safety risks.

Some symptoms of error conditions of drones that can be recognized visually:

- **Drone not taking off**: If the drone fails to take off or struggles to take off, it may indicate a problem with the motor, propellers, or software.
- **Unstable flight:** If the drone wobbles or drifts during flight, it may indicate a problem with the drone's sensors or calibration.
- **Drifting during hovering:** If the drone drifts while hovering in place, it may indicate a problem with the drone's GPS or altitude sensors.
- **Unexpected landing:** If the drone lands unexpectedly during flight, it may indicate a problem with the drone's battery or power system or propulsion system.
- **Abnormal battery behavior:** If the drone's battery drains faster than usual, takes longer to charge, or shows abnormal voltage readings, it may indicate a problem with the battery or power system.
- **Loss of control:** If the drone suddenly loses control or flies erratically, it may indicate a problem with the drone's communication system or flight controller.

4.2 Schedule Maintenance Plan for Components

Sr. No	Components	Part No.	Subcomponents	Flight Hours	Action	Inspection
1	Motor	SAVSCV10201 SAVSCV10202	-	Frequent	Remove settled dust, check for clearance	Operational Checks
2	Propeller	SAVSCV10201 SAVSCV10202	-	Frequent	Check fasteners, physical inspection	Continuity checks
3	Battery	SAVSCV10212	Connectors	Frequent	Follow battery logbook	Continuity checks, Individual cell voltage
			Power cables	Frequent	Follow battery logbook	
			Cells	Frequent	Follow battery logbook	
4	Power cables		-	25 Hrs	-	Continuity check
5	Signal Cables		-	25 Hrs	-	Continuity check
6	Water pump		-	25 Hrs	-	Operational Check
7	ESC		-	25 Hrs	-	Operational Check
8	HYB BEC	SAVSCV10208	-	25 Hrs	-	Operational Check
9	Current Sensor	SAVSCV10209	-	25 Hrs	-	Operational Check
10	Flight Controller	SAVSCV10204	-	25 Hrs	-	Operational Check
11	Flow meter	SAVSCV10211	-	25 Hrs	-	Operational Check
12	Level Sensor	SAVSCV10227	-	25 Hrs	-	Operational Check
13	Telemetry Receiver	SAVSCV10207	-	25 Hrs	-	Operational Check

4.3 Ground Control Station Error Messages

Sr. No.	Message/Error Display on GCS	Meaning of Error
1	Compass inconsistent	Compass has not calibrated for location
		Action: Need recalibration
2	Need 3D Fix	The GPS does not have a 3D fix and the vehicle is in a flight mode that requires the GPS
		Action: wait for some time more
3	Check Board Voltage	This Error shown after battery failsafe if you again try to arm drone this error thrown.
		Action: Connect Charged Battery
4	Gyros not healthy	Sensor is not initialized at start-up.
		Action: Need Reboot
5	EKF Velocity error	If velocity is more than expected value so EKF velocity error thrown
		Action: Automatically LAND or RTL depending upon the value of velocity.
6	EKF Position (Horizontal/Vertical)	GPS signal strength error of primary GPS
		Action: Switch to second GPS or Blend the of
7	EKF Compass	Magnetic Field variation receive by primary compass if error is more switch to second and third compass
		Action: If condition is more critical LAND mode is activated automatically.
8	EKF Terrain	Drone calibration is required
9	Battery Voltage Warning	Check the battery voltage, use fully charged batteries
10	GCS failsafe Warning	Drone may fly beyond the range, GCS battery low
		Action: Fly the drone within 1000 m range.

4.4 Maintenance Procedure

- **Body Maintenance:**
  - Inspect the drone body for any visible damage, cracks, or missing parts
  - Clean the drone body with a soft-bristled brush to remove any dirt, debris, or pesticides.
  - Tighten any loose screws or bolts on the body
  - Replace any damaged or missing parts immediately
  - Store the drone in a dry and cool place, away from direct sunlight

- **Propeller Maintenance:**
  - Inspect the propellers for any chips, cracks, or other damage
  - Clean the propellers with a soft-bristled brush to remove any dirt, debris, or pesticides
  - Tighten any loose screws or bolts on the propellers (With specified torque)
  - Replace any damaged or worn-out propellers immediately

- **Battery Maintenance:**
  - Handle the batteries with care and charge them according to the manufacturer's instructions
  - Do not overcharge or discharge the battery
  - Store the batteries in a cool and dry place
  - Replace any damaged or worn-out batteries immediately, store the damaged batteries according to the OEM manual.

- **Ground control Station**
  - Check the control station for faulty components like throttle sticks, their functioning.
  - Check the GCS connectivity with a drone.

- **Storage**
  - Store the drone and its components in a dry and cool place, away from direct sunlight
  - Remove the battery from the drone and store it separately in a cool and dry place.

4.5 Preventive Maintenance Plan

A preventive maintenance plan for drones is a schedule of regular inspections, cleaning, and maintenance activities designed to ensure that the drone operates safely and efficiently. The goal of a preventive maintenance plan is to prevent malfunctions or accidents caused by wear and tear or other factors. Here are some key components of a preventive maintenance plan:

The maintenance should be done after the number of cycles or date of delivery whichever comes first.

Sr. No.	Usage Timeline	Components to Check	Observations
1	First flight after drone delivery at sight	• Visual Inspection for all airframe connections • Inspection for any possible cracks • Calibration of all the primary sensors • Checking battery discharge and charge rate • Radio connection between Drone and GCS • Secure login through provided credentials	All the components are tested, and all are in working condition

