Virginia Tech Guide for Safe Drone Flight Practice

This document presents operating procedures for the safe use of unmanned aircraft within the Virginia Tech community. There may also be additional operating requirements specific to the mission and operational site location.

1. Logging flights

While not a requirement from the FAA to log drone flights, it is recommended to log remote pilot flight hours and aircraft flight hours. Logged aircraft time can be used to track periodic inspections and maintenance on a particular aircraft. In the near future, we will have an online tool for logging these hours.

2. Preflight Planning

Prior to flying, several tasks must be completed:

1. You have already visited https://drones.ictas.vt.edu to determine if your flights are eligible under VT's Policy 5820, and you have responded to any requested information and received authorization to fly.

2. You have confirmed approval to fly at the site. For the Kentland Experimental Airfield, this means you have reserved time at the site or you have deconflicted operations with other users. For the Drone Park, this means that a reservation has been made. For other sites this means that approval has been given by the person/group/authority that owns/controls the site.

3. Review maintenance logs for the UAV that is intended for the flight to make sure there are no outstanding issues.

4. Make sure pilots are up to date (Part 107 current, trained/experienced with UAV).

5. A mission plan should be put together outlining the goals for the flight(s) and how they will be completed.

3. Flight Site Requirements and Preflight

Safe operation of the UAV requires an appropriate choice of the operations area. This section outlines the recommended site requirements.

1. Safe take-off and landing area - the specific size requirements will vary by scale of UAV, but these general rules apply.

   ○ **VTOL**

      i. Area is mostly level (low slope, minimal bumps)

      ii. Open area with at least *4m* radius around the UAV

      iii. Minimal loose debris to be kicked up during take-off or landing (place heavy blanket or plywood on ground if this is an issue)

      iv.   No vertical obstacles *above 5m* of flying altitude within *15m* radius of take-off location

      v.   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

      vi.   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.

      vii.   Ground station is at least *16m* from take-off point

- **Fixed Wing**

      i.   Area is mostly level (low slope, minimal bumps)

      ii.   Runway is long enough and wide enough for UAV takeoff and landing operations

      iii.   No vertical obstacles greater than *5m* high within a *35m* perimeter of runway

      iv.   Operator location is at least *8m* from take-off point (start)

      v.   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.

      vi.   Ground station is at least *16m* from take-off point

2. Alternative landing sites are identified before flight to prepare for possible emergency landings (low battery, mechanical failures, intrusions into airspace, etc.).

3. Radio frequencies in operation should be identified to minimize the likelihood of communication interference. Radios that could possibly conflict should be disabled if they are nonessential or set to different channels.

4. Potential hazards should be identified and briefed among the crew. These include both fixed hazards (trees, buildings, power lines, etc.) and moving hazards (people and vehicles that may enter the flight area). When the flight site includes areas with potential vehicle or foot traffic it may be necessary to manage the traffic with some combination of barriers and personnel.

4. UAV Preflight

Proper inspection of the UAV and payload is critical to safe operation. This section outlines the general checks needed - more specific guidelines may be necessary for each UAV and payload configuration.

1. Structural integrity: airframe is in good working condition - no cracks or visible damage, frame has "normal" stiffness, all parts are securely attached

2. Folding parts: any parts that are collapsed/folded/retracted for transport are locked in the operating position

3. Landing gear: all parts of the landing gear are intact

4. Motors: all motors spin smoothly

5. Motor mounts: all motors are mounted rigidly and in the correct position

6. Props: props are free from defects and securely mounted to the motor for the correct direction of rotation

7. UAV actuators (motors, control surfaces): each actuator is checked to ensure it moves in the right direction and with the correct range of motion.

8. Batteries: batteries are properly charged (appropriate voltage and cell balance) and show no signs of damage (puffiness, cuts in outer housing or wires, dents, etc.) and are securely mounted.

9. Center of gravity: the UAV center of gravity is in the designed/intended location and has been verified by a balance test. Battery and payload mounts are adjusted to set center of gravity if necessary.

10. Wiring harness: all wires are properly connected, no wires are loose, and no damage to wires or connectors (this inspection can be visual, but if there is any doubt then electrical checks with a multimeter, cable tester, or operation on the ground should be completed)

11. Payload mounts: payload is appropriately mounted to the UAV and has the proper signal and power connections

12. Flight controller: flight controller powers on correctly, settings are checked, communication to ground station is verified

13. Radios: each radio link is verified on the ground, ground antennas are securely placed (mounted to tripods, laptop, vehicle roof, etc.), antenna connections on UAV are checked, antenna orientations are correct, no visible damage to any antenna

14. RTK GPS (if used): base station is properly set up and configured to send correction data to each RTK node (powered, auto-surveyed, radio, ethernet or USB connection, antenna is securely mounted on tripod, tripod is staked or weighted so it cannot move)

15. Other safety equipment: any lighting, rotor guards, emergency stops, etc that might be installed on the UAV are inspected and function correctly.

