NSSL UAS STANDARD OPERATING PROCEDURE

ABSTRACT

The purpose of this procedure is to provide instruction and direction to NSSL/CIWRO personnel regarding NSSL UAS operations.

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Contents

1. Purpose

The purpose of this procedure is to provide instruction and direction to NSSL/CIWRO personnel regarding NSSL UAS operations. All UAS flights must be approved by the NOAA Uncrewed Aircraft Systems Division (UASD), which is briefly discussed in Section 5.6.4. For more detailed information on NOAA UAS protocol, the reader is referred to NOAA's UAS handbook (available here). The following procedures are intended to promote safe, efficient and lawful operation of NSSL's UAS.

2. Scope

The Standard Operating Procedures for UAS Operations (SOP) has been prepared for the use and guidance of UAS in flight operations, flight planning, training, and oversight as a requirement to exercise the privileges of operating under 1) any Public Agency Operation when operating a Public Aircraft 2) any remote pilot operating under 14 CRR Part 107, 3) any other operations conducted under a Certificate of Waiver or Authorization (COA) including an Airspace Authorization, Airspace Waiver or Operational Waiver or 4) any operation categorized as a moderate and above Risk Level. All personnel operating under or in support of NSSL UAS operations must follow all applicable Federal Aviation Administration (FAA) regulations and guidelines, NOAA UAS policies, as well as local, state, and federal rules and regulations.

The SOP is intended to be a convenient source of the NSSL's UAS operation procedures. Everyone participating in applicable UAS activity should study this entire manual and NOAA UAS Policy 1107 (available here) and NOAA UAS Handbook (available here) to familiarize themselves with its requirements before participating in any UAS activity for research purposes. The SOP does not address every possible contingency that may arise or every rule of safety and good practice. UAS operators are expected to be aware of their surroundings and consider any special characteristics of the area or the mission being flown.

3. Roles and Responsibilities

3.1. Mission Commander (MC)

All NOAA UAS operations are required to have a Mission Commander. As defined in NOAA UAS Handbook policy, the MC has the final oversight and responsibility to ensure all applicable statutory requirements are met during all NOAA UAS operations.

3.1.1. Responsibilities

- The MC will provide federal oversight of the project and have operational authority in conjunction with the Remote Pilot In Command, to include go no-go decisions based on weather, safety and operational payload status.

- The MC shall have knowledge in the limitations of the platform, airspace, and required approvals in the operation.
- In the event of an incident, the MC will act as the liaison with NOAA UASD to determine root causes and file any required paperwork before UAS flights are authorized by AOC to resume.
- Although the MC is not required to have a remote pilot certificate with a small UAS rating issued pursuant to subpart C of 14 CFR Part 107 according to NOAA's UAS Handbook Policy, it is highly recommended.

3.1.2. Qualifications

- NOAA Federal Employee.
- Non-NOAA Federal employees must be recommended by their supervisor to receive a UASD MC Designation Letter.
- MC Designation Letter signed by the Chief, UASD.

3.1.3. Training

- MC specific training course provided by the UASD.

3.1.4. Currency

- MC will attend or review the UASD provided policy and regulation update annually.

3.2. Remote Pilot In Command (RPIC)

The Remote Pilot In Command (RPIC) is directly responsible for and is the final authority over the operation of the UAS. The RPIC retains complete and overall responsibility for safety in flight, regardless of who is piloting the UAS.

3.2.1. Responsibilities

The RPIC retains complete and overall responsibility for safety in flight, regardless of who is operating the controls. The RPIC has the final decision to initiate or terminate any flight.

- The RPIC will evaluate each UAS activity in detail prior to operation. It is the responsibility of the RPIC to recognize and refuse any UAS activity that in the RPIC's judgment is not safe. The RPIC's shall determine whether the UAS activity is feasible and can be conducted in a safe and efficient manner.
- The RPIC must understand the UAS activity and have all applicable maps, charts and manuals available while on-site. Additionally, the RPIC is required to be aware of weather forecasts, winds, hazards, temporary flight restrictions, and all pertinent information necessary to perform the UAS activity.
- The RPIC is responsible for ensuring that all documentation has been completed, submitted and accepted, including submission of the UAS Activity Request Form, filing of any necessary notices, and any necessary flight plans or safety mitigation analysis.