2	15 Days after drones first flight/Delivery (100 Flights)	• Visual inspection for all airframe and wiring connections • Inspection for any possible cracks • Checking battery discharging and charging rates • Careful observation for excess vibrations • Proper check for excess noise levels	All components should be normal working conditions
3	30 Days after first flight/Delivery (200 Flights)	• Visual inspection for all airframe and wiring connections • Inspection for any possible cracks • Checking battery discharging and charging rates • Careful observation for excess vibrations • Proper check for excess noise levels • Check all the nuts and screws for their tightness • Check for landing gear conditions	All components should be normal working conditions
4	6 months after delivery / First flight (500 flights)	• Visual inspection for all airframe and wiring connections • Inspection for any possible cracks • Checking battery discharging and charging rates • Careful observation for excess vibrations • Proper check for excess noise levels • Check all the nuts and screws for their tightness • Check for landing gear conditions • Check for obstacle avoidance RADAR working	1. Battery may need to be replaced depending on way of usage 2. Need to tighten Screws and nuts. 3. Checking for sensor functioning
5	1 Year after first flight/Delivery (1000 Flights)	• Visual inspection for all airframe and wiring connections • Inspection for any possible cracks • Checking battery discharging and charging rates • Careful observation for excess vibrations • Proper check for excess noise levels • Check all the nuts and screws for their tightness • Check for landing gear conditions • Check for obstacle avoidance RADAR working • Check water flow sensor • Check motor functioning • Check for propeller conditions	1. Landing gear replacement (if required) 2. Propeller's replacement (Based on condition) 3. Software/Firmware upgrades
6	2 years after first flight /Delivery (2000 flights)	• Visual inspection for all airframe and wiring connections • Inspection for any possible cracks • Checking battery discharging and charging rates • Careful observation for excess vibrations • Proper check for excess noise levels • Check all the nuts and screws for their tightness • Check for landing gear conditions • Check for obstacle avoidance RADAR working • Check water flow sensor • Check motor functioning	1. Landing gear replacement (if required) 2. Propeller's replacement (Based on condition) 3. Software/Firmware upgrades 4. Replace motors 5. Replace sensors

		• Check for propeller conditions	
7	3 year after first flight /Delivery (Sooryauday Aerial Vehicles Private Limited. flights)	• Visual inspection for all airframe and wiring connections • Inspection for any possible cracks • Checking battery discharging and charging rates • Careful observation for excess vibrations • Proper check for excess noise levels • Check all the nuts and screws for their tightness • Check for landing gear conditions • Check for obstacle avoidance RADAR working • Check water flow sensor • Check motor functioning • Check for propeller conditions • Radio communication links	1. Landing gear replacement (if required) 2. Propeller's replacement (Based on condition) 3. Software/Firmware upgrades 4. Replace motors 6. Replace sensors 7. Replace antenna

5. Component Monitoring Process

5.1 Objective

- Identify and address any potential issues or wear and tear in key components.
- Prevent unexpected failures or malfunctions during flight.
- Extend the drone's lifespan by detecting and addressing maintenance needs on time.
- Ensure the drone operates within safety guidelines and regulations.
- Optimize performance and reliability for various missions or applications.

5.2 Procedure

- Conduct a quick visual inspection of the drone's critical components, including motors, propellers,
- wiring, and battery connections, looking for any visible damage or loose connections.
- Inspect the battery for physical damage, bulges, or unusual odors. Verify that the battery contacts are clean and securely connected.
- Power on the drone and perform a functional test, including a motor spin-up and a brief test flight in a safe area to check for any unusual behavior or vibrations.
- Check the drone's flight control app for any error messages or warnings related to component health or performance.
- Review the flight log data for any irregularities or issues encountered during recent flights.
- Keep a simplified record of your monitoring activities, noting any findings, the date, and any actions taken.

5.3 Parts of UAV and Type of Failure

5.3.1 Propellers

Cracks or Breakage: Physical damage to propellers can lead to imbalance and reduced flight stability.
Balancing Issues: Imbalanced propellers can cause excessive vibration and affect flight performance.

5.3.2 Motors

Motor Burnout: Overheating or excessive wear can lead to motor burnout, causing loss of thrust and flight control.
Electronic Failure: Electronic speed controllers (ESCs) may fail, resulting in motor issues.

5.3.3 Batteries

Reduced Capacity: Over time, lithium-polymer batteries can degrade, resulting in reduced flight time and power.
Cell Failure: Individual cells within the battery pack can fail, leading to voltage imbalances or unexpected power loss.

5.3.4 Sensors

Sensor Calibration Errors: Incorrect sensor calibration or calibration drift can affect the flight stability.
Sensor Damage: Physical damage to sensors or cameras can result in blurred images or inaccurate data.

5.3.5 Flight Controller

Software Glitches: Software bugs or glitches in the flight control system can lead to erratic behavior or crashes.
Hardware Failure: Hardware components of the flight controller, such as the microcontroller or The gyroscope can fail.

5.3.6 Frame and Chassis

Cracks or Structural Damage: Physical damage to the frame or chassis can compromise the structural integrity of the drone.

Corrosion: Exposure to harsh environmental conditions can lead to corrosion of metal components.

5.3.7 Landing Gear

Landing gear Failure: Damaged or worn landing gears can result in hard landings or loss of payload.
Payload Equipment (e.g., Spraying Systems):
Clog or Blockage: Agricultural payload equipment may experience clogs or blockages that affect spraying accuracy.
Pump or Valve Failure: Mechanical components in the payload system may fail, affecting spraying or data collection.

5.3.8 GPS

GPS Signal Loss: Signal interference or loss of GPS reception can lead to navigation errors or drifting during flight.

5.3.9 Communication System

Radio Signal Interference: Interference with the drone's communication systems can lead to loss of control or telemetry data.

5.3.10 Wiring and Connectors

Connection Issues: Loose or damaged wiring or connectors can result in electrical failures.

5.3.11 Environment Factors

Weather-Related Failures: Adverse

5.4 Description of In-Service Wear Components

5.4.1 Propellers

Due to improper piloting, propellers get affected while generating thrust and can cause propeller breakdown while the drone is in flight. Pesticides can also affect propellers while spraying.

Prevention - To prevent propellers, pilots should follow the S.O.P. of the spraying route so it can reduce the effect on propellers. To protect propellers from pesticides, the pilot team uses oil polishing at the end of the day after spraying

5.4.2 Arms

Propulsion systems are mounted on arms; an improper or unstable take-off can have an effect on arms as the propulsion system generates momentum at the time of take-off and during flight.

Prevention - For prevention of the effects of momentum on carbon-fiber arms, pilot take-off speed should be below 70% of the throttle as guided by the Sooryauday Aerial Vehicles Private Limited. technical team, and damping or negative control commands (e.g., drifting) during flight should not be done.

