



**Standard Operating Procedures
Small Unmanned Aerial Vehicles (sUAVs)
and
Small Unmanned Surveillance Vehicle (sUSVs)**

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Standard Operating Procedures Small Unmanned Aerial Vehicles (sUAVs) and Small Unmanned Surveillance Vehicles (sUSVs)

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**Note: This document does NOT form a Risk Assessment.
It may, however, be referred to in a Risk Assessment.**

Rationale: small, radio-controlled unmanned air vehicles or sUAVs (also referred to as small unmanned surveillance vehicles, or sUSVs) – fixed- and rotary-wing vehicles with a mean (gross) take-off weight of 7kg or less and single or multiple onboard sensors – are now widely available from online vendors, at prices that are affordable for casual users, researchers and hobbyists. At present, the main limiting factor with these devices, regardless of whether they are flown under conditions of direct view or via onboard camera systems generating a ground station “First Person View” (FPV), is that of the untrained or minimally trained human pilot, and incidents have been reported in the recent past which demonstrate the sometime injurious end results of human error or lack of experience, system failure, flying in inappropriate weather conditions, flying over inappropriate geographical features, and so on.

Overarching Guidance: Air Navigation Order (CAP 393), Article 167 states that the person in charge of a small unmanned surveillance aircraft must not fly the aircraft in any of the circumstances described below except in accordance with permission issued by the CAA.

Specific Guidance: In addition to these high-level guidance points, the University of Birmingham’s Human Interface Technologies Team has, in recognition of its duty of care, adopted a number of specific operating procedures with the aim of preserving the health and safety of all personnel (staff and students) involved in the deployment and operation of sUAVs and sUSVs, and of members of the public. These specific guidance points are included with the overarching guidance below, using blue underlined text.

- An unmanned aircraft must never be flown beyond the normal unaided line of sight of the person operating it. This is generally measured as 500m (1640ft) horizontally or 122m (400ft) vertically.
- An unmanned aircraft must not be flown over or within 150m (492ft) of a congested area or an organised open-air assembly of more than 1,000 persons.
- An unmanned aircraft must not be flown within 50m (164ft) of any vessel, vehicle or structure which is not under the control of the person in charge of the aircraft.
- An unmanned aircraft must not be flown within 50m of any person.
- During take-off or landing, a small unmanned surveillance aircraft must not be flown within 30m (98ft) of any person.
- All users (pilots, persons in charge, etc.) must have completed an appropriate course of training, including simulator time and/or supervision by a nominated experienced trainer.
- Abide by the sUAV/sUSV products specific instructions and operating procedures at all times, especially with regard to actuation and shut down, noting the correct process for arming/activating the vehicle and transmitter.

- Propeller guards, if available, should be used at all times.
- Do not handle an sUAV/sUSV whilst the propellers are active and never place fingers near rotating propellers or any other moving component.
- An appropriately equipped first aid kit should be carried with the sUAV/sUSV at all times.
- A log book, charting all flights, be they for training, research or real-world applications, should be kept updated at all times, and should include names of the pilot/person in charge, observers, date, location, conditions, flight times and any specific incidents, including those requiring follow-up actions.

CAP 393, Article 167 deals with the use of onboard cameras for “surveillance” and/or “data acquisition” purposes. However, in situations where a camera is used for the sole purpose of controlling the aircraft the flight is not considered surveillance or data acquisition. CAP 722 (<http://www.caa.co.uk/cap722>), Article 3.6 in Section 3 Chapter 1 page 4 states that “the provision of image or other data solely for the use of controlling or monitoring the aircraft is not considered to be applicable to the meaning of ‘Surveillance or Data Acquisition’ covered at Article 167 for Small Unmanned Surveillance Aircraft”. In line with the UK’s Data Protection Act (1998), ensuring the privacy of citizens and the protection of personal data is of paramount concern to the Human Interface Technologies Team. Therefore, every attempt will be made to avoid flying sUAVs or sUSVs in the vicinity or private properties or residences. In the event that a private property or member of the public is inadvertently captured on still or video imagery, then these frames will be removed from the recorded media, or, depending on the importance of the material captured to the nature of the survey being conducted, the sensitive parts of captured frames will be pixellated or made invisible using an appropriate video/software technique.

