Standard Operating Procedures

Session #2

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In this lecture you will learn:

- Operational procedures
  - General mission planning

Standard operating procedures (SOPs) are used for assessments related to safety of flight and mission completion

- **Project feasibility and safety assessments** are conducted using procedures and checklists that are established to ensure risk to the mission will be minimized
- **Pre-flight checklists** are used to force a critical look at several items in the flight operation with regard to function and safety
- **Non-normal scenarios and emergency procedures** are documented and classified to facilitate a rapid response if they occur
- **Post flight and pack-up** procedures allow the flight lessons to be recorded and support the next flight operation

Project feasibility and safety assessments

- In all flight planning, multiple aspects of the flight operation must be considered to manage risk and maximize the success of the flight outcome
  - A flight planning process is used that guides a pilot through feasibility and safety assessment
  - A flight planning form is used to enter initial data for the flight operation

Appendix 2: Initial Risk Assessment

(Done for all new operations in Flight Request Form)

Initial Operations Risk Assessment Documentation	
Risk Assessment For: Organization & Location	Today's Date:
Reason for Risk Assessment (select all that apply):	
☐ New System Design	☐ Modification to an Existing Operation or Procedure
☐ Change to Existing System Design	☐ Operational Environmental Change
☐ New Operational Procedure	☐ Ineffective Risk Control
☐ Other:	
Process/System Analysis	
Brief description of process of system to be assessed:	
Risk Analysis / Hazard Identification	

	Hazard	**Potential Consequences**
H1		
H2		
H3		

Risk management is conducted throughout a flight activity and it incorporates a **safety culture** starting with the preflight activity to post-flight debrief

- Using multiple checks throughout the flight operations process, we are able to manage risk effectively
- This means identifying risks and applying mitigations to reduce likelihood and severity

Project feasibility and safety assessments

- A risk metric is computed in the flight planning process for all potential hazards
- An overall risk metric for the mission is determined (weighted scores on a 5-point scale)
- Mitigations are applied to control the risk to an acceptable level

Appendix 5: Flight Risk Assessment Tool

(Implemented in Flight Request and Flight Planning Forms)

		1	2	3	4	5	Rating
Operational Factors	Type of Operation	Normal	Demo	Training/ Recurrency	Initial Flight	Test Flight	
	Duration of Operation	< 1 hour	1-2 hours	2-4 hours	4-6 hours	>6 hours	
	Simultaneous Operations	1 UA		2 UAs		>2 UAs	
Crew Factors (any member)	Hours of Rest in Last 24 Hours	>8	7-8	5-6	3-5	<3 (No Fly)	
	# of Flights in Type	>20	10-20	5-10	1-5	0	
	# of Flights in Last 90 Days	>20	15-20	10-14	5-9	<5	
	Total UAS Hours	>20	10-20	5-10	1-5	0	
Environmental Factors	Current Wind or Max Gust	<8 kts	9-12 kts	13-15 kts	16-18 kts	>18 kts (No Fly)	

Project feasibility and safety assessments

- Although a 5-pt scale is the easiest to use when computing risk, a risk matrix provides a more accurate assessment of how risk can impact a mission
- The **risk matrix** considers two components: **frequency** and **severity**

	Risk Severity				
Risk Likelihood	**Catastrophic A**	**Critical B**	**Moderate C**	**Minor D**	**Negligible E**
5 – Frequent	5A	5B	5C	5D	5E
4 – Likely	4A	4B	4C	4D	4E
3 – Occasional	3A	3B	3C	3D	3E
2 – Seldom	2A	2B	2C	2D	2E
1 – Improbable	1A	1B	1C	1D	1E

Project feasibility and safety assessments

- Severity is defined as the worst thing that can result due to an individual hazard (SMS Sec 3.2)
- Likelihood is defined as the degree to which the hazard is probable to occur (SMS Sec 3.2)

Risk Likelihood	Catastrophic A	Critical B	Risk Sever Modera C
5 – Frequent	5A	5B	5C
4 – Likely	4A	4B	4C
3 – Occasional	3A	3B	3C
2 – Seldom	2A	2B	2C
1 – Improbable	1A	1B	1C