5.4.3 Arm Joint

Folding and unfolding the outer arm from the inner arm after and before flight causes tear wear at the joint of the folding joint. If the Roller is not twisted properly, it can damage the Arm joint assembly.

Prevention - The user should do the folding exercise of the bracket and press the push pin with light strength in such a way that the folding bracket does not get worn.

5.4.4 Landing gears

Instant landing or emergency landing can affect vertical landing gears due to the impact of the load in the upward direction.

Prevention - For the prevention of landing gear failure, land the UAS safely with landing speed no more than 0.5 m/s, which is by default set in the Firmware.

NOTE: USER Should follow Pre-Flight Checklist and Post-Flight Checklist for good efficiency & minimum wear of the critical components of SprayCoptor UAS.

5.5 Life of Critical Components/PSE's and Their Replacement Procedure

Below is the list of critical components that are to be replaced before its designated limit of life.

Sr. No.	Component Description	Life Cycle (Hours)
1	Arm Joint	8000
2	Tank Connector	8000
3	Landing T Connectors	8000
4	Landing Gear Connector	8000
5	Propeller	500
7	Landing Gear	10000 Landings
8	Airframe	8000
9	Motor	500

5.5.1 Procedure for Replacement of Propellers

The propeller can be replaced by a user following the below procedure:

The obtained life of the propeller is 500 hours. After the duration of the assigned life of the component is completed, it should be replaced with a new component.

Contact Manufacturer:

Inform the manufacturer about the damaged propeller and request a new identical propeller.

Verify Propeller Direction:

Upon receiving the new propeller, verify that its direction matches the damaged propeller.

Remove Damaged Propeller:

Utilize a 2.5 mm Allen key from the provided toolbox for the replacement process.

Carefully use the Allen key to remove the 4 XM3 screws securing the damaged propeller.

Take out the damaged propeller while ensuring not to damage the mounting points.

Assemble New Propeller:

Place the new propeller in position, aligning it with the mounting points.

Apply Loctite 243 threadlocker on the threads of the screws before assembly.

Secure the new propeller by fastening it with the 4X M3 screws.

Ensure Perfect Assembly:

Verify that the new propeller is securely and perfectly assembled.

Confirm that the screws are tightened adequately to prevent any loosening during operation.

Logbook Entries:

Make entries in the Line replaceable units logbook detailing the replacement, including the date and relevant information.

Flight Test:

Conduct a thorough flight test in a controlled environment to ensure the proper functioning of the replaced propeller. Monitor for any abnormal vibrations, noise, or performance issues during the test.

Contact Manufacturer for Issues:

In case of any issues identified during the flight test or concerns with the replacement, promptly contact the manufacturer for further assistance.

By following these steps, users can safely and effectively replace a damaged or life-expired propeller on the UAS, ensuring optimal performance and adherence to safety standards.

For replacement of any other component, the user should contact the manufacturer (Sooryauday Aerial Vehicles Private Limited).

6. Leak Prevention and Inspection of Spraying Accessories Connections

The spray system comprises an 11.4 liter tank with a 10-liter payload capacity, a gravity-fed Brushless pump, fluid routing pipes, and Flat Jet Nozzles for optimized agrochemical application. The operation of the spray system is as follows: The agrochemical fluid is pumped from the tank to the nozzle by the brushless pump, maintaining the fluid pressure at an optimal level for the specified droplet size of the agrochemical solution.

As the payload is the integral part of UAS, operators/users are not allowed to make any changes to the payload system. In case any maintenance will be required, contact the manufacturer for support. Only the spray connectors can be changed by operators.

Figure 2: working schematic of spraying system

6.1 Components of Spraying System

- **Battery:**

This is the power storage unit and supplies to other components. GENX Lipo 6S1P 25000 mAh Battery is used. It has a capacity of 25000 mAh and nominal voltage of 22.2 V. The battery has a discharge rate of 25C with a net weight of 3.135 Kg.

- **PDB:**

PDB (Power Distribution Board) is a board that allows transferring the power from the battery to ESCs / Motors. The PDB has 8 different ports which can provide continuous live battery voltage. The PDB is capable of handling 480A current and capable of providing power for UAV.

- **Tank:**

Stores the liquid inside it and has the storing capacity of 11.4 L but the filling is restricted to 10 L or 10 Kg.

- **Pump:**

It is used to pump the liquid payload from the tank and raise sufficient pressure so that the liquid flows through the pipes and goes to the nozzle. The pump has a rating of 35 W with a maximum flow rate of 5 L/min. Voltage rating is 12V with a rated pressure of 0.48 MPa.

- **Flow meter:**

Measures the flow of liquid from the tank to the spray system and gives PWM input to the Flight controller.

- Measurement range: 0.5-5 L/min
- Accuracy: 10 ml

- **Flat Jet Nozzle:**

A flat jet nozzle, also called a spray nozzle, is a device that facilitates the dispersion of a liquid by the formation of a spray. Doubling the pressure while maintaining the same flow rate results in a doubling of the impact. Flat jet nozzles stand for high impact and uniform liquid distribution with spray angles up to 60°. Flat jet nozzles with low flow rates are especially suited for humidifying and spraying in general. The specifications for flat jet nozzles by EFT are given below.

- Opening Flow: 4-5 L/min
- Spray Width/ swath: 4 m
- Working Pressure: 0.35 MPa
- Droplet Size: 300-600 microns

A flat jet nozzle serves the purpose of spraying onto a surface or an object moving in a transverse direction with respect to one of the jet surfaces. Flat jet nozzles produce a thin, flat liquid sheet spreading outwards from the nozzle tip. These have been developed to reduce spray drift, which was beneficial to target deposition.

6.2 Spraying System Working

The battery gives power to PDB and the power distribution board further supplies the power to each component. PDB further distributes power to the flight controller and Pump. The flight controller gives the data to the pump of the rate of liquid that must be sprayed. The liquid starts to flow in the water pipes due to pumping and moves towards the nozzles. Nozzles accelerate the liquid and disperse it in the field.

The purpose of the spraying system is to pass the liquid from the Tank where it is stored, to the nozzle through which the liquid will be sprayed.