3.2.2. Qualifications

- The RPIC must have (and maintain) a remote pilot certificate with a small UAS rating issued pursuant to subpart C of 14 CFR Part 107, or any other certificate or license required for the operation being conducted.
- PIC Designation Letter specific to the platform being operated.
    - UASD will only designate NOAA federal employees as PICs.
    - Non-NOAA federal employees (i.e. contractors) are required to meet the same criteria set forth for NOAA federal employee PICs and must be designated in writing by their Agency, contracting vendor, or specific UAS manufacturer.

3.2.3. Training

- Original Equipment Manufacturer (OEM) or UASD approved equivalent training specific to the UAS platform documented via training completion certificate.
- Training in all specific details of the UAS being operated including normal, abnormal, and emergency procedures.

3.2.4. Currency

- Maintain proficiency via three (3) takeoffs and landings within the previous ninety (90) days utilizing the specific UAS to which the PIC is qualified.
- Currency may be regained using an appropriate simulator, if available. Currency may also be regained under the direct supervision of a qualified, current PIC operating the specified UAS.
- If the above means are unavailable, currency may be regained with dedicated training flights on the specified UAS before conducting any operational flights.

3.3. Visual Observer (VO)

A Visual Observer (VO) is a person designated by the RPIC to assist the RPIC and the person manipulating the flight controls of the UAS to see-and-avoid any obstacle (other air traffic or objects aloft or on the ground) that will lessen safety during the mission.

3.3.1. Responsibilities

- A VO is responsible for assisting the RPIC in maintaining situational awareness and complying with `see-and-avoid' by scanning the area around the UAS for potentially conflicting traffic or other hazards to the safety of the flight.
- A VO shall remain alert for persons or activities on the ground and coordinate response by other UAS flight crewmembers.

- A VO shall maintain visual contact with the aircraft and maintain visual lookout for any airborne or ground-based threats in accordance with 14 CFR 107.31 or other FAA requirement.
- A VO will maintain verbal contact with the RPIC at all times and be able to advise the RPIC of any hazards that arise during flight. Intermittent forms of communications (texting, email, messaging systems) are not acceptable means of compliance. A cell-phone is acceptable if the connection was made prior to launch and is connected through the duration of the flight.
- A VO is responsible for the completion of pre- and post-flight checklists.

3.3.2. Qualifications

- Beyond Visual Line of Sight (BVLOS) certification from UASD where applicable.

3.3.3 Training

- PIC brief prior to operations to ensure competency.
- Complete UAS Safety Training course provided by NSSL/CIWRO.

3.3.4 Currency

- For BVLOS operations, VOs must complete an annual refresher course as designated by the UASD.

3.4. Ground Support Personnel

A Ground Support Personnel is any person with an assigned responsibility to ensure the safety of the UAS activity but not tasked as the RPIC or VO.

3.4.1. Responsibilities

- A Ground Support Personnel is responsible for assisting the RPIC in maintaining situational awareness, providing ground support and other activity to ensure the safety of the flight.
- A Ground Support Personnel may be tasked with supporting launch and recovery operations.
- A Ground Support Personnel may be tasked with preventing non-participants from entering the flight area.
- A Ground Support Personnel may be tasked with interacting with curious bystanders or spectators.

4. Uncrewed Aircraft Systems

All UAS must be operated and maintained in accordance with the recent revision of the UAS Manufacturer’s Manual.

The term `Manufacturer's Manual' as used in this Manual includes all manuals and publications provided by the relevant UAS manufacturer including, but not limited to:

- User Manuals
- Instruction Manuals
- Training Manuals
- Operations Manuals
- Pilot Operating Handbooks
- Component Maintenance Manuals
- Service or Safety Bulletins
- Service Information Letters

4.1. Registration

All NSSL UAS platforms that weigh between 0.55 - 55 lbs must be registered with the FAA under 14 CFR 48. https://faadronezone.faa.gov/ Federally owned aircraft shall be registered by NOAA UASD whereas non-federally owned aircraft shall be registered by the non-federal agency (e.g., CIWRO).

For UAS platforms that weigh more than 55 lbs, registration for these platforms must be valid internationally following 14 CFR 47 and submitted via mail using Original Aircraft Registration Form, AC Form 8050-1.

4.2. Record Keeping

Records of UAS flight missions shall be documented through NOAA's UAS AlarisPro (available here) and NSSL UAS flight log following flight operations. Database entries include but are not limited to the following:

- Date and duration of flight
- Names of MC, RPIC, and additional crew
- Platform
- Takeoff and landing times
- Battery number
- Pre- and post-flight battery voltage
- Number of landings and lost links
- Software/Firmware updates
- any malfunctions such as lost link, damage of parts, and serial numbered parts that require replacement

This information should also be recorded through NSSL UAS Google forms. All of these databases keep record of UAS operations in NOAA and NSSL and provide information for tracking metrics and different kinds of reporting.

