SURVEY DRONES IRELAND

Student Handbook

A2 Open Category - EU 945/947

A recognised Declared Unmanned Aerial Systems Training Organisation of the IAA

Amendment Record

Document Reference: "Ground School Student Handbook – A2 Open Category Ver 1.0"

Issue: V1.0 – 15 May 2021

Document Author: Wayne Floyd

Accountable Manager: William Carroll

The Theoretical Manual describes the subject matter that is laid down by the IAA, who in turn have examined and certified Survey Drones Ireland to hold a Registered Training Facility accreditation for UAS.

It is accepted that the contents of this document do not override the necessity of reviewing and complying appropriately with any new or amended regulations, published from time to time by the relevant National Aviation Authorities addressed by this document.

CONTENTS

,

LIST OF ABBREVIATIONS

AEC	airspace encounter category
AEH	airborne electronic hardware
ANSP	air navigation service provider
ARC	air risk class
AGL	above ground level
AMC	acceptable means of compliance
AO	airspace observer
ATC	air traffic control
BVLOS	beyond visual line of sight
C2	command and control
C3	command, control and communication
ConOps	concept of operations
DAA	detect and avoid
EASA	European Union Aviation Safety Agency
ERP	emergency response plan
EU	European Union
FHSS	frequency-hopping spread spectrum
GRC	ground risk class
GM	guidance material
GNSS	Global Navigation Satellite System
HMI	human machine interface
ISM	industrial, scientific and medical
JARUS	Joint Authorities for Rulemaking on Unmanned Systems
METAR	aviation routine weather report (in (aeronautical) meteorological code)
MCC	multi-crew cooperation
MTOM	maximum take-off mass
NAA	national aviation authority
OM	operations manual
OSO	operational safety objective
PDRA	predefined risk assessment
RBO	risk-based oversight
RCP	required communication performance
RF	radio frequency
RLP	required C2 link performance
RP	remote pilot
RPS	remote pilot station
SAIL	specific assurance and integrity level
SMM	safety management manual
SORA	specific operations risk assessment
SPECI	aviation selected special weather code in (aeronautical) meteorological code
STS	standard scenario
SW	software
TAF	terminal area forecast
TCAS	traffic collision avoidance system
TMPR	tactical mitigation performance requirement
UA	unmanned aircraft
UAS	unmanned aircraft system
UAS Regulation	Commission Implementing Regulation (EU) 2019/947 of 24 May 2019 on the rules and procedures for the operation of unmanned aircraft
VLL	very low level
VLOS	visual line of sight

1. Introduction to Multi-Rotor UAS's

Below are some samples of the most commonly used UAS's used in Ireland.

DJI Phantom 4 Pro V2

DJI Phantom 4 PRO RTK

DJI Matrice 300 RTK

Skydio 2

They have 2 main roles:

- Hobbyist
- Commercial

Three Main Components:

- Aircraft / Battery
- Ground Controller / Station
- Video Display

1.1. The Aircraft

- Has three, four, six or eight rotors.
- The frame is made up of plastic, carbon fibre or light alloy.
- GPS system on board.
- Radio communications which can receive and transmit (Rx & Tx).
- Flight controller
- Electronic speed controller (ESC).
- Inertial measurement unit (IMU).
- Compass
- Battery compartment

1.2. Ground Controller / Station:

- Constructed from plastic or light alloy.
- Flight control sticks.
- Radio communications which can receive and transmit (Rx & Tx).
- Antenna(s).
- USB port for firmware upgrades.
- Battery, either disposable or rechargeable.
- Multiple channels to switch between different tasks, most commonly 4 channels.

1.3. Video Display:

Can be any of the following devices:

- Apple products will require the relevant ios version to operate. Compatible with iPhone 5s, iPhone 6, iPhone 6+, iPad Air, iPad Air 2, iPad mini 2, and iPad mini 3.

- Android compatible models include: Samsung S4, S5, S6, S6 edge, Samsung Tab 7" / 10", VDU and Black Pearl.

1.4. Summary:

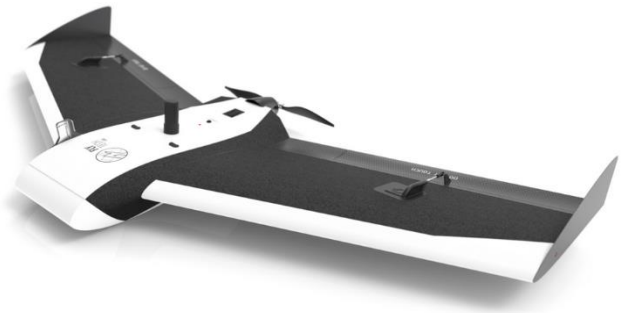
- Remember that they can come out of the air at any given time.
- Risk assessment is carried out before every flight.
- Keep an eye on the telemetry as this will help you in flight.
- If you feel unsure of anything before you put the aircraft up in the air, stop to assess or check.
- Have an emergency procedure in place and a predefined emergency landing site on all jobs.
- Keep within the guidelines of your operating procedures, safety is paramount.