6.3 Leak Prevention and Inspection of Spraying Accessories Connections

- **Purpose:** The proper functioning of spraying accessories connections, including the tank, pump, flow meter, and pipe connectors, is crucial to the safe and effective operation of the drone spraying system. Ensuring leak-free connections is essential to prevent any inadvertent leakage of chemicals during flight.
- **Pre-Flight Inspection:**
  - **Tank Connection:**

    Before each flight, ensure that the tank connection, where the chemical solution is stored, is securely fastened and free from any visible signs of wear or damage.

  - **Pump and Flow Meter**:

    Inspect the pump and flow meter connections for any loose fittings, cracks, or signs of leakage. Ensure that all components are properly aligned and tightened.

  - **Pipe Connectors:** Examine all pipe connectors, such as hoses and nozzles, for secure attachment. Verify that there are no kinks, blockages, or damage to the hoses that could lead to leaks.

  - **Pressure Test before Take-off:**

Check all the spraying connections, and then start the pump at 85% capacity and do a visual check on each connection for any sign of leakage. If some signs are observed, then rectify the connection before take-off.

- **Proper Connection Techniques**:

  Use appropriate fittings and connectors designed for the specific purpose, ensuring compatibility with the spraying system. When connecting or disconnecting accessories, follow the manufacturer's guidelines regarding tightening torque and sealing methods to prevent leaks.

- **Leak Testing:**

  Conduct a leak test on the entire spraying system, paying particular attention to the accessories' connections. Follow the procedures outlined in the "Conducting a Leak Test" section of the User Manual.

- **Maintenance and Servicing:**

  Perform routine maintenance to inspect and maintain the spraying accessories connections. Replace damaged or worn components promptly. Lubricate moving parts as per the manufacturer's recommendations to prevent corrosion and maintain the integrity of connections.

7. Flight Checklists

7.1 Round Checklist

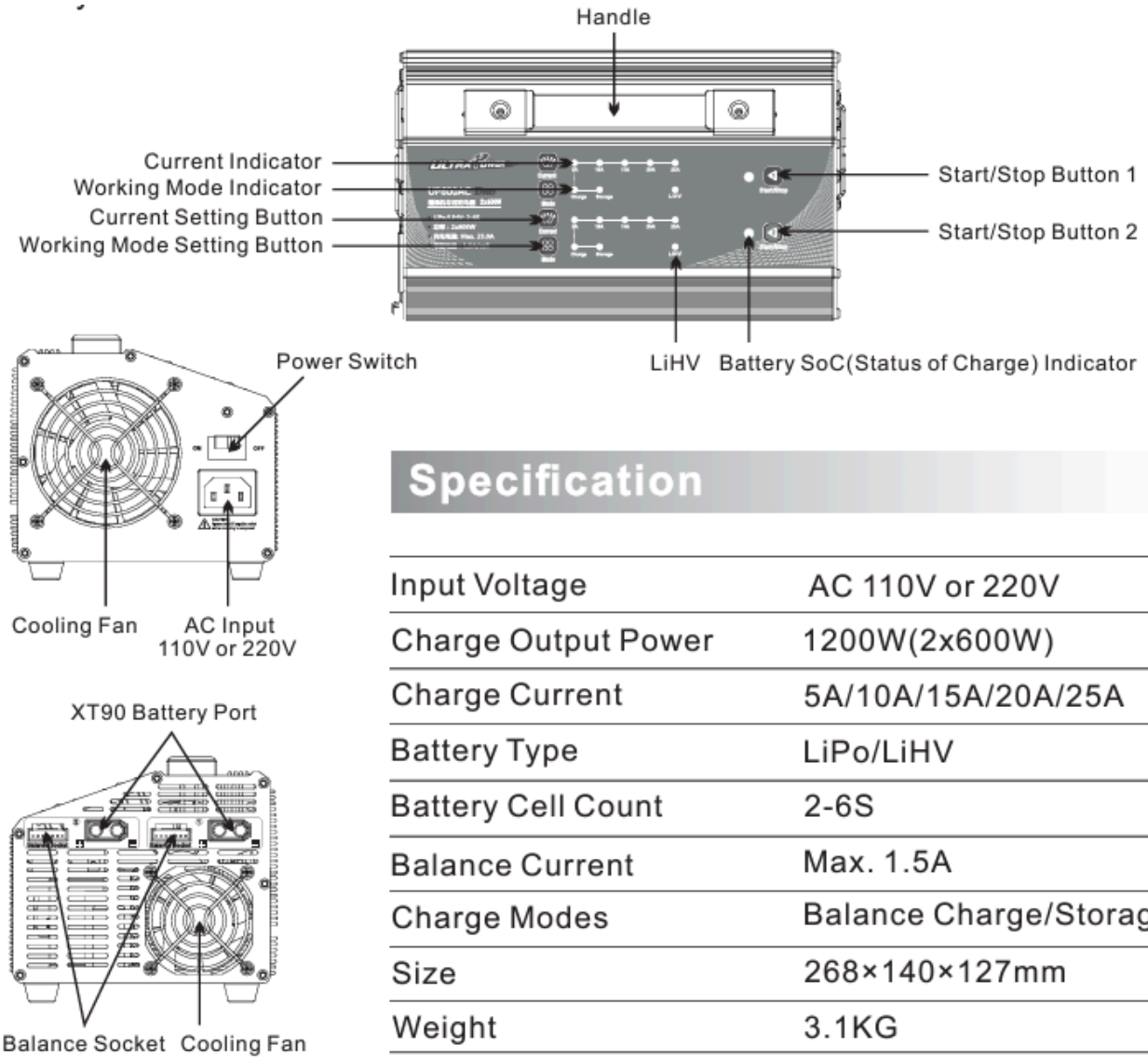
- Conduct a routine checkup after every 20 flights to ensure that the drone is in good working condition and prevent any potential issues.
- Check all the screws present on the base plate, propellers, landing gear, and other components to ensure they are securely fastened and tightened. Loose screws can lead to drone instability or component failure.
- Check the alignment of the landing gear, motor balancing, and tank balancing of the drone to ensure that the drone is properly balanced and stable during flight.
- Rinse the tank and the pipes properly to remove any remaining pesticides or chemicals that may have been used during the flight. Use clean water to prevent residue buildup and potential damage to the tank and pipes.
- Do the accelerometer calibration as explained in the drone's user manual to ensure accurate and stable flight performance.
- Do the compass calibration as explained in the drone's user manual to ensure the drone's compass is properly calibrated and accurate.
- Inspect the drone's propellers for any signs of wear or damage. Replace any damaged propellers before the next flight.
- Check the drone's sensors, cameras, and other components for any signs of dirt, debris, or damage. Clean or repair, as necessary.
- Check the drone's battery for any signs of damage or swelling. Replace any damaged or swollen batteries before the next flight.
- Check the weather forecast for the next flight to ensure that conditions are safe and favorable for flying.