Table 1. Safety risk severity table

Severity	Meaning	Value
Catastrophic	Equipment destroyed, death	A
Hazardous	Large reduction in safety margins, physical distress, serious injury, major equipment damage	B
Major	Significant reduction in safety margins, reduction in ability to cope with adverse conditions, serious incident, injury to persons	C
Minor	Nuisance, operating limitations, use of emergency procedures, minor incident	D
Negligible	Few consequences	E

Table 2. Safety risk probability table

Likelihood	Meaning	Value
Frequent	Likely to occur many times (has occurred frequently)	5
Occasional	Likely to occur sometimes (has occurred infrequently)	4
Remote	Unlikely to occur, but possible (has occurred rarely)	3
Improbable	Very unlikely to occur (not known to have occurred)	2
Extremely improbable	Almost inconceivable that the event will occur	1

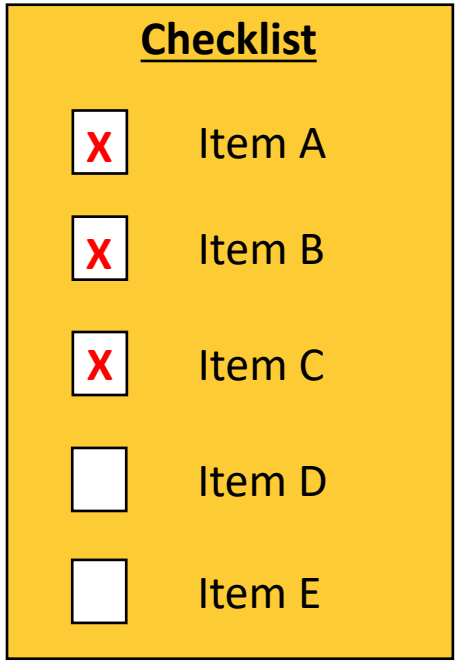
Project feasibility and safety assessments

- The outcome of the assessment of risk can be summarized below:

Assessment Risk Index	Criteria	Accountability
5A, 5B, 5C, 4A, 4B, 3A	Unacceptable under existing circumstances, requires immediate action.	Program Lead, Project Manager, Aviation Safety Officer, & Head of Training
5D, 5E, 4C, 3B, 3C, 2A, 2B	Manageable under risk control & mitigation. Requires authorized decision.	Project Manager, Aviation Safety Officer, & Head of Training
4D, 4E, 3D, 2C, 1A, 1B	Acceptable after review of the operation. Requires continued tracking and recorded action plans.	Project Manager or Aviation Safety Officer
3E, 2D, 2E, 1C, 1D, 1E	Acceptable with continued data collection and trending for continuous monitoring.	RPIC

Pre-flight checklists

- Checklists are used to make sure all critical elements of a system are inspected and verified for safe and reliable operation
  - *Items on a checklist are added when a critical component or system has been shown to contribute to failure if it is not configured properly*
  - In manned aircraft, many checklist items appear because an incorrect setting resulted in a *crash*
- There is a method for using a checklist:
  - **Read** the item on the list
  - **"Do"** the action, accompanied by pointing to or touching whatever is being checked
  - **Verify** that the action has been completed



Pre-flight checklists

- FOM 3.5.1: Aircraft-specific document review -
- For reference, all aircraft-specific documents should be available for inspection
  - RPA operational certificate (ROC) or letter of approval (RLA), where applicable
  - Aircraft operations manual, where applicable, including operational limitations
  - Standard operating procedures manual (SOPM)
  - Maintenance manual, where applicable
  - Aircraft and battery logbooks
  - Certificate of registration, where applicable
  - Certificate of airworthiness, where applicable
  - Waivers of operation, if any

Pre-flight checklists: document review for aircraft

- The aircraft logbook will contain a record of the history of maintenance and significant events regarding the operation of the aircraft
  - It is the best source of information to learn about the current operational state of the aircraft
- The **user manual** and **standard operating procedure manual (SOPM)** are aircraft-specific documents: they contain information about operations limitations and specific guidelines on operating the aircraft.