2. Introduction to Fixed-Wing UAS's

Below are some samples of the most commonly used UAS's used in Ireland.

Sensefly eBee Plus

Flytech Birdie



Smartplanes Freya

SIrisus PRO

They have 2 main roles:

- Hobbyist
- Commercial

Three Main Components:

- Aircraft / Battery
- Ground Controller / Station
- Video Display

2.1. The Aircraft

- Has at least 1 propeller.
- The frame is made up of foam, plastic or carbon fibre.
- GPS system on board.
- Radio communications which can receive and transmit (Rx & Tx).
- Flight controller
- Electronic speed controller (ESC).
- Inertial measurement unit (IMU).
- Compass
- Battery compartment

2.2. Ground Controller / Station:

- Constructed from plastic or light alloy.
- Flight control sticks.
- Radio communications which can receive and transmit (Rx & Tx).
- Antenna(s).
- USB port for firmware upgrades.
- Battery, either disposable or rechargeable.
- Multiple channels to switch between different tasks, most commonly 4 channels.

2.3. Video Display:

Can be any of the following devices:

- Apple products will require the relevant ios version to operate. Compatible with iPhone 5s, iPhone 6, iPhone 6+, iPad Air, iPad Air 2, iPad mini 2, and iPad mini 3.

- Android compatible models include: Samsung S4, S5, S6, S6 edge, Samsung Tab 7" / 10", VDU and Black Pearl.

2.4. Summary:

- Remember that they can come out of the air at any given time.
- Risk assessment is carried out before every flight.
- Keep an eye on the telemetry as this will help you in flight.
- If you feel unsure of anything before you put the aircraft up in the air, stop to assess or check.
- Have an emergency procedure in place and a predefined emergency landing site on all jobs.
- Keep within the guidelines of your operating procedures, safety is paramount.

3. Introduction to Vertical Take-off & Landing UAS's

Wingcopter 178 VTOL

Flytech Birdie VTOL

Quantum Systems Trinity F90 VTOL

WIngtra VTOL

They have 2 main roles:

- Delivery
- Commercial

Three Main Components:

- Aircraft / Battery
- Ground Controller / Station
- Video Display

Functionality of this type of Aircraft

3.1. The Aircraft

- Can have up to 5 propellers. Four for Take-off and Land and then One for Primary Flight.
- Other Aircrafts might only have three or two. Depends on the design of the aircraft.
- The frame is made up of foam, plastic or carbon fibre.
- GPS system on board.
- Radio communications which can receive and transmit (Rx & Tx).
- Flight controller
- Electronic speed controller (ESC).
- Inertial measurement unit (IMU).
- Compass
- Barometer
- IMU
- Battery compartment

3.2. Ground Controller / Station:

- VTOL systems have primarily a Ground Station. Which could be a Laptop, or a Tablet connected to the remote controller.
- Flight control sticks.
- Radio communications which can receive and transmit (Rx & Tx).
- Antenna(s).
- USB port for firmware upgrades.
- Battery, either disposable or rechargeable.
- Multiple channels to switch between different tasks, most commonly 4 channels.

3.3. Video Display:

In the Ground Control Station, it would be a make-up of a Laptop or a tablet intergraded with a Remote Controller. This would be used fro flight planning and flighting the aircraft.

3.4. Summary:

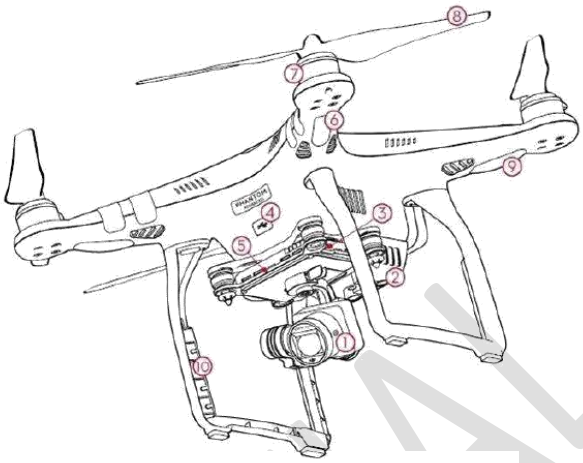
- Remember that they can come out of the air at any given time.
- Risk assessment is carried out before every flight.
- Keep an eye on the telemetry as this will help you in flight.
- If you feel unsure of anything before you put the aircraft up in the air, stop to assess or check.
- Have an emergency procedure in place and a predefined emergency landing site on all jobs.

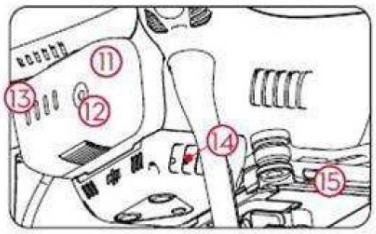
Keep within the guidelines of your operating procedures, safety is paramount.

4. Aerial Systems

This is written in reflection of the most commonly used UAS on the market at present. It is also the bases of all UASS.