4.3. Maintenance

- The RPIC will ensure the UAS has been inspected and maintained per the manufacturer's procedures, FAA guidelines, and/or UASD guidance.
- Software, firmware, and hardware changes must be documented as part of the normal maintenance procedures.
- For UAS discrepancies and/or payload changes related to maintenance, a record entry must be made in the aircraft logbook (AlarisPro and NSSL UAS Google forms) and submitted to the UASD.

5. Flight Safety Guidelines

It is the responsibility of every flight crew member to contribute to the goal of continued safe operations in part by maintaining situational awareness and adhering to FAA part 107 rules and regulations, and those specified in the COA and/or operations plan approved by NOAA UASD. Any safety hazard, whether procedural, operational, or maintenance related must be identified as soon as possible after, if not before, an incident occurs. If any member of the flight Crew observes or has knowledge of an unsafe or dangerous act committed by another member, the Mission Commander is to be notified immediately so corrective action may be taken. The RPIC is responsible for ensuring a safe operating environment, which includes but is not limited to monitoring weather conditions, managing intrusions, maintaining equipment, and crew safety.

5.1. Weather

Local weather must be checked prior to UAS activity to ensure wind speeds, precipitation, temperature or other environmental factors will not adversely affect the safety of the UAS activity. The operator shall utilize NOAA and/or FAA approved weather resources to obtain the latest and most current weather conditions.

- Prior to each flight, weather conditions shall be recorded in the pre-flight checklist and re-evaluated prior to take-off.
- No UAS activity shall occur when weather conditions exceed visual flight rules (VFR) weather minimums or the listed aircraft tolerance per the manufacturer's manual.
- Flight operations shall follow FAA restrictions on visibility and offsets (e.g., clouds) that fall under weather conditions.
- Flight operations shall be terminated if weather conditions become unsuitable for safe operations (e.g., precipitation, winds exceeding manufacturer's recommendation).

5.2. Site Characteristics

The RPIC and VOs will ensure that the location for take-off and emergency landing is adequate for a safe deployment. Take-off/landing sites shall provide sufficient clearance away powerlines, trees, and radio antenna/cellular towers and should be clearly marked and identifiable with short cones or similar marking system if necessary.

The RPIC, VOs, and ground support personnel shall monitor the skies for intruding air traffic and take any necessary corrective action to avoid collisions with crewed aircraft. This is especially important following high magnitude events where emergency vehicles often fly at low altitudes in airspace above impacted areas.

In remote and agricultural areas, RPIC and VOs should be aware that crewed aircraft, including fixed-wing aircraft and helicopters, may be operating very close to ground level. Pilots conducting agricultural, firefighting, law enforcement, emergency medical, wildlife survey operations and a variety of other services all legally and routinely work in low level airspace. UAS operators should maintain situational awareness, give way to, and remain a safe distance from these low-level, manned airplanes and helicopters.

The RPIC shall also be cognizant of the variation of elevation and activate the terrain following features where applicable.

5.3. Battery

The RPIC must ensure that the UAS maintains a sufficient power reserve as recommended by the manufacturer. If the required battery reserves cannot be maintained, the RPIC must terminate the flight and land the UAS at any time.

5.3.1. Battery Storage

Lithium-ion (Li-ion) batteries are common in sUAS. Li-ion batteries can be dangerous under some conditions and can pose a safety hazard because they, unlike other rechargeable batteries, contain a flammable electrolyte and are kept pressurized. It is extremely important that all Li-ion batteries be handled in accordance with the manufacturer's recommendations. Do not store the battery or aircraft in a hot garage, car or direct sunlight as the battery can be damaged or even catch fire.

5.3.2. Battery Maintenance

As part of battery maintenance, the RPIC shall ensure batteries are rotated through, preferably sequentially, during flight operations. In the case of storage, batteries should be discharged according to the manufacturer’s recommended voltage or percentage. In the case of new batteries, crew should perform a capacity test on all new battery packs to ensure they work properly before flying with them. Batteries connected to a charging device and actively charging should not be left attended.