Pre-flight checklists: document review for aircraft

- Battery logs are important since batteries have a limited life and it is dependent both on their ***age*** and ***number of charging cycles***.
- Check the battery logs frequently to make sure the batteries are capable of a successful flight before takeoff
  - Battery maintenance records should not show any irregularities that would indicate a failing battery
  - Signs of problems include a swelling of the battery pack and/or an inability to hold charge

Pre-flight checklists - document review for pilot

- FOM 3.5.2: Document review - pilot
- The pilot needs to verify that their paperwork is up-to-date to be legal to operate:
  - Remotely piloted aircraft pilot's license (RPL) where applicable
  - Student pilot license, where applicable
  - Logbook review for flight currency, if applicable
  - Medical certificate, if applicable
  - Waivers to operate, if any

Pre-flight checklists - flight planning

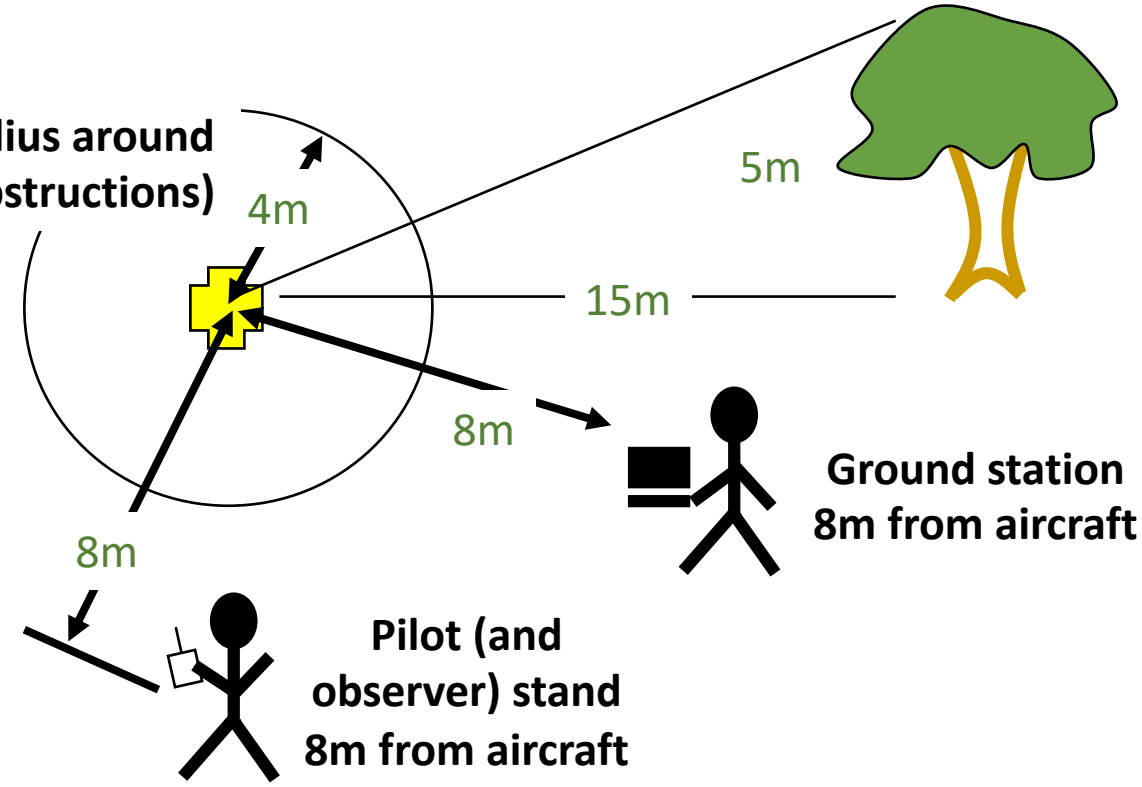
The flight planning checklist includes a site survey:

- **VTOL:**
  - Area is mostly level (low slope, minimal bumps)
  - Open area with at least *4m* radius around the UAV
  - Minimal loose debris to be kicked up during take-off or landing (place heavy blanket or plywood on ground if this is an issue)
  - No vertical obstacles *above 5m* of flying altitude within *15m* radius of take-off location
  - Pilot and observer location is at least *8m* feet from take-off point and have room to move from that location away from the UAV
  - Pilot and observer have clear line of sight to UAV at take-off and can safely move to a position to maintain line of sight through entire flight. Beyond visual line of sight (BVLOS) flights are not allowed unless the operator has written permission from the agency controlling agency the airspace.
  - Ground station is at least *8m* from take-off point

Pre-flight checklists - flight planning

The flight planning checklist includes a site survey:

- **VTOL site dimensions:**



No obstacle more than 5m in height closer than 15m to takeoff location

Alternative landing site identified

Pre-flight checklists - flight planning

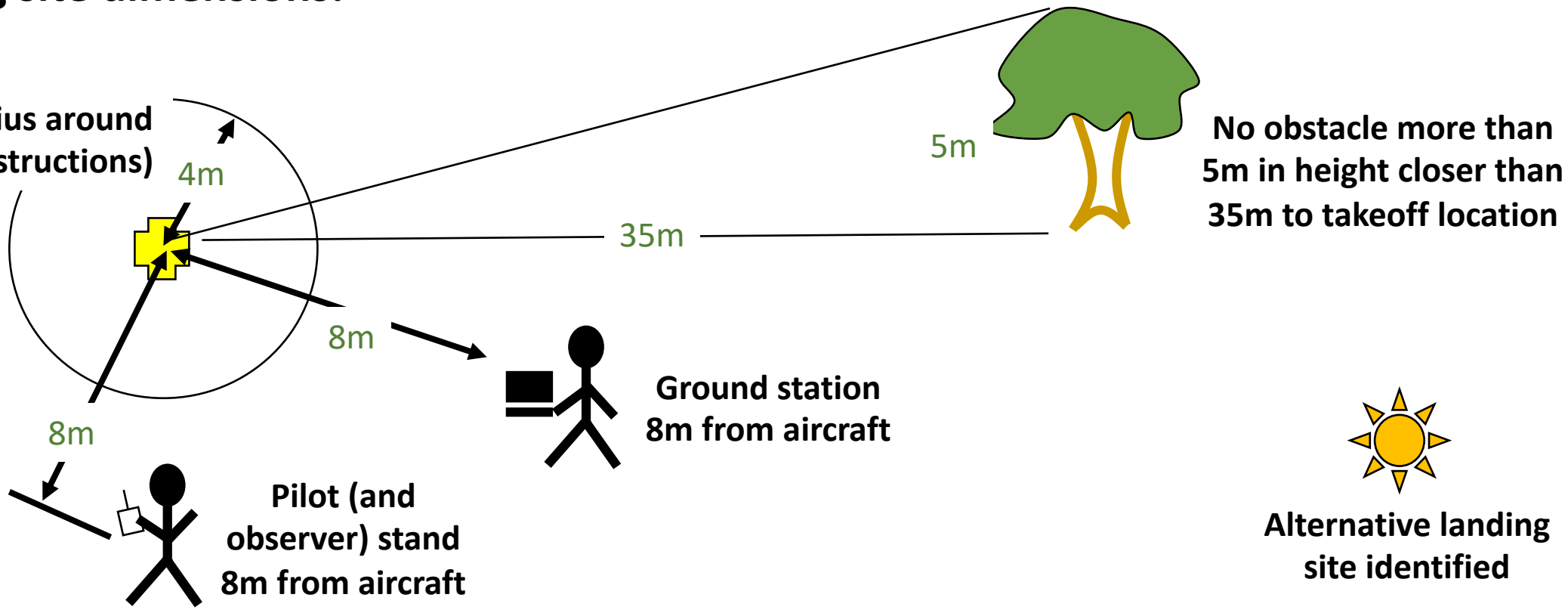
The flight planning checklist includes a site survey:

- **Fixed wing:**
  - Area is mostly level (low slope, minimal bumps)
  - Runway is long enough and wide enough for UAV takeoff and landing operations
  - No vertical obstacles greater than *5m* high within a *35m* perimeter of runway
  - Operator location is at least *8m* from take-off point (start)
  - Operator has clear line-of-sight of UAV at take-off and can safely move to a position to maintain line of sight through entire flight. Beyond visual line of sight (BVLOS) flights are not allowed unless the operator has written permission from the agency controlling agency the airspace.
  - Ground station is at least *8m* from take-off point

Pre-flight checklists - flight planning

The flight planning checklist includes a site survey:

- **Fixed wing site dimensions:**



Pre-flight checklists - flight planning

- As part of the feasibility assessment for the flight, the operator should review the operational airspace and determine that the flight is authorized
  - Airspace rules require that the drone stay outside certain areas in order to be compliant with operations that serve all aircraft, both manned and unmanned
  - Altitude restrictions and operations in the proximity of aerodromes are controlled by the civil aviation authority

Pre-flight checks - Air law: Check compliance with the applicable operational environment

Malawi DCA Draft Regulations

- Operator limitations:

30. 1) Notwithstanding the provisions of sub regulation (1), operations for private and commercial categories of RPA may be conducted at such heights and lateral distances as the Authority may approve.