1. Gimbal & Camera
2. Vision Position System
3. Camera Micro-SD card slot
4. Aircraft Micro-SD USB port
5. Camera status indicator
6. Front LED's
7. Motors
8. Propellers
9. Aircraft status indicator
10. Antennas
11. Intelligent flight battery
12. Power button
13. Battery level indicator
14. Link button
15. Camera Micro-USB port





4.1. The Aircraft-Compass

Make sure the compass is calibrated before every flight. Failure to calibrate the compass may lead to poor flight performance or a crash. Do not attempt to calibrate a compass where there is a chance of strong magnetic interference. These include areas where there are large metal objects, multi storey car parks, steel reinforcements underground (large concreted areas) or under bridges. The compass should also always be calibrated when moving from indoor spaces to outdoor spaces. If the rear LED's show solid red, recalibrate immediately. After successful calibration, it is best to check the flight functions quickly to ensure the compass calibrated without any abnormalities.

If compass data is abnormal or the aircraft status indicators are blinking red and yellow, severe drifting can occur in flight i.e. the aircraft does not fly in a straight line. The main causes for this are; flying in a new location that is different from the last flight or the mechanical structure of the aircraft has changed i.e. the mounting position of the compass has changed.

4.2. The GPS Receiver

The Function of the GPS is to determine the position – the data is fed into the main Flight Controller, it uses the likes of GPS & GLONASS satellites. They are a very small component in the drone. Normal position is on the top of the drone. Can be damaged by misuse Your GPS is different from your Compass some people make the mistake thinking they are the same.

4.3. The Flight Controller.

A flight controller (FC) is a small circuit board of varying complexity. The majority of flight controllers also employ sensors to supplement their calculations. The problem with multi-rotors, is that no human is capable of controlling the rotational speeds of three or more motors simultaneously with enough precision to balance a craft in the air. This is where flight controllers come into play. Many flight controllers allow for different flight modes, selectable using a transmitter switch.

4.4. The Inertial Measuring Unit.

IMUs are used to measure acceleration, angular velocity and magnetic fields, and, when combined with sensor fusion software. Help also in Orientation, navigation, and stabilization. Six Degrees of Movement, X Axis, Y Axis, Z Axis, Pitch, Yaw & Roll.

4.5. The Barometer.

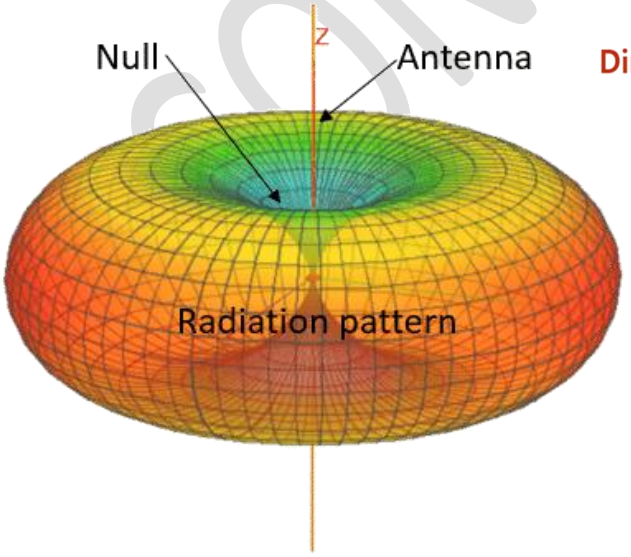
A barometer is used to control the flight height by detecting the atmospheric pressure change. Digital Barometric Pressure Sensor Drones utilize air pressure sensors to stabilize altitude. Before take off always check to make sure your Altitude reads Zero. If there is big different in height as in +/- 2 Meters, switch off drone and restart again. Checking that the Height is 0. while a GPS receiver is mainly used to determine the horizontal position of the drone. While both barometer and GPS are capable of measuring height, they are based on different algorithms. Combined with the accelerometer and gyroscope, barometric pressure sensors enable drones to fly with precision. During Flight Check your Altitude in your telemetry to make sure no abnormalities are happening.

4.6. The Gyroscope.

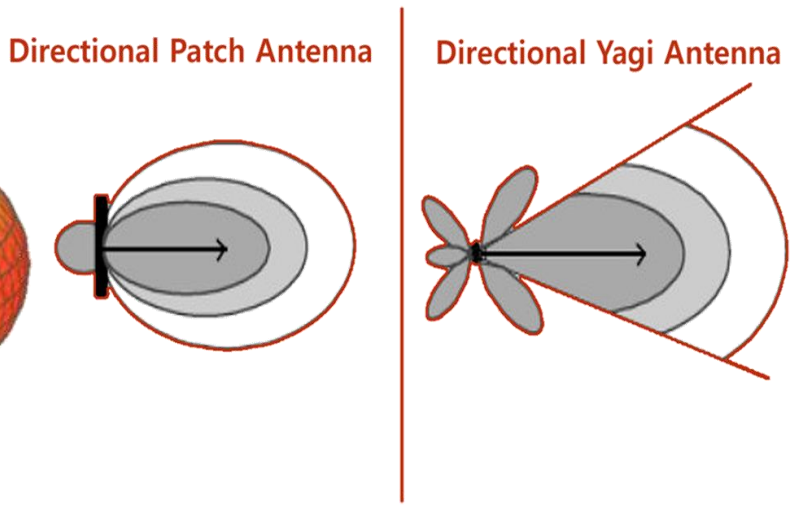
While accelerometers can measure linear acceleration, they can't measure twisting or rotational movement. To understand the role of gyro stabilization, it's important to realize that every drone is constantly being subjected to a number of forces coming from different directions. Integrated gyroscopes can almost instantly detect changes in the position of a drone and compensate for it in such a way, that it basically seems unaffected. The Gyroscope helps keeps the phantom body level during flight, it helps with measures angular velocity and helps maintain orientation.