5.4. Crew

Due to the nature of the mission, the minimum personnel required on ALL missions will be an RPIC and Visual Observer. Under no circumstances will an operator attempt to complete a deployment alone, including training. The primary goal of the flight crew is to maintain a safe

environment for crewed aircraft, flight crew, and public safety. Visual acuity of the aircraft by both the RPIC and VO is essential for a safe and productive flight.

UAS flight crew personnel shall wear safety vests. Certain missions may require the use of work/hiking boots, hard hats, and eye protection. Other safety equipment for the flight crews that should be included: two-way radios, first aid kit, and fire extinguisher.

In accordance to NOAA UASD and FAA guidelines, a crew duty day will consist of no more than 16 hours. During the 16 hour duty, no person may act as crew member for 8 hours of flight time.

5.5. Privacy

Data will only be collected for use that is consistent and relevant to NSSL's mission. Flight crews will make every attempt to limit the collection of personally identifiable information (PII). Unintentional collection of PII will be deleted, masked or obscured following the methods described in NSSL UAS Privacy Policy.

5.6. Permissions

5.6.1. Controlled Airspace

Airspace must be verified to check for controlled airspace and/or emergency restrictions following a disaster. In the case of controlled airspace, the RPIC must submit an airspace authorization request via Low Altitude Authorization and Notification Capability (LAANC) or apply for a certificate of waiver or authorization (COA) with non-LAANC participating airports.

5.6.2. Temporarily Flight Restriction

Temporarily Flight Restriction (TFR) is a type of Notice to Airmen (NOTAM) that defines the area restricted due to a hazardous condition, special event, or general warning for the entire FAA airspace. Following a large scale disaster, TFRs are often issued for active emergency response operations and/or surveillance by government officials. In the issuance of a TFR, the MC and RPIC shall work with NOAA UAS to obtain a Special Government Interest (SGI) waiver to operate in TFR airspace.

5.6.3. Operations on Private Property

If the takeoff and landing point falls on private property, the RPIC, VOs, or ground support personnel must obtain permission from the property owners. The flight crew shall make all attempts to obtain written permission (name, address and signature).

5.6.4. NOAA UAS Procedures and Permissions

There are several NOAA UAS procedures/protocols that must be followed to receive approval for UAS operations prior to deployment. Below is a flow chart the details the processes and timelines involved in obtaining approval for UAS operations. The MC and RPIC should already understand

these procedures and have submitted the necessary paperwork from NOAA UAS. For more detailed information, the operator/reader is referred to NOAA UAS Handbook Policy here.