8. Battery and battery chargers

8.1 Battery

Figure 3: 25000 mAh Battery

8.2 Battery charger



Specification

Input Voltage	AC 110V or 220V
Charge Output Power	1200W(2x600W)
Charge Current	5A/10A/15A/20A/25A
Battery Type	LiPo/LiHV
Battery Cell Count	2-6S
Balance Current	Max. 1.5A
Charge Modes	Balance Charge/Storage
Size	268×140×127mm
Weight	3.1KG

Figure 4: Battery Charger Specifications

- **Parameter control buttons:**
  - **Stop/Setting button**: Press once to stop the charging process, and long-press to access settings.
  - **Status buttons**: These buttons allow you to switch between different status.
  - **Start button**: Press once to select any configuration, and long-press to start the charging process.
- **Battery Power Input port.**
  - Connect the battery power cable to this port.
- **Balance charging port**
  - Connect the balance charging cable of the battery to the balance port on the device.

For more details refer to the Battery Charger Manual provided in the flight box.

8.3 Battery Charger Setup Procedure

- Switch on the charger from the AC supply plug and from Back side of the charger.

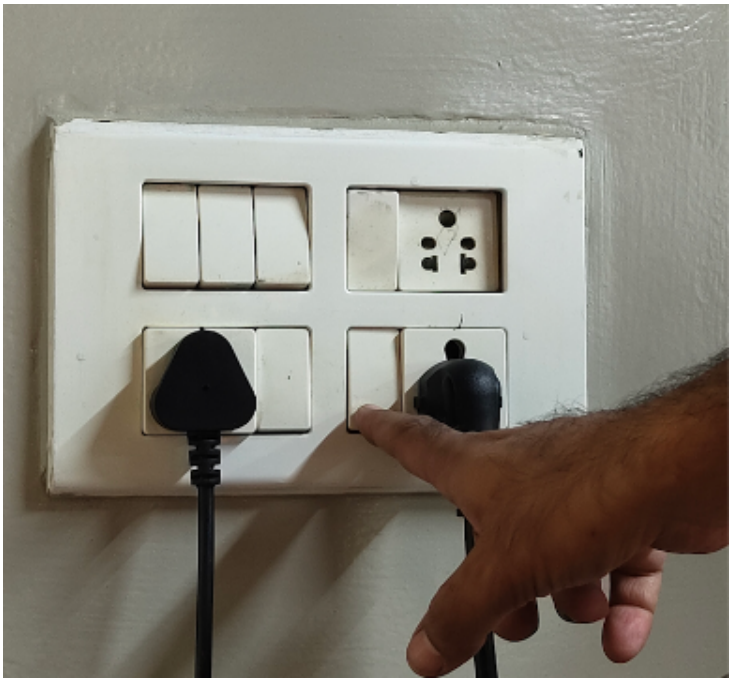


Figure 5: Connecting plug to the power supply

- Connect the battery balance connector to the balance port in the charger in the following manner.

Figure 6: Connecting balance connector to the balance port

- Connect the main battery cable to the battery port of the charger.

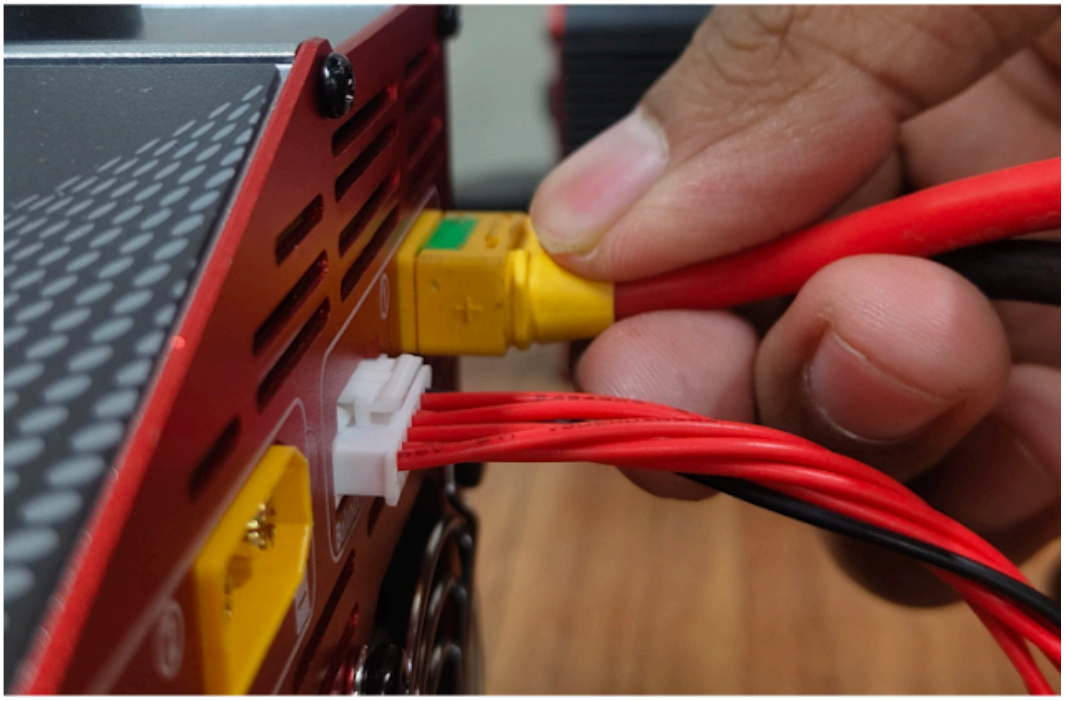


Figure 7: Connecting main battery cable to battery port

- Select the battery type to Li-Po in Balance charge mode and charging rate to 10 Amps.