4.7. The Antennas.

The roll of the Antennas is to send information from your remote controller to the drone in flight. The Remote Controller has to main functions and that is to transmit information to the Drone and to receive. information from the drone to the Remote Controller in the Form of Telemetry. Rx is Receive. Tx is Transmit. Omnidirectional Antenna is an Antenna that has to functions one to transmit a signal to almost 360° and then once Omni range is no longer possible the Directional part of the antenna is used by pointing the antenna in the direction of the drone in flight.



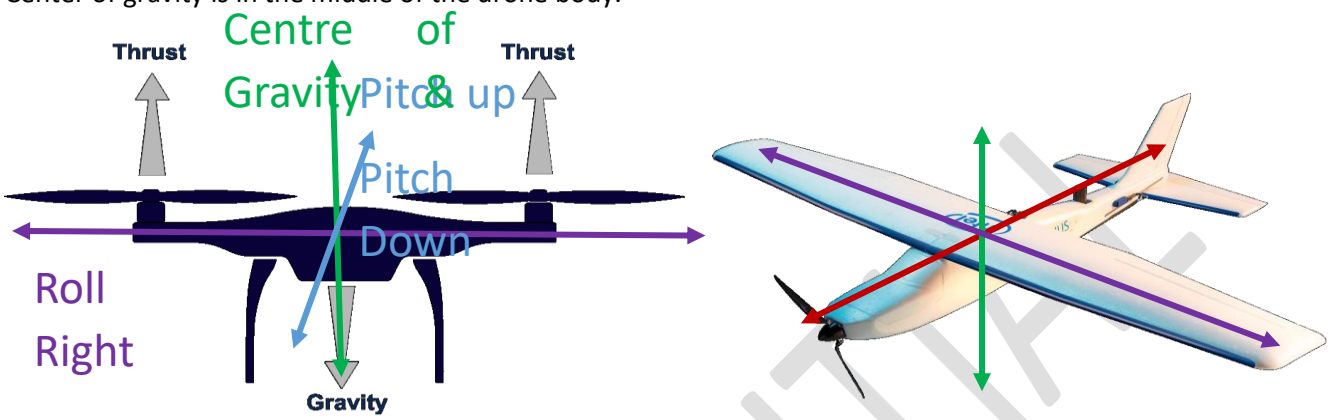
Omni Antenna transmitting signal Pattern



Directional Antenna Transmitting Signal Pattern.

4.8. The centre of gravity (CG)

The centre of gravity (CG) of an aircraft is the point over which the aircraft would balance. Its position is calculated after supporting the aircraft on at least two sets of weighing scales. The centre of gravity affects the stability of the aircraft. To ensure the aircraft is safe to fly, the centre of gravity must fall within specified limits established by the aircraft manufacturer. Most Fixed wing Drones are designed so the center of gravity is located within the airfoil (profile) of the wing where it's attached to the fuselage. Multi-Rotor Drones Center of gravity is in the middle of the drone body.



5. The Aircraft Propulsion System

The three main components that make up the propulsion system are the propellers, motors and electronic speed controller.

5.1. Propellers

Do Not use aged, chipped or broken propellers.
Always power off the aircraft before touching the propellers.
Be aware of the sharp edges of the propellers when mounting or removing the propellers.
Whenever necessary, use tools to safely remove or install the propellers.
Ensure the propellers are securely mounted to prevent them from falling off the motors.
Do not turn on the motors when propellers are mounted and there are other people or animals in the immediate vicinity.

5.2. Motors

Ensure the motors are securely mounted and rotating smoothly.
Do Not attempt to modify the structure of the motors.
Do Not touch or let your hands come in contact with the motors after flight as they may be hot.
Do Not block any of the ventilation holes on the motor or on the aircraft itself.
Keep the motors free of dust.
If a motor gets stuck or stalls on start-up, execute the combination stick command (CSC) to stop immediately.

5.3. Electronic Speed Controllers

These perform several tasks. The primary and most importantly task is to control the speed of the motor they are connected to. It is done by taking a signal from the main controller and sending it to the motors. The secondary task is to act as an inverter and powering the motors. The final task is to regulate the voltage to the motors.