2) A person shall not operate an RPA unless approved by the Authority

a) In conditions other than Visual Meteorological Conditions (VMC)

b) At night; and

c) Beyond Visual Line of Sight (B-VLoS).

Pre-flight checks - Air law: Check compliance with the applicable operational environment

Malawi DCA Draft Regulations

- Operations in controlled airspace:

32. 1) No RPA may be operated in controlled airspace, except by the holder of an ROC and as approved by the Authority

2) The Authority may approve an RPA operation in controlled airspace as contemplated in Aviation (Rules of the Air and Air Traffic Control) Regulations currently in force, only in

a) VMC in an ATZ and CTR below 400feet; and

b) Subject to compliance with the conditions prescribed in the Malawi Aviation Regulations currently in force.

Pre-flight checks - Air law: Check compliance with the applicable operational environment

Malawi DCA Draft Regulations

- Operations in controlled airspace:

32. Continued

3. RPA operating in controlled airspace shall have the same ability to automatically detect-and-avoid traffic/ obstacles, as other aircraft while moving through the air.
4. ATC communication:
   a) RPA pilots shall ensure that ATC is made aware of any operations that shall take place in areas which are likely to affect manned and controlled air traffic;
   b) The ATC shall establish procedures, acceptable to the Authority, for integration of RPA operation into the airspace to ensure aviation safety. Such procedures shall include communication and surveillance detection; and
   c) Procedures referred to in sub-regulation (b) shall prescribe required information to be passed to ATC by RPA pilot before and during RPA operations.

Pre-flight checks - Air law: Check compliance with the applicable operational environment

Malawi DCA Draft Regulations

- Operations in the vicinity of an aerodrome:

33. A person shall not operate an RPA:

a) within 10 kilometers of an aerodrome from the aerodrome reference point for code C, D ,E and F aerodromes;

b) within 7 kilometers of an aerodrome from the aerodrome reference point for code A and B aerodromes;

c) on approach and take-off paths;

d) within the vicinity of navigation aids;

e) within the aerodrome traffic zone;

f) within terminal traffic holding patterns;

Before takeoff, the remote pilot in command (RPIC) conducts a briefing with the flight crew

- For students receiving instruction, it is during this briefing that the remote pilot instructor (RPI) will explain the maneuvers that will be practiced
  - A lesson plan will be presented which has specific objectives that must be completed for a successful lesson
- If a visual observer (VO) is assigned, then during this briefing the communications protocols will be agreed upon to handle routine and emergency situations

Before takeoff, the remote pilot in command (RPIC) conducts a briefing with the flight crew

- The Airmanship Principles are reviewed with the flight crew:
  - Know your aircraft, the capabilities and limitations in normal and non-normal scenarios.
  - Know yourself, your limitations and personal habits that effect safety.
  - Know your environment, the airspace, the weather, the operation.
  - Know your team, conduct briefings, use your observers, communicate, be positive and resolve conflicts quickly and fairly.
  - Know the Risks, always conduct a thorough risk assessment.
  - Stay Proficient, practice and conduct ‘dry runs’ of complex operations, and scenario based training for emergencies.
  - Have the discipline to keep up to date on the latest safety and operational knowledge, including technical information regarding your platform.

Non-normal scenarios and **emergency procedures** are just as important to the mission as are the routine operations

- Whenever there is a deviation in flight operations that is not anticipated, the pilot should have a pre-memorized procedure to follow since there will not be any time to refer to the aircraft SOPM or the user manual
- In general, the pilot should “fly the aircraft” first, and resolve the anomaly second
- A landing is to be executed as soon as practical, even if the anomaly is corrected in flight.
  - A repeat of the anomaly could happen, and the outcome may not be as good the second time as it was the first time

Non-normal scenarios and **emergency procedures** are just as important to the mission as are the routine operations

- For the S-500, the SOPM has the following recommended action for emergencies:
  - Low Endurance
    - Immediate Landing in Controlled Area
  - Loss of GCS or Radio Communications
    - Immediate RTL at Communication Regain
  - Loss of Flight Control
    - Immediate Change to Stabilize and Landing (if possible).
  - Loss of Visual Line of Sight
    - Regain LOS and Navigate Back to Home

Non-normal scenarios and **emergency procedures** are just as important to the mission as are the routine operations

- An Emergency Response Plan (ERP) is also available in the Safety Management System (SMS) Manual
- Emergency Procedures Quick Reference Checklist:
  - If necessary, call emergency services.
  - Render first aid as necessary.
  - Contact the Project Manager via the call out list.
  - Preserve accident/incident site to ensure aircraft wreckage is not tampered with.
  - Secure the Ground Control Station.
  - Once the flight crew and scene are secure/safe take pictures and begin documentation of the incident.