NOTE- IN MASTER SLAVE MODE THE SETTING APPLIED IN MASTER PORT AUTOMATICALLY APPLIES TO SLAVE PORT.

Figure 8: Selecting the battery type and charging rate

- Press Start button after cross checking the inputs. The charger will make a sound once it starts charging.

Figure 9: Pressing start button on the charger

- Press Stop to end the charging once it is done or for emergency stop of charging.

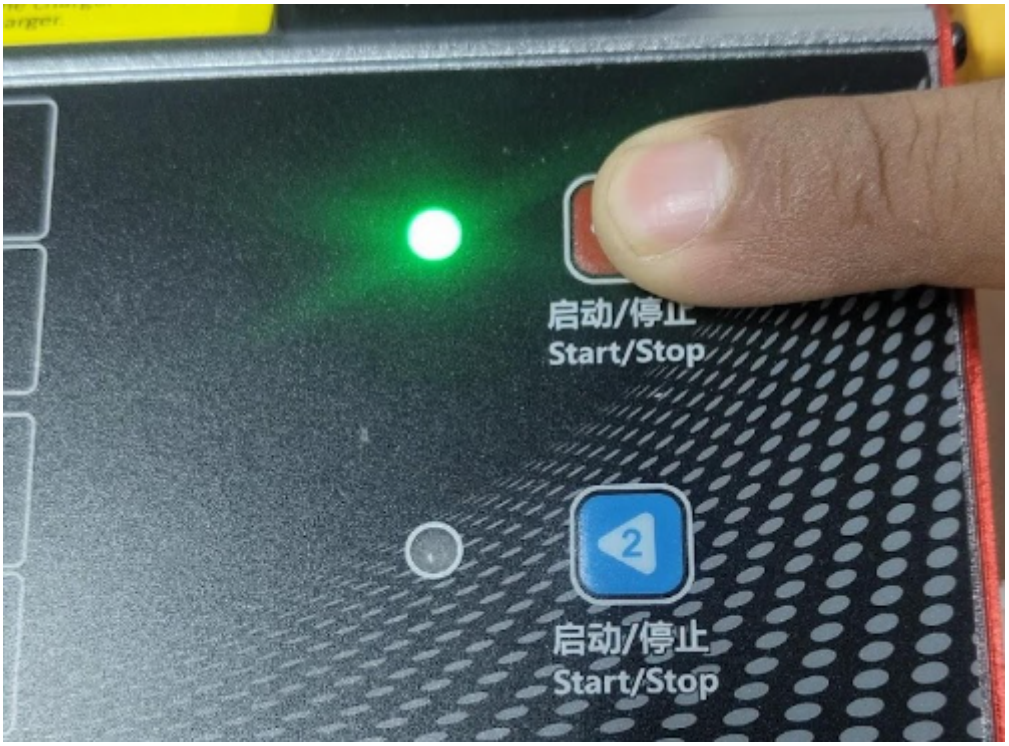


Figure 10:. Pressing stop button on the charger

- After charging is complete, disconnect the battery from the charger and turn off the charger.

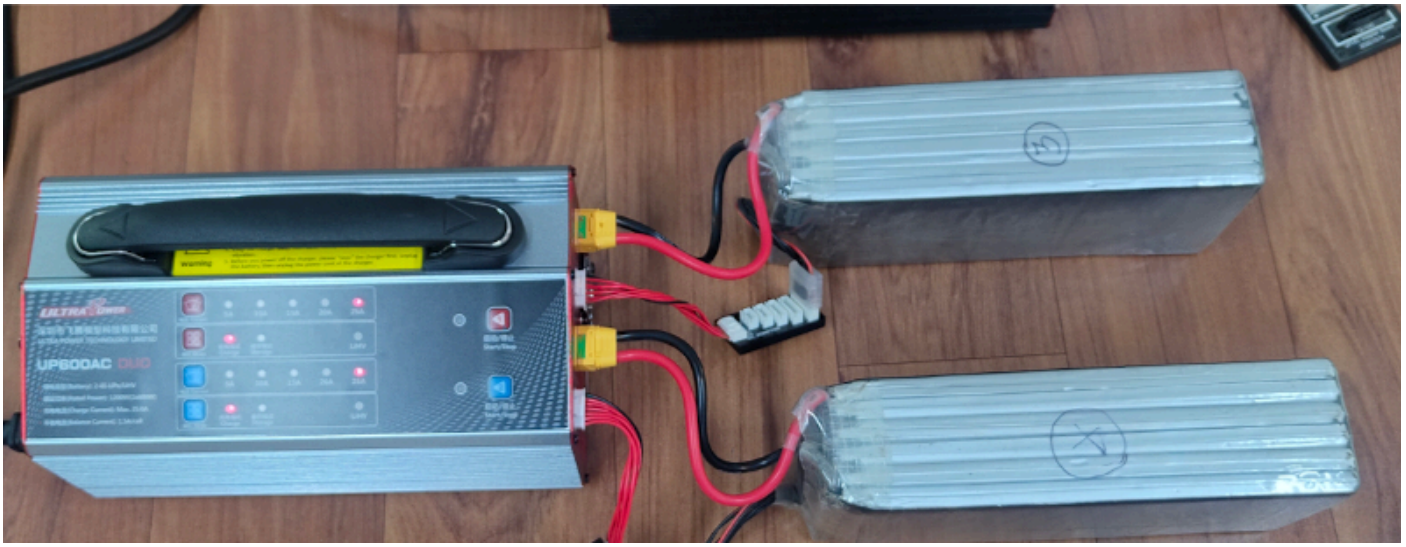


Figure 11: Battery Charging

8.4 Sop for Battery Storage and Charging

8.4.1 Battery Storage and Transport

- When not in use, store the batteries in a battery storage box to protect them from damage.
- Store the battery packs in a room with a low temperature, ideally below 25 degrees Celsius.
- Be aware that damaging a cell in a pack can permanently damage the entire pack and potentially cause a fire.
- Store fired batteries in a cool and dry chamber to prevent the risk of smoke or flames.
- Ensure that fire extinguishers are readily available during storage, transportation, and loading.
- Store the battery pack at its nominal voltage of 3.7 V (22.2 V across the pack) to increase its lifespan and reduce volatility.
- Avoid placing batteries in pockets or near conductive metals where they can short circuit.