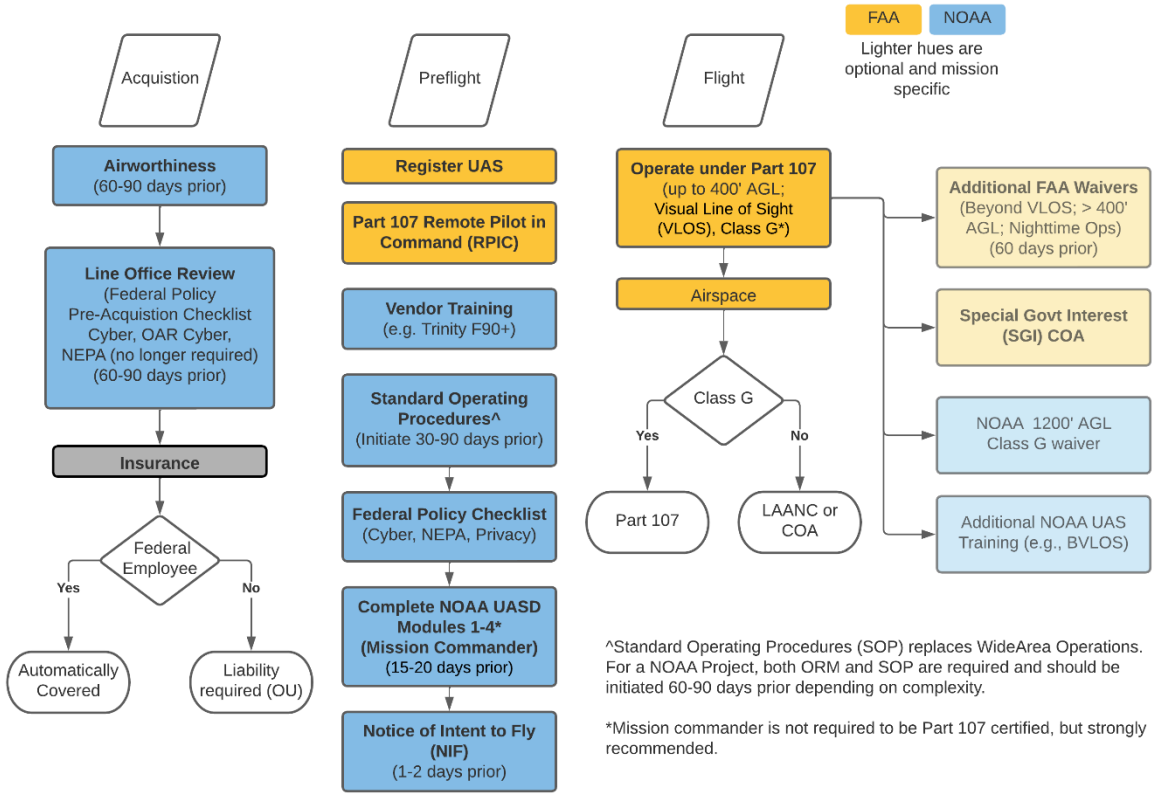

Figure 1. Flow chart of NOAA UAS procedures required to obtain flight approval by NOAA UAS and in compliance with FAA regulations.

6. Pre-Flight Operations:

The RPIC/VOs shall familiarize themselves with all available information concerning the flight. At least one emergency landing area should be identified per deployment. RPIC & VOs will ensure that they are aware of their surroundings in the event that an emergency landing is necessary. This includes the ability to recover the UAS. The flight area shall be depicted on a flight planning software.

Before any UAS activity is conducted under the provisions of this SOP, the RPIC will obtain permission to conduct these operations from all necessary parties. Approval may also be necessary from local and state government officials especially following a disaster.

RPICs and VOs are both responsible for a thorough preflight inspection of the UAS.

RPICs and VOs shall check airspace onsite for any potential changes in airspace restrictions or to submit an airspace authorization via the LAANC network. The RPIC must submit and receive an airspace authorization prior to takeoff. If a TFR has been issued in the designated area, UAS operations must be aborted until the proper authorization has been obtained.

RPICs and VOs must complete pre-flight checklists to ensure the highest level of safety for flight. (see Appendix).

7. Flight Operations

All Flight Personnel must remain at their station as listed in the Flight Operation Plan during takeoff, landing, recovery, and other critical phases of flight, except when performing those duties required for the safe operation of the aircraft.

The RPIC must ensure that the unmanned aircraft maintains a sufficient power reserve as recommended by the manufacturer.

All flight operations must be done in accordance with the prepared flight plan and as described during the pre-flight briefing. Intentional deviations are prohibited.

Below is a list of general guidelines that should be followed by the RPIC during flight operations.

- Ensure the operating environment is safe and that the RPIC is competent and proficient in the operation of the SUAS.
- Fly no higher than 400 feet AGL unless operating under an approved COA and remain below any surrounding obstacles when possible.
- For VLOS operations, keep your sUAS in eyesight at all times and use an observer to assist if needed.
- Remain well clear of and do not interfere with crewed aircraft operations, and you must see and avoid other aircraft and obstacles at all times.
- Contact the airport or control tower before flying within five miles of an airport.
- Fly no closer than two nautical miles from a heliport with a published instrument flight procedure.
- Do not fly near or over sensitive infrastructure or property such as power stations, water treatment facilities, correctional facilities, heavily traveled roadways, government facilities, etc.

8. Post-flight Operations

UAS shutdown and post flight actions will be taken in accordance with the Manufacturer’s Manual.

The RPIC or a properly trained Visual Observer or Ground Support Personnel must conduct a post flight aircraft inspection as recommended in the Manufacturer’s Manual.

RPICs and VOs must complete post-flight checklists (see Appendix).

RPICs and VOs are both responsible for a thorough post-flight inspection of the UAS.

9. Emergency Operations and Response

Procedures suggested here are best practices for coping with particular conditions but are not a substitute for sound judgment and common sense. All personnel (RPIC, VOs, and ground support personnel) should familiarize themselves with general procedures here and in Manufacturer's Manual as well as be prepared to take the appropriate action should an emergency arise. The RPIC is responsible for ensuring flight safety and is responsible for making any assessment in regard to flight safety. If the RPIC is incapacitated for any reason, the responsibility goes to the VO, unless an alternate has been selected.