6. The Aircraft Vision Positioning System

The effective altitude for the vision positioning system (VPS) to function correctly is less than 13 meters above AGL, depending on brand. It is essential to operate the aircraft cautiously when in any of the following situations:

- Flying over monochrome surfaces.
- Flying over highly reflective surfaces.
- Flying at high speeds (over 8m/s at 2 meters or over 4m/s at 1 meter).
- Flying over water or transparent surfaces.
- Flying over moving objects.
- Flying in areas where the lighting changes frequently or drastically.
- Flying over extremely dark or bright surfaces.
- Flying over surfaces that can absorb sound waves.
- Flying over surfaces with identical repeating patterns or textures.
- Flying over inclined surfaces that will deflect sound waves away from the aircraft.
- In the event of loss of the remote controller signal, the aircraft will hover for 8 seconds and then auto-land if it is in 'P' mode.

7. The Gimbal & Camera

The gimbal allows the camera to operate in a number of operation modes while also improving the quality of images / videos captured in flight. Some operation modes include, follow mode and FPV mode. Most gimbals also come with an anti-drop kit. The kit keeps the Gimbal & Camera connected to the aircraft. Mounting the anti-drop pins diagonally from each other is best.

The camera is a 4k, 12 mega pixel camera with 1:2.3 CMOS sensor. It comes with a Micro-SD card slot and is shipped with a 16Gig Micro-SD card but can handle cards up to 64Gig. Do Not Remove the Micro-SD card from the aircraft when it is powered on. The data can also be downloaded by USB cable via the camera data port. For this the aircraft must be powered on to access the files on the SD card.

8. The Battery & Charger

Flight batteries must be fully charged before first used. The flight battery is a 4480 mAh 15.2 Volts.
The battery level display, the LED indicators display the current battery level. Battery life display, the LED's display the current battery pawer cycle.

Auto-discharging function is used to prevent swelling. The battery automatically discharges to below 65% of total power when it is idle for more than 10 days. It takes around two days to discharge to 65%. It is normal to feel moderate heat being emitted from the battery during the discharge process. Discharge thresholds can be set in the DJI GO app. Balanced charging is used to automatically cut the power supply when a short circuit is detected.

Overcharging protection when charging automatically stops when the battery is fully charged.
Temperature protection will only charge a battery when the temperature is between 0°C & 40°C.
Over current protection stops the battery from charging when the amperage exceeds 8A.
Over discharge protection prevents over discharge damage. Discharging automatically stops when the battery voltages reaches 12V.
Short circuit protection will automatically cut power from the supply when a short circuit is detected.

9. Battery Safety

Do Not allow the batteries to come into contact with any kind of liquid; rain, water or storing in a wet room. Use the right Kind of Battery for the right kind of aircraft. Never remove or install a battery from the aircraft when it is turned on. Never use or charge swollen, leaky, or damaged batteries. Do Not use the battery in strong electrostatic or electromagnetic environments. Otherwise, the battery control board may malfunction & cause a serious accident during flight. Never Disassemble or pierce the battery in any way or the battery may leak, catch fire or explode. If a battery falls out of an aircraft check to make sure that the battery is not damaged or leaking before putting it back into the aircraft.
Do Not put batteries in a microwave oven or in a pressurized container. Do Not heat batteries.
Extinguish a battery fire using sand or a dry power fire extinguisher. Be careful not to inhale fumes.
Clean battery terminals with a clean, dry cloth.

10. Battery Storage

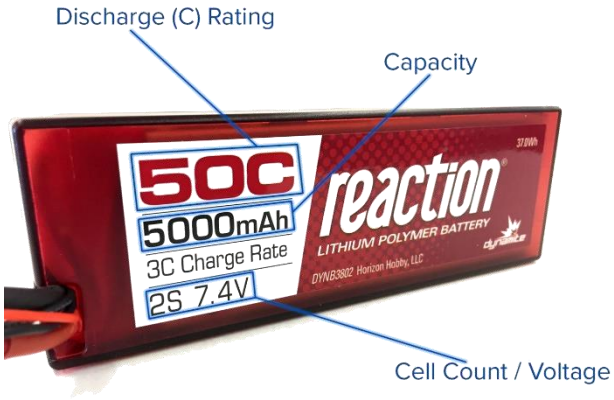
Do Not leave the battery near heat sources such as a furnace or heater. Do Not leave the batteries inside a vehicle on hot days. Ideal storage temperature is 22°C to 28°C. Do Not drop, strike, impale, or manually short-circuit the battery. Keep the battery dry. Never store the battery in environments with a temperature higher than 60°C Remove batteries from aircraft when stored for an extended period.

Example of An Intelligent Battery

Example of an non-Intelligent Battery

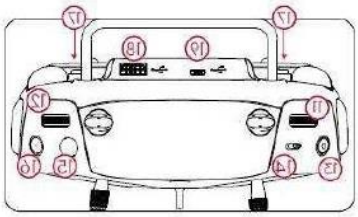
10.1. Battery Labels and meanings. - Non-Intelligent Batteries