- Do not store, transport, or carry the battery in a way that it may come into contact with sharp or metallic objects.
- Avoid storing Li Ion batteries in extreme temperatures below 0°C or above 50°C.
- Always store Lipo packs in safe, non-flammable containers and away from combustible materials.
- Refrain from bulk-storage of Lipo batteries in non-laboratory areas such as offices.
- Store Li Ion batteries partially charged as they maintain their performance level over time. Cycling is not necessary unless stored for more than 3-6 months, ideally.

8.5 Safe Battery Storage

- Avoid placing the battery close to liquids and do not store it in a humid environment to prevent moisture damage to the battery.
- Keep the battery away from open flames, heaters, or other fire sources, as it can pose a fire hazard.
- Store the battery in a location that is inaccessible to children to prevent accidental handling or misuse.
- Ensure that the battery has enough storage space and is not squeezed between other batteries or objects, as it can cause damage or deformation.
- Store the battery in a cool and dry place with a temperature of around 25 degrees Celsius, as extreme temperatures can affect battery performance and lifespan.
- For batteries that will not be used for an extended period, control the storage voltage to be between 3.7 V to 3.85 V to prevent over-discharge or overcharge, which can damage the battery.
- Regularly check the status of the battery storage box at least once every two weeks for any signs of damage, leakage, or other abnormalities. If any issues are detected, take appropriate action, such as replacing damaged battery storage boxes.
- Perform a full charging and discharging cycle on the battery at least once every two months to maintain battery stability and prevent capacity loss due to prolonged storage.
- Store the battery in a well-ventilated area to ensure proper airflow and prevent the accumulation of gas or fumes that may be released by the battery during storage.
- Avoid storing the battery in direct sunlight or in excessively humid or damp conditions, as it can affect battery performance and potentially cause safety hazards.
- Use appropriate storage containers or cases specifically designed for batteries to prevent physical damage, short-circuiting, or exposure to foreign objects that may cause damage.
- Follow manufacturer recommendations for battery storage duration and conditions, as different battery types and brands may have specific requirements.
- If you are unsure about the proper storage procedure for a particular battery, refer to the manufacturer's instructions or seek professional guidance to ensure safe and optimal storage practices.

8.6 Precautions To Take While Charging The Battery

8.6.1 Before Charging and Discharging

- Before charging, carefully inspect the surface of the battery for any signs of damage, such as dents, cracks, or corrosion. Do not charge a battery with a damaged surface.
- Check if the battery is swollen or bulging, which may indicate a potential internal issue. Do not charge a swollen battery as it can be dangerous.
- Look for any signs of leakage, such as fluid or stains, on the battery. If the battery has leaked, do not charge it as it may pose a risk of damage or injury.
- Check the voltage of each cell in the battery to ensure they are within the normal range, typically around 3.3 volts. If any single cell has a voltage lower than the normal range or if the voltage among cells is unbalanced, it may indicate a quality issue with the battery, and it should not be charged.
- Double-check that the positive and negative poles of the battery plug are correctly aligned before connecting it to a charger. Never short circuit the battery, as it can cause damage or even result in a fire or explosion.
- Ensure that the lithium battery charger you are using is in good condition, free from any visible damage or defects. A faulty charger can potentially damage the battery or pose a safety risk during charging.
- Follow the manufacturer's instructions and recommendations for charging the specific type and model of battery you have. Different batteries may have different charging requirements, so it is

important to adhere to the guidelines provided by the manufacturer.

- Charge the battery in a well-ventilated area, away from flammable materials and out of the reach of children or pets. Avoid leaving the battery unattended while charging.
- Use a charger that is specifically designed for lithium batteries and has the appropriate voltage and current ratings. Using an incompatible charger can damage the battery or pose a safety risk.
- Monitor the battery during charging for any unusual signs, such as excessive heat, smoke, or a strong odor. If any abnormalities are detected, immediately stop charging and disconnect the battery from the charger.
- Once the battery is fully charged, disconnect it from the charger and store it in a cool, dry place away from direct sunlight or extreme temperatures. Avoid overcharging the battery, as it can shorten its lifespan or cause damage.

8.6.2 During Charging and Discharging

- Use only chargers provided by the original equipment manufacturer (OEM) specifically designed for charging Li Ion batteries. Do not use chargers meant for other types of batteries such as NICD or NIMH.
- Never leave the battery unattended while it is being charged to minimize the risk of overcharging, overheating, or other potential safety hazards.
- Avoid overcharging the battery. Make sure the voltage of each battery cell does not exceed 4.2 V when fully charged. Also, do not short circuit the battery, as it can cause damage or even fire.
- Charge the battery within the recommended temperature range of 0-45 degrees Celsius to ensure safe and efficient charging. Avoid charging in extreme temperatures that can damage the battery.
- Ensure that the charging table or platform used is heat resistant and can withstand high temperatures during the charging process to prevent any potential fire hazards.
- Place the battery on a concrete floor or in a flowerpot filled with sand during charging to provide a stable and non-flammable surface, minimizing the risk of accidents.
- Avoid overheating the battery and its cells at any time, as it can lead to reduced performance, damage, or safety risks. If the temperature of the battery cell reaches 60 degrees Celsius, there is a potential hazard or risk of fire.
- Do not charge the battery directly on flammable materials such as paper, carpet, plastic, vinyl, leather, or wood, and do not charge it inside the device. Also, do not over-discharge the battery, as it can damage the battery, cause swelling, or reduce its lifespan. Make sure the voltage of each cell after discharge is not less than 3.3 V.
- Avoid contact with the electrolyte in the battery, as it can cause harm to eyes or skin. If accidental contact occurs, immediately wash with clean water, and seek medical attention if necessary.
- Do not disassemble or rewire the battery, and do not attempt to combine old battery cells or disassembled cells with another pack of batteries without proper equipment. Improper assembly can cause short circuits and result in burning or other hazards.
- Do not touch leaking batteries directly, as the electrolyte can be harmful. Handle with care and dispose of properly according to local regulations.
- Avoid assembling batteries privately and follow manufacturer guidelines for battery assembly. Improper assembly can result in safety risks, such as short circuits or fires.
- If the battery is involved in a collision during use, remove it and assess for any potential damage before continuing to use or charge it.
- Carefully inspect the battery and connector for any signs of damage, wear, or abnormality before charging or using it to ensure safe operation.
- ***After charging, make entries in the battery charging logbook.***