16. **The UAV should be re-inspected between flights**

5. Flight Operations

All flight crew members are responsible for safe operations and should speak up if they are uncomfortable with anything during operation.

5.1 Site setup

The site should meet the requirements outlined under the Flight Site Requirements section.

1. The pilot and observer should be at least *8m* from the take-off location with clear line of sight to the UAV. If possible the pilot and observer should be positioned so that they do not need to look into the sun to see/track the UAV (may not be possible for all sites/configurations)

2. The ground station and the rest of the crew should be at least *16m* from the take off point

3. The UAV cannot fly over non-participants of the mission, and flight directly over participants (pilot and observer only) should be restricted to short time intervals.

4. The return to launch (RTL) path for any point of the flight should not pass over the ground station (such path would require flight over people during an emergency landing that the pilot was not controller due to a communication failure)

5. Alternative landing sites are identified and communicated to the entire crew.

6. Proper traffic management is in place (barriers/gates, signs, and/or gatekeeper)

7. All crew members should be in an orientation towards the aircraft

8. All crew members should in a position where they could move away in the event of an uncontrolled UAV.

9. All cabling for power and communications is secured to minimize disconnection and tripping hazards.

5.2   Flight crew roles

<The same person may serve multiple roles for simpler operations>

Person Manipulating the Controls – A person other than the remote pilot in command (PIC) who is controlling the flight of an sUAS under the supervision of the remote PIC.

Remote Pilot in Command (Remote PIC or Remote Pilot) – A person who holds a remote pilot certificate with an sUAS rating and has the final authority and responsibility for the operation and safety of an sUAS operation conducted under part 107.

Visual Observer (VO) – A person acting as a flightcrew member who assists the small UA remote PIC and the person manipulating the controls to see and avoid other air traffic or objects aloft or on the ground.

Ground Station Operator - runs the ground station computer(s). They are responsible for mission planning, telemetry monitoring, GPS RTK, and communication systems. They make sure the entire team knows and understands the current flight plan before take-off.

Traffic Management/Gatekeeper - controls entry to and movement within flight operations area.

Site Coordinator/Liaison - point of contact for site and any other groups operating in the area. They are responsible for verifying approval to start each flight and deconfliction with other groups.

5.3   Crew communication

The crew needs to be able to clearly communicate critical information rapidly during flight operations. This will be done directly for smaller sites with quiet UAVs or over radios. Each member of the crew should have a radio that is only used for necessary messages. A standard set of commands is used to eliminate confusion during operation (these are a guide, but can be adapted as needed). Commands should be acknowledged.

Take-off - the pilot is clear to start flight

Start Mission - the pilot is clear to start the mission (flip into auto or start the planned manual flight)

Mode *New Mode* - when the UAV changes flight modes the ground station communicated the current mode

Battery - Battery status update in minutes of flight and current voltage

RTK State - current GPS mode on UAV

Turns/waypoints are announced by ground station operator

Abort - stop the mission and fly home

Pause - switch to loiter or stabilize and remain at the current location until abort or resume is commanded

Resume - restart the mission after a pause

Land - land at the closest safe location without delay

No comms - communication is lost (should switch to RTL so a mode change will also be announced)

Off track - not following mission, be ready to abort or land

5.4   Crew PPE

Each crew member should have appropriate PPE. This is the minimum requirement for the USL. Specific sites may require additional PPE.

Safety Glasses - All flight personnel within *8m* of the UAV operation should wear approved safety glasses. If sun is concern they should be tinted.

Hat - a hat with a sun brim may be necessary for during sunny days.

Hard hat/helmet - a hard hat or helmet is not required. Their efficacy is questionable and they possibly are a distraction. Some sites may however require them. If used they should have a strap to prevent falling off.

Sun protection - sunscreen and appropriate clothing should be used to prevent sunburn for all crew

Sun canopy - where possible a canopy will be used as sun protection for the ground crew and to keep computer monitors viewable during sunny days.

Water - all crew should have access to water and appropriate bathroom breaks. The schedule for operations should reflect the necessity of these breaks.

Footwear - all crew should wear appropriate shoes for the flight environment.

High vis vest/clothing - some sites may require the pilot and observer to wear clothing that clearly communicates that they are the pilot and are allowed within a *16m* radius that the rest of the crew needs to maintain during flight.

5.5   Post Flight

Flight Documentation

All flights should be documented in a logbook. Flight documentation should include information about the UAV, site, mission goals, batteries used, flight time, and any issues that arise.

Incident Reporting

Refer to the Virginia Tech UAS Incident Response Plan Protocol, Supplement to the University Policy Governing the Operation of Unmanned Aircraft Systems, Policy 5820.

UAV Inspection

After each flight the same basic set of checks performed for preflight should be repeated. Any failures should be noted so that appropriate repairs can be made before the next set of flights.

Departing the flight site

Before leaving the flight site all equipment should be appropriate stored or packed and the site should be left in as good or better condition as when the USL arrived.

The flight crew should contact the site to let them know they are leaving for the day (or a break). Departure should also be communicated to any other group operating in the area.