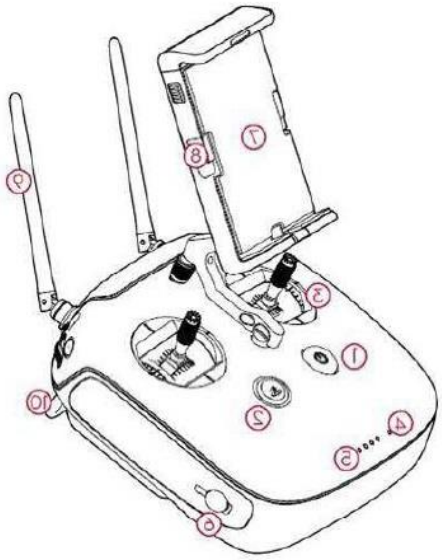
When you have an 'S' on the label this means that the configuration of the battery cells is serial. Flight Battery should be fully charged before first use. IF a Battery label had the number like '40C' on the label The 'C' means the battery may be discharged at 40 times its rated capacity without damage. If it had a Number of 35C this then means the battery may be discharged at 35 times its rated capacity without damage. When a battery is close to end of life during flight the warning signs are the temperature of the LiPo increases with each flight. During all flights you should be checking battery telemetry via the Flight App.



11. Controller Configuration

1. power Button
2. Return Home Button (RTH)
3. Control Sticks.
4. Status LED
5. Battery Level LEDs
6. Power Port
7. Mobile Device Holder
8. Small Device Positioning Tabs
9. Antennas
10. Handle Bar
11. Gimbal Dial
12. Camera Settings Dial
13. Video Recording Button
14. Flight Mode Switch
15. Shutter Button
16. Playback Button
17. C1/C2 Buttons (Customizable)
18. USB Port
19. Micro-USB Port





12. Telemetry

Telemetry is the automatic transmission and measurement of the data coming from the SUA to the display unit. This is vital information that must not be ignored while flying. As a UAS Pilot it's impossible to get a feeling from what the aircraft is doing in the air, how it is reacting. Telemetry will give you this capability. Reading telemetry must be done in a systematic manner over and over while the UAS is in the air. It is also important that you don't get fixated on the telemetry, a happy balance between the actual aircraft flying and the telemetry is a must which will come with experience. During flight, if you think something is going wrong, do not make any harsh decisions check and check again with the telemetry, a quick two second look on your display will make your decision clearer.

Most Remote Controllers at present have a built-in screen with a android operating system. This set up is better than attaching your phone to the Remote Controller and operating a Drone, as we have now all come very custom to our Mobile phone that when a call comes in we will always try to answer it. This is not good practice when operating a Drone.

There are still Remote Controllers that have the ability to house the likes of your Mobile Phone or an iPad/Tablet. We are slowing moving away form these.

13. Irish Airspace/Rules of the Air

- No person whose function is critical to the safety of aviation, shall undertake that function while under the influence of any psychoactive substance by reason of which human performance is impaired.
  NO DRUGS!
- No person or article shall be dropped from an aircraft in flight that might create a hazard to that person, other persons or property.
- Aircraft shall not be flown in airspace designated as a prohibited area or airspace in which there are flight restrictions, the particulars of which have been duly notified by the authority, except in accordance with the conditions of the restrictions or by permission of the Authority. EIP 11 Phoenix Park - EIP 18 Mountjoy Prison
- The Authority may impose such restrictions as may be prescribed on the flying of aircraft over or in the vicinity of any district or place within the state and aircraft shall not fly in contravention of any such restrictions.
- The authority may prescribe danger areas of airspace within which the safety of aircraft cannot be assured. EID 1 Gormanston - EID 6 Glen of Immal.

13.1. Classification of Airspace

Class A: Instrument Flight Rules (IFR) flights only are permitted; all flights are subject to air traffic control service and are separated from each other.
Class B: IFR and Visual Flight Rules (VFR) flights are permitted, all flights are subject to air traffic control service and are separated from each other.
Class C: IFR and VFR flights are permitted, all flights are subject to air traffic control service and IFR flights are separated from other IFR flights and from VFR flights. VFR flights are separated from IFR flights and receive traffic information in respect of other VFR flights.
Class D: IFR and VFR flights are permitted, and all flights are subject to air traffic control service. IFR flights are separated from other IFR flights and receive traffic information in respect of VFR flights. VFR flights receive traffic information in respect of all other flights.
Class E: IFR and VFR flights are permitted, IFR flights are subject to air traffic control service and are separated from other IFR flights. All flights receive traffic information as far as is practical.
Class F: IFR and VFR flights are permitted, all participating IFR flights receive an air traffic advisory service and all flights receive flight information service if requested.
Class G: IFR and VFR flights are permitted and receive flight information service if requested.

- UAS do not have an automatic right to airspace use. UAS operators should recognise the expectations of other airspace users. UAS operators must ensure that their aircraft can demonstrate an equivalent level of compliance with the rules and procedures that apply to manned aircraft E.g. Operations Manual.
- The UAS must be able to comply with instructions from the ATC provider and with equipment requirements applicable to the class of airspace within which they intend to operate.
- On first contact with the ATC provider the operator must ensure that air traffic controllers are fully aware that they are dealing with a UAS flight.
- Where “special provisions” are made with the associated ATC unit, it is essential that these do not reduce the situational awareness of other airspace users.
- Accidents / Serious Incidents involving the operation of a UAS are to be reported to the Air Accident Investigation Unit of the Department of Transport, Tourism and Sport and to the Flight Operations Department of the IAA.