8.7 Procedure for Battery Disposal

Dispose of the battery by following local regulations for hazardous materials. The battery should be properly packaged, labeled, and transported to a certified disposal facility.

Precautions: Safety to be taken care of

- Only authorized and trained personnel should handle the battery

- Personnel should wear appropriate protective gear, including gloves and eye protection when handling the battery.
- Personnel involved in the process should take precautions to avoid damaging the environment.
- Hazards that may be encountered during the disposal process may include flammable materials and hazardous chemicals. Personnel involved in the process should be trained to identify and mitigate these hazards.

Record-Keeping

- Records of the disposal should be kept for a minimum of five years.
- Any associated hazardous materials should be properly documented.
- Keep a record of the disposal, including the date and location.

This SOP outlines the steps to be taken for the safe and compliant disposal of the Battery of the drone that has reached its designated life of 300 Cycles. By following these procedures, the disposal process can be completed in a manner that is safe for personnel and the environment.

Once the battery life is over (300 cycles) or the battery gets damaged, it will be considered as battery waste. Collect such all the batteries and hand it over to Sooryauday Aerial Vehicles Private Limited.

8.8 Procedure for GCS Charging

- Check blue lights on the RC power button.

Figure 12: Solid blue light on power button on RC

- Now connect the charging cable to the charging point of the RC and switch on the main power supply button.

Figure 13 Charging port on RC

- The charging indicator blue light, and the transmitter starts charging.
- When the charging indicator turns full, charging is finished as shown in the figure.

Battery Level LED definition ● ON ○ OFF

Bettery Level LED definition				
●	●	●	●	75%–100%
●	●	●	○	50%–75%
●	●	○	○	25%–50%
●	○	○	○	0%–25%

Figure 14: Charging Status Indicator and its meaning

9. Reporting of Component Failure and Performance Issues

Step 1: Identify the Issue

If you observe any issues with the drone's performance or encounter a component failure, take note of the specific problem you are facing.

Step 2: Contact Manufacturer

Reach out to the manufacturer using the provided communication channels. This could be through a dedicated support email provided below.

For Administrative/ Technical Support	**Ravi Kumar** Administrative Support Executive contact@sooryauday.com 011-49753306 Plot No-40, Sector-68, IMT Faridabad, Faridabad, Haryana, India - 121004.

Step 3: Provide Drone Information

Include crucial details such as the drone's serial number and model in your communication. Briefly describe the identified problem for a more efficient diagnosis. It may include reference photographs, flight videos etc.

Step 4: Describe the Issue

Clearly explain the observed issue, including any unusual behavior, error messages, or deviations in performance. A detailed description helps the manufacturer better understand and address the problem.

Step 5: Await Manufacturer Response

After reporting the issue, wait for a response from the manufacturer. This may include confirmation of the problem, additional questions for clarification, or instructions on the next steps.

Annexure – I

1. Structural Inspection Checklist

Checklist During Scheduled maintenance				
Structural Inspection				
RPAS UIN:			**Maintenance Sr. No.:**	**Maintenance date:**
Sr. No	**Inspection**	**Action**		**Remarks**
1	Clean chassis of mud and dirt	Checked		
2	Inspect chassis for cracks	Checked		
3	Check for loose screws	Checked		
4	Check propeller for damage	Checked		
5	Check propellers are free spinning	Checked		
6	Check motors for debris and obstruction from rotating	Checked		
7	Check state of wiring and solder joints	Checked		
8	Check landing gear condition	Checked		
9	Inspect antennae	Checked		
10	Check control station for faulty errors	Checked		
11	Inspect battery charger for visible damage	Checked		
12	Inspect battery packs for bulges	Checked		
13	Check for firmware update	Checked		
14	Check for control station update	Checked		
15	Inspect for Hardware tampering	Checked		

**In case some problems were identified during structural component checks, please contact the manufacturer technical support.*

2. Equipment Check Logbook

RPAS Maintenance Log			
Equipment Check			
RPAS UIN:		**Maintenance Serial No.:**	**Maintenance Date:**
Sr. No.	**Components**	**Action**	**Remarks**
1	Motors	Checked	
2	Electronic Speed Controller (ESC)	Checked	
3	Airframe	Checked	
4	Propellers	Checked	
5	Battery	Checked	
6	Remote controller	Checked	
7	Flight controller	Checked	
8	RC battery	Checked	
9	Compass	Checked	
10	Power Distribution board	Checked	
11	Telemetry	Checked	
12	Receiver	Checked	
13	Payload	Checked	
14	Landing gear	Checked	
15	Power cables	Checked	
16	Canopy	Checked	

In case some problems were identified during Equipment checks, please contact the manufacturer technical support.

3. Line Replaceable Units Logbook

UAS Maintenance Log								
Line Replaceable Units Log								
RPAS UIN:								
Sr. No	**Date**	**Replace Part**	**Old Part Id**	**New Part ID**	**Technician Name**	**Engineer Name**	**Maintenance Sr. No**	**Remarks**

**In case of change of critical components of SprayCoptor UAS , please contact the manufacturer technical support.*

4. RPAS Maintenance Logbook

RPAS Maintenance Log						
RPAS UIN:						
CLASS:						
CATEGORY:						
Sr. No.	**Date**	**Issues Faced**	**Corrective Activities**	**Technician Name**	**Engineer Name**	**Remarks**
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						