All operations require the RPIC to designate a lost link/emergency termination zone prior to UAS activity. The RPIC retains the right to change or modify that selection if potentially unsafe conditions exist. These zones may be the same location or different locations, depending on the needs of the mission.

The RPIC shall take all necessary actions to ensure that the launch and recovery of the UAS does not present a hazard to persons and property on the ground. The RPIC, VO and any ground support personnel will take all reasonable actions to ensure all non-essential personnel and nonparticipating persons remain at least 10 feet laterally away from landing zones, including emergency landing zones, while the UAS is taking off or landing.

In an emergency situation involving the safety of persons or property, the RPIC or any other crew member may take action that is considered necessary under the circumstances to ensure safety. The RPIC may deviate from prescribed operations procedures and methods, weather minimums, regulations, this manual, etc., to the extent necessary, in the interest of safety.

If, for any reason, the UAS needs to conduct an emergency landing, the flight crew will take actions to immediately warn people on the ground below where the UAS is operating and alert the RPIC of any potential hazards so the RPIC can take appropriate action to ensure safe flight operations. They must also immediately warn people on the ground below where the UAS is operating of any potential hazards associated with the UAS.

A member of the flight crew, typically the VO, shall keep the appropriate ATC facilities fully informed when an in-flight UAS emergency could potentially impact operations of aircraft in navigable airspace.

9.1. Emergency Response

9.1.1. Loss of Link

The RPIC should maintain an unobstructed line of sight between the controller and UAS to ensure a strong signal. Occasionally, signal will drop out as a result of obscurations in the environment in which the controller will attempt to regain signal with the UAS. In the event of

signal loss, every effort should be made to reestablish link communications between the controller and UAS.

Trinity F90+

- The link loss should be established before UAS operations. If the RC link as well as the flight data link is lost during the flight, the Trinity F90+ returns to the link reestablishing waypoint after the selected time expired (~30 seconds). If link cannot be reestablished during the selected time, the Trinity will return to home displaying and broadcasting link loss message on control and laptop, respectively.

Skydio 2

- Wait Before Return - sets the amount of time that you want Skydio to wait before it initiates a return flight, allowing time to reconnect.
- Land Once Returned - when enabled, Skydio will return, hover for a specified amount of time, and then land.
- Wait Before Land - set the amount of time between 0 to 300 seconds (the default is 240 seconds) that you want Skydio to wait before landing. This setting is only enabled when Land Once Return is toggled on.

Marlyn

- Link loss should be turned on before UAS operations. If link is lost during flight, the Marlyn will returns to the link reestablishing waypoint (flight leg) after the selected time expired. Using the *'Time before returning*' slider, a value between 30s and 180s can be set. Upon reaching the set value, Marlyn will automatically switch to 'Return to Home' mode and fly back to the take-off location.
- If you uncheck the 'Return on lost link' box the aircraft will continue its flight even if the Telemetry radio link is lost.
- The RC loss of link behaviour is not selectable and is implemented as follows:
    - When Marlyn executes its mission, a loss of the RC link is ignored.
    - When Marlyn is in a Manual flight mode, a loss of the RC link for more than 5 seconds triggers the Return to home procedure.

Evo II

- Failsafe will be activated if communication is lost between your aircraft and remote control for 3 seconds. Failsafe is an automatic function designed to help the Evo II return home or land in its current position (when necessary),
- If GPS is available when the **Failsafe** function is activated, the aircraft will automatically use the Go Home function. Otherwise, it will land from its current position. When communication is restored, you can still press the **Pause** button to regain control of the aircraft.

9.1.2. Fly Away

- Contact the nearest Air Traffic Control (ATC)

- Note the UAS remaining available flight time, direction of travel, last known location (on screen and in the flight mission)
- Keep eyes on the UAS and track it for as long as possible

9.1.3. Low Battery

Although some platforms (i.e., Trinity F90+) will automatically return to home due to low battery, it is recommended that flight operations (missions) conclude before reaching low battery voltage. This practice allows for sufficient time for the UAS to return to home and safely land. Ideally, the RPIC should initiate return to home operations when battery voltage reaches 30% of its voltage. If battery voltage falls to levels insufficient to return, the RPIC should land the UAS at the designated lost link/emergency termination zone. If this option is not feasible (due to critically low battery voltage), the RPIC should land the UAS immediately in an open area avoiding any potential obstacles.

Trinity F90+

- Low Battery (yellow) provides a 10 minute warning before the UAS returns home due to battery capacity.
- Critical Battery (red) will automatically trigger the UAS to return to home and land.