- Incidents are to be reported to the Flight Operations Department of the IAA.
- Irish aviation legislation is designed to enable the safe and efficient operation of manned aircraft in all classes of airspace, UAS operators must operate within the same regulatory framework.
- It is IAA policy that UAS operations in Ireland must meet at least the same safety and operational standards as manned aircraft. Therefore, UAS operations must be as safe as manned aircraft insofar as they must not present or create a greater hazard to persons, property, vehicles or vessels, whilst in the air or on the ground, than those attributable to the operation of manned aircraft.
- In Ireland, the only specific legislation governing Drone Operations is that of EU rules and regulations 2019/947 & 2019/945 Additionally, Aeronautical Notice U04 sets out the requirement for an operators who want to operate in controlled airspace under the Open Category. These areas are now called Geographical Zones.

Military Airspace is broken down into two separate classifications Restricted Airspace (Class C & Class G) & Military Operating Areas

- EIR15 - Baldonnell, and surroundings areas (Check Aircharts for its exact location and shape)
- EIR16 - Starts At 1000ft AMSL
- EIR22 - Finner Army Camp
- EIR23 - Casement Aerodrome this is inside EIR15
- Military Operating Areas -mark on Irish Air Charts, you enter these at your own risk and VFR apply.

Prohibited & Danger Airspace: There are five Prohibited that are defined as a NO-FLY ZONE. It is forbidden for you as a UAS operator to be flying inside these airspaces.

- EIP8 - Portlaoise Prison, Co Laois *(your UAS could be shot down by Defence Forces personnel)*
- EIP9 - Limerick City Prison, Co Limerick
- EIP10 - Defence Forces Training Centre & Part of the Curragh Plains, Co Kildare
- EIP11 - Áras an Uachtaráin, Phoenix Park, Dublin, Co Dublin
- EIP18 - Mountjoy Prison

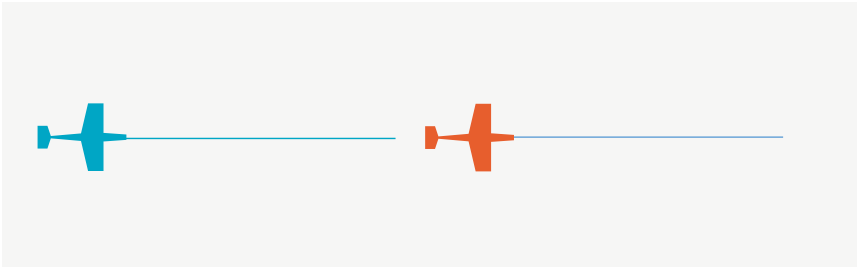
Five DANGER AREAS: You can enter only when they are not active.

- EID1- Gormanston, Co Meath
- EID5 - Glen of Imaal, Co Wicklow
- EID6 - Kilworth, Co Cork
- EID13 - Naval Training Area At sea, Southwest of Cork
- EID14 - Naval Training Area At sea, Southwest of Kerry

13.2. Rules of the Air.

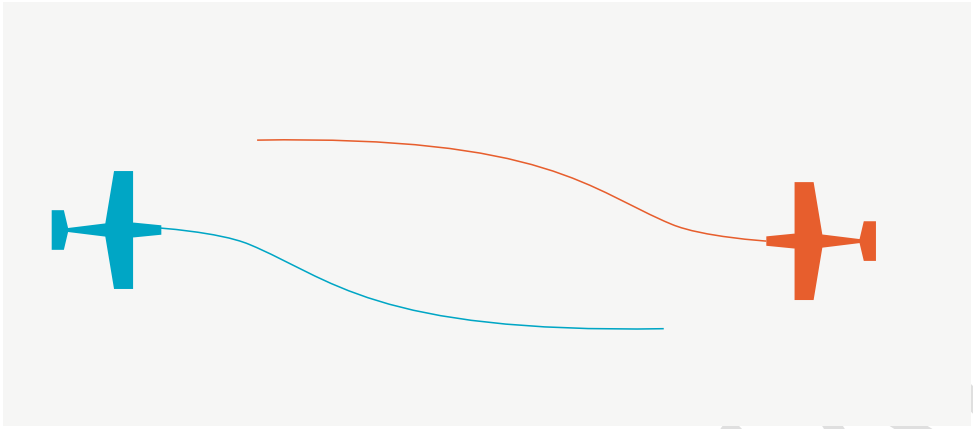
Proximity of aircraft

Do not intentionally fly close to other aircraft so as to cause a collision hazard. There must be “Air Separation” between you another Aircraft whether it be Manned or Unmanned.