- Where appropriate (e.g. at heritage or other tourist sites where visiting members of the public may have access at certain times of the day), every attempt will be made to conduct flights outside of visiting hours or in location within that site which are not accessible to the public, or have been cordoned off. In any event, and again where appropriate, signs alerting visitors and staff to the likelihood of aerial activity and video recording will be deployed at visible locations.
- The person in charge of a small unmanned aircraft may only fly the aircraft if reasonably satisfied that the flight can safely be made. The person in charge and the sUAV/sUSV team should conduct a pre-mission survey of the flight area, using appropriate maps and, if possible images from Google Earth or similar online databases, with the aim of defining local geography, sightlines, potential no-fly areas, potential “no-recover” areas and other obstacles.
- The person in charge, together with any observers, should understand the operational limitations of the sUAV or sUSV being deployed and conduct pre-mission and pre-flight checks of weather conditions (precipitation, wind speed, etc.). Where possible, hand-held devices capable of recording wind speed and direction should be used prior to and during all stages of flight.
- If the sUAV or sUSV is GPS-enabled, then the quality of the GPS signal must be established prior to any flight and a full GPS lock must be obtained prior to take-off.
- The person in charge of a small unmanned aircraft must maintain direct, unaided visual contact with the aircraft sufficient to monitor its flight path in relation to other aircraft, persons, vehicles, vessels and structures for the purpose of avoiding collisions.
- The person in charge of a small unmanned aircraft must not fly the aircraft for the purposes of aerial work except in accordance with a permission granted by the CAA.

- A person must not cause or permit any article or animal (whether or not attached to a parachute) to be dropped from a small unmanned aircraft so as to endanger persons or property.

In the case of FPV flying, Air Navigation Order 2009 (General Exemption E3780) additionally demands that:

- The person in charge of the sUAV or sUSV must be accompanied by one or more competent observer(s) whose role is to maintain adequate, direct unaided visual contact with the vehicle in order to provide clear verbal reports to the person in charge of said vehicle and to monitor its flight path in relation to other aircraft, persons, vehicles, vessels and structures for the purpose of avoiding collisions.
- The person in charge of the sUAV or sUSV must ensure that:
 - The competent observer(s) is (are) fully briefed on the planned flight and what is expected of him/her/them taking, into account the prevailing conditions.
 - The competent observer(s) understand(s) that he/she/they must stay directly adjacent to the person in charge and maintain direct unaided visual contact with the sUAV or sUSV at all times, to visually and aurally monitor the airspace for other aircraft and the take-off and landing area for any persons.
 - The competent observer(s) has (have) been instructed on the actions to take in the event of another aircraft being spotted and a risk of collision is assessed.
 - The competent observer(s) understand(s) that he/she/they must advise the person in charge if the sUAV or sUSV is proceeding beyond the point at which he/she/they is (are) able to monitor its flight path sufficiently to identify a risk of collision.
- The observing individuals must not engage in any other activity other than observing the sUAV or sUSV and must focus on the task of observing at all times. For example, photographing or videoing the during launch, flight and recovery stages should NOT be undertaken by a person or persons whose sole role it is to observe the sUAV or sUSV.
- When there is a likelihood that one or more observers need to move away from the location of the person in charge, then short-range radios should be used to maintain good communication. Such radios should be equipped with voice-operated (“VOX”) headsets in order to promote hands-and-eyes free communication wherever possible. Whistles should also be used in cases where the attention of the pilot (or, indeed, members of the public who may have inadvertently strayed into the vehicle flying zone) need to be attracted as a matter of urgency.
- To promote effective communication and safety, observers, together with the person in charge, should wear high-visibility clothing whenever possible. Eye protection should be considered, especially when approaching an sUAV or sUSV before take-off and after landing and during operations where the nature of the terrain presents a flying object hazard (sand, small stones, bracken, etc.).