Skydio 2

- Skydio will assess your altitude and distance from the Home Point, then warn you when it is time to return home. It is recommended that you initiate a return or land at this time, however you can choose to keep flying.
- Skydio will then notify you when it has 2 minutes of flight time left based on its current altitude and the battery indicator will begin a two-minute countdown. You may choose to continue flying, however it is strongly recommended that you fly to a safe location and land.
- When the two-minute countdown is complete, Skydio will initiate an automatic landing that you will be unable to cancel. You will maintain the ability to nudge the drone in roll, pitch, and yaw to avoid any obstacles.

Marlyn

- When the battery percentage in one of the two batteries drops below this value, the aircraft will abort its mapping flight and it will return to its home location immediately. It is highly recommended to select a value of 20% or higher to have margin for unforeseen circumstances for flying a nearby mapping region at 120m and less than 10m/s wind. A safe battery margin may be different for each project and environmental condition.
- Setting the Return on low battery to a low value can risk running out of energy before landing the drone, which will result in damage to the drone. Take good caution and commons sense in choosing an appropriate value.

Evo II

- When the aircraft's battery level reaches the 25% threshold, you'll receive a Low Battery Warning and Failsafe will be activated, after which the aircraft will automatically return home.
- If you retake control of the aircraft, you'll receive a Critically Low Battery Warning when the battery reaches 15%, and the aircraft will automatically land in its current position. If landing in the current position may result in an emergency, you can press the Pause Button to halt the landing and fly it to the nearest possible safe landing site.

9.1.4. Evasive Maneuvers

RPIC should manually fly the UAS to avoid any potential obstacles using any or a combination of the following evasive maneuvers:

1) Decrease or increase altitude (Eagle function on Trinity F90+)

2) Loiter at a current altitude and location (Hold function on Trinity F90+; Divert Right function of the Marlyn)

3) Land at an established alternative landing site

4) Land at current location

- Use Land Now function (Trinity F90+) which will descend and land at current location
- Forced Landing (function Marlyn)
  - In Airplane Mode, it will immediately transition to Helicopter Mode and begin descent at 2.5 m/s, slowing to 0.6 m/s below 5m above the altitude of the home point. When Marlyn touches down and a jolt is detected, the Motors will continue to idle for 2 seconds before shutting off.
  - In Helicopter Mode it will abort any automated takeoff or flight and immediately begin descent.

5) Emergency Motor Shutdown

- Use Hard Abort (function Trinity F90+) which will switch off motors and entire spiral dive crashing the UAS. This option should be used as a last resort to avoid an in-air collision and/or collide with an obstacle
- For Marlyn Shut down motors by pushing and holding down buttons marked E & F. If the buttons are released within 5 seconds of triggering, the motors will spin up again. The drone will likely recover to a normal state, but this is not guaranteed. Press both buttons for more than 5 seconds to confirm the emergency motor shutdown.

10. Incident/Accident Response and Reporting

The RPIC shall immediately notify the MC if the MC is not present. The MC will immediately establish communications with operations officer at NOAA UAS within 24 hours via email or phone:

NOAA UAS Division Group Email: uas@noaa.gov
NOAA UAS Deputy Phone: 863.296.8102

And complete the Mishap reporting form (here). According to NOAA's UAS policy handbook section 6.15.3, *all NOAA UAS operations will be suspended until positive clearance is given by the Chief, OMAO UAS Section of their designee*. The MC or RPIC will also notify and brief NSSL's lab director and upper management on the incident and current status of NSSL UAS operations. If the incident involves CIWRO staff, CIWRO's director and relevant management will also be notified and briefed.

The incident should also be reported using NASA's Aviation Safety Reporting System (ASRS) within 10 days of the incident (available here). After completing the detailed document, you will receive a code that can be given to the FAA. This form can also be used to report a close call.

10.1. Documentation

As soon as it is safe, the flight crew should write down a narrative about the incident detailing as much as possible. Take note of anything out of the ordinary and include any information that might be relevant to understanding how the incident occurred. If the platform is recoverable, document the scene by first taking photos and videos prior to retrieving the platform. All documentation collected will be used to improve future practices.

11. Checklists

The Marlyn has programmed pre-flight checklists that will not allow the user to advance to the next step. Post-flight checklists have been developed for the Atmos Marlyn and will be included in the next SOP update. For all other platforms, preflight and postflight checklists for Trinity and Skydio are accessible via Google Forms and detailed below. Checklists for Evo will be developed and included in next SOP update after training has been completed.