Non-normal scenarios and **emergency procedures** are just as important to the mission as are the routine operations

- An Emergency Response Coordinator (ERC) is always designated (by the Aviation Safety Officer) at the site to take the lead on responding to an emergency, accident or incident
  - This person has the responsibility to prepare for emergencies by providing the following at the flying site:
    - First aid kit that includes enough supplies to handle expected injuries from drone flight
    - A phone number of the nearest emergency response unit for transportation to a hospital
    - 2l of drinking water
    - Clean patient space to administer first aid
    - A bucket of sand for putting out fires

Non-normal scenarios and **emergency procedures** are just as important to the mission as are the routine operations

- An Emergency Contact Tree is used to sequentially contact personnel to activate an emergency response:
  - First, contact the Emergency Response Coordinator (ERC) in the event of an incident or accident. This person is responsible for planning ahead for emergency situations
  - Next, the Head of Training is contacted
  - Next, contact the Project Manager if the Head of Training cannot be reached. The Project Manager also serves as the Aviation Safety Officer Both the Head of Training and the Project Manager should be on-site
  - Next, contact the Chief Pilot who may or may not be on-site
  - Next, contact the Programmatic Lead who may or may not be on-site

Non-normal scenarios and **emergency procedures** are just as important to the mission as are the routine operations

- **Mandatory Incident/Accident Reporting System:** All UAS operators are required to submit a complete and detailed incident/accident report if any of the following occur during operations:
- ***Incidents***
  - Near miss with an object or person.
  - Crash with any amount of damage beyond normal wear and tear.
  - Reputation conflict.
- ***Accidents***
  - Property damage of any type/cost
  - Injury of any type.
- All reports received will be reviewed and addressed by members of the Safety Committee.

Non-normal scenarios and **emergency procedures** are just as important to the mission as are the routine operations

The incident/accident reporting form must be filled out immediately after the event:

The Incident/Accident involved (check all that apply):

	Injury		Prop Strike/Tipover		Loss of Data Downlink
	Death		Foreign Object Damage		Airspace Violations
	Property Damage		Wildlife		Procedure Error
	Traffic Conflict in Flight		Near Midair Collision		Human Factor Error
	Fatigue		Hard Landing		Other
	Fuel/Energy Event		Loss of Command Uplink		
	Altitude Deviations		Loss of Telemetry Downlink		

Classification (check all appropriate responses):

	Damage to Aircraft (salvageable)		Injury to Person (no hospital)
	Damage to Aircraft (hull loss)		Injury to Person (hospitalized)
	Lost Aircraft (unrecoverable)		Death of Person

	Damage to Property (<$500)
	Damage to Property (>$500)

Post-flight and Pack-up

- Securing the aircraft
  - After a flight mission has ended, it is necessary to secure the aircraft and conduct a post-flight check of the aircraft
- Post-flight inspection
  - The purpose of a post-flight inspection is to find if anything changed on the aircraft during the flight which could affect the safety of the next flight
    - Abnormal sounds during flight may indicate a developing problem
      - Screws and wiring can loosen up during a flight
    - The props are always inspected after landing even though they will be inspected again before the next flight
    - Battery condition should be checked after landing to determine the state of charge

Post-flight and Pack-up

- Any noted anomalies in the post-flight inspection are recorded
- The remote pilot in command will debrief the crew on the flight
  - The RPIC will note any interesting control or operational conditions that should be shared with the crew
  - Likewise, if the flight crew has anything to share, they will share it at this time
  - Logbooks are updated at this time by the RPIC

Logbook	For what?	Who maintains?
Maint_S500_SNXX	Maintenance logging of S-500 aircraft	RPI or designee
Flightlog_S500_SNXX	Aircraft logbook	RPIC
Bat_SNXX	Battery logbook	RPIC
Pilot <Name> Logbook	Pilot logbook	RPIC or SP