FPV Flying Special Case – Use of Wearable or Head-Mounted Displays

FPV flying typically occurs by using sUAV/sUSV flight control-integrated displays or mobile 'phone/tablet display attached to the flight control unit. However, it is also possible to relay images to, and motion commands from, head-mounted display (HMD) or other wearable computer systems. For example, head tracked HMDs can be linked to monoscopic or stereoscopic cameras deployed with the sUAV/sUSV, such that the motion of the pilot's head controls pan-and-tilt functions of the camera platform. Wearable computer technologies are developing at a fast pace and can take many forms. Focusing on HMDs, these vary from from monocular displays, such as *Google Glass*, to partially see-through headsets for head-up or Augmented Reality information display (e.g. the *Atheer One* and *Meta*), to fully face-enclosing Virtual reality HMDs, such as the *Oculus Rift*. Other display and control systems can be arm or wrist-mounted.

Given the current state of development of these systems – and HMDs in particular – their use by pilots or persons in charge during FPV sUAV/sUSV flying is NOT RECOMMENDED. Human Factors issues underpinning this recommendation include the adverse performance effects of low-resolution displays, restrictive fields of view, loss of local-to-pilot and remote/global situational awareness and disorientation resulting from distorted imagery, visual-vestibular conflicts and random flight perturbations caused by wind speed and directional change.

If this recommendation is not heeded, then a number of fundamental requirements MUST be met. If the pilot or person in charge is wearing an HMD, then a MINIMUM of two observers should be used. One of these observers must focus his/her attention on the pilot or person in charge, ensuring (a) that he/she does not cause self-harm by moving into a hazardous area or tripping on/colliding with an obstacle and (b) that known side effects of wearing HMDs, especially those that fully cover the user's face, are not evident (particularly postural instability). The other observer(s) should maintain close attention to the flight profile of the sUAV/sUSV. If one of the observers is wearing an HMD whilst the pilot or person in charge maintains direct line-of-sight control of the sUAV/sUSV, then standard Health & Safety guidance must be followed. Health & Safety guidelines applying to the use of HMDs have been drawn up for Virtual and Augmented Reality applications (including issues to be aware of during donning, operation, doffing and recovery periods). Many of these are equally applicable to the use of HMDs for remote control and telerobotic applications. A summary of these guidelines can be found in:

Stone, R.J. *“Human Factors Guidance for Designers of Interactive 3D and Games-Based Training Systems” (Second Edition); Human Factors Integration Defence Technology Centre Publication; February, 2012.* Available from www.birmingham.ac.uk/stone.

SUMMARY

1. Total weight of sUAV must not exceed 7kg.
2. Operations should only take place in good weather conditions and with good visibility
3. Training for operators/pilots and prior instruction to observers are mandatory requirements.
4. The sUAV team should consist of AT LEAST 2 people:
 - a. Operator/Pilot – this team member MUST maintain visual contact at ALL times, and the sUAV must not be flown more than 500m (1640ft) horizontally or 122m (400ft) vertically from the operator's/pilot's position.
 - b. Observer(s) should maintain visual contact with the sUAV at ALL times to monitor proximity to prohibited areas or objects/environmental features which could cause damage to the sUAV leading to a crash. Observer(s) must be in communication with the operator/pilot at all times.
 - c. Additional observers may be necessary to monitor the operator/pilot, especially in conditions of FPV- and head-mounted display-based flying.
 - d. Depending upon the circumstances and environment, 2-way communications devices may be necessary.
5. The sUAV must not be flown within a 150m (492ft) radius of a congested area or an organised open air assembly of more than 1000 persons.
6. The sUAV must not be flown within 50m (164ft) of any person.
7. During take-off or landing, the sUAV should not be within 30m (98ft) of any person.
8. Propeller guards must be fitted when available.
9. A detailed flight log should be kept and Risk Assessment noted.