11.1. Trinity Pre-Flight

Content contained in the preflight checklist is listed below and may not always be updated. Current and up-to-date content can be accessed here.

1. Evaluate weather forecasts, airspace, and possible hazards in potential survey sites.
2. Carefully inspect the props, landing gear, shell and structure of the UAS.
3. Select fully charged battery, record, and install.
4. Calibrate magnetometer if flight is more than 50km away from the location where magnetometer was last calibrated.
5. Insert microSD card into the iBase if not already in the iBase.
6. Place survey mat on level ground and away from any obstructions or shaded areas. Press button once to power on. Green light should be on logging.
7. Set up iBase station. Center the iBase station directly in the center of the survey mat. Connect the power bank to the iBase via the USB cable and power on. Blue LED should be blinking.
8. Set up QBase modem. Connect modem to laptop and place modem as high above the ground as possible. Ensure modem has a direct line of sight with the Trinity.
9. Choose a take-off position free from obstacles and with sufficient clearance to transition from vertical to horizontal flight.
10. Check to see that SD cards are in both cameras.
11. Assemble the Trinity. Place the Trinity on the case and ensure the nose is facing int the direction of the wind.
12. Plan the mission in Qbase. Set take-off point (check transition height). Draw the survey area - flying height should be set to 120 m, ensure 75% front and side overlap. Set retransition area - return to home point should be close to launch point. Retransition height should be higher than nearby obstacles. Retransition path should be free from obstacles and over flat terrain. Transition/Retransitions should be green (if yellow increase flying heights).
13. Ensure the direction of the aircraft in QBase corresponds to the direction of the Trinity.
14. Turn on remote control (transmitter).
15. Upload (write) mission to Trinity.
16. Record battery voltage and time of take off.
17. RPIC obtains verbal status from crew.
18. RPIC announces "Arming Aircraft"
19. Select preflight check.
20. Arm the UAS. Select Arm and confirm the arming process by pressing Yes.

21. Takeoff. Select Takeoff on remote controller. Select yes when prompted.

11.2. Trinity Post-Flight Checklist

Content contained in the postflight checklist is listed below and may not always be updated. Current and up-to-date content can be accessed here.

1. Landing. RPIC announces "Landing". Flight crew maintains a safe distance of 25 feet away from landing point.
2. Turn of motors by holding throttle down until motors cut-off.
3. Record battery voltage and time.
4. Calibrate reflectance panel. Trigger via laptop or remote control.
5. Save flight mission.
6. Disassemble Trinity and place in box.
7. Disassemble iBase station. Turn off powerbank first and pack up iBase station
8. Turn off survey mat by pressing button (green light should flash on network).
9. Disconnect and pack-up modem.
10. Sweep the area - making certain all items are accounted for before leaving the site.

11.3. Skydio 2 Pre-Flight Checklist

Content contained in the preflight checklist is listed below and may not always be updated. Current and up-to-date content can be accessed here.

1. Evaluate weather forecasts, airspace and possible hazards in the flight site.
2. Visual inspection of the UAS. Check motors and shell are fastened. Check props for cracks and tightness.
3. Identify areas of interest for scouting and confirm flight pattern with the UAS and crew.
4. Flight crew agrees on a takeoff and landing zone as well as emergency landing areas.
5. Select a fully charged battery, take note of its ID and install it on the UAS.
6. Set up controller - connect to iPad and assure the iPad is securely seated.
7. Place the UAS on the designated launch pad, and power it up (press once and then press and hold). Don't move the UAS while it is booting up (calibrating).
8. Open the Skydio app to connect to the UAS. Once connection has been established, clear a safe perimeter.
9. RPIC announces “Takeoff”.
10. Hold the take-off button down until UAS launches.
11. Record battery voltage and time of takeoff.

11.4. Skydio 2 Post-Flight Checklist

Content contained in the preflight checklist is listed below and may not always be updated. Current and up-to-date content can be accessed here.

1. Landing. RPIC announces "Landing". Flight crew maintains a safe distance of 25 feet away from landing point.

2. Power down the UAS and remove the battery.
3. Record battery voltage and time.
4. Remove iPad from remote control (transmitter). Power off remote control.
5. Inspect UAS for visible damage before departure.
6. Put Skydio back in case and pack up all Skydio accessories.
7. Sweep the area - making certain all items are accounted for before leaving the site.