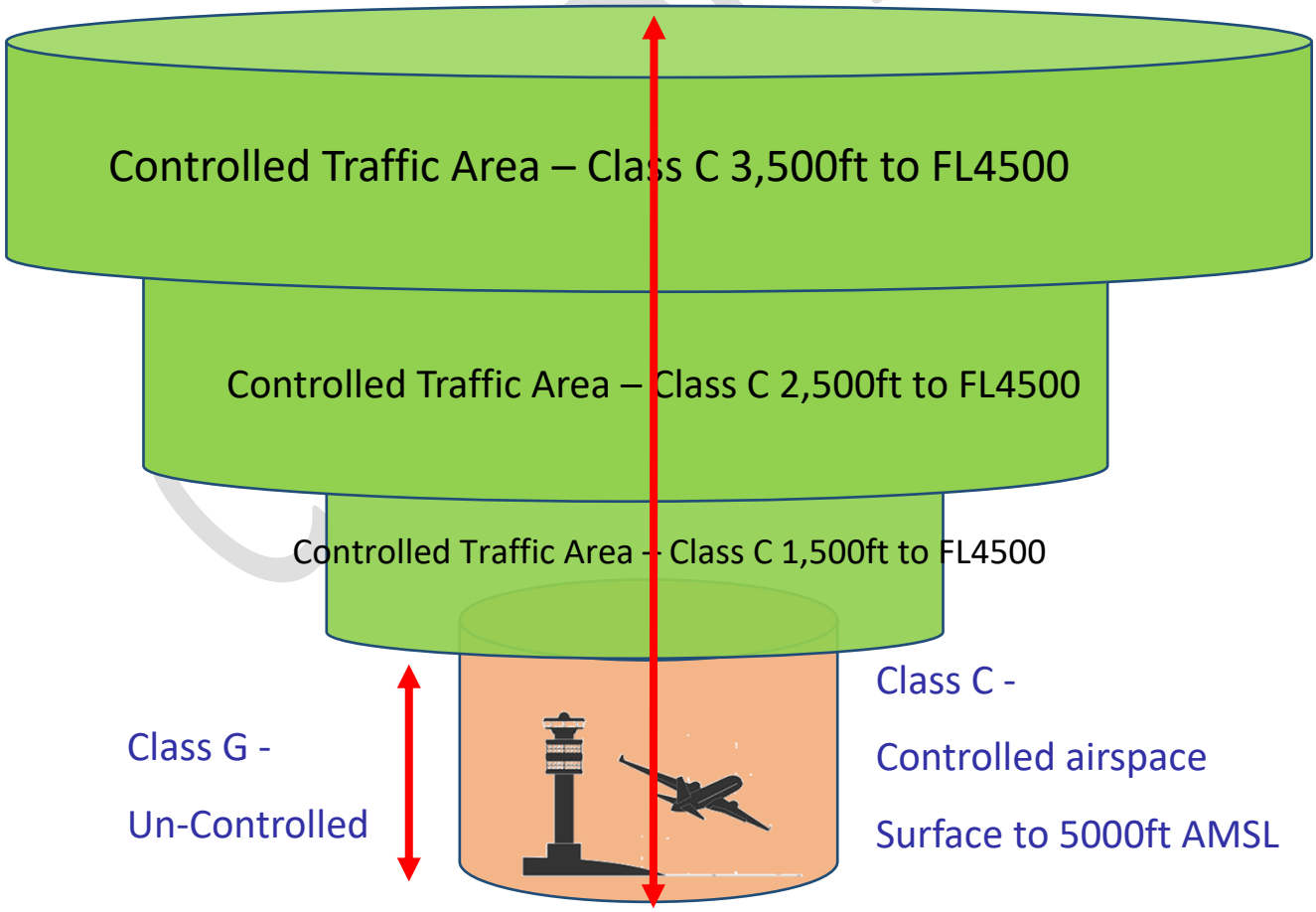


Rights of way in the air

If approaching another aircraft head on, such that there is a risk of collision, both aircraft shall turn right to avoid each other.



Converging. When two aircraft are converging at approximately the same altitude, the aircraft that has the other on its right shall give way, except as follows: Powered, heavier-than-air, aircraft (for example aeroplanes or helicopters), must give way to airships, gliders, and balloons.
Airships must give way to gliders and balloons.
Gliders must give way to balloons; and Powered aircraft must give way to aircraft that are towing other aircraft or objects. Drones Must Give way to Powered aircraft.



13.1. Aeronautical Notice U04 – Geographical Zones.

The Member State is responsible for defining the airspace structures in accordance with Regulation (EU) 2017/373; in addition, as required in **Article 15 of the UAS Regulation**, the Member State will define the geographical zones for UAS operators. The Member State, when defining the airspace structure, considers the traffic type and complexity and defines the airspace classes and services being provided in accordance with the SERA. This information, which can be published either in the aeronautical information publication (AIP) or any other aeronautical publication, can be used by the UAS operator to identify the initial air risk.

In relation to Geographical Zones according to Article 18 section F, the IAA will have to

> *"making available in a common unique digital format information on UAS geographical zones identified by the Member States and established within the national airspace of its State;"*

Article 15 - Operational conditions for UAS geographical zones Regulation (EU) 2020/639

1. When defining UAS geographical zones for safety, security, privacy or environmental reasons, Member States may:

   (a) prohibit certain or all UAS operations, request particular conditions for certain or all UAS operations or require a prior flight authorisation for certain or all UAS operations.

   (b) subject UAS operations to specified environmental standards.

   (c) allow access to certain UAS classes only.

   (d) allow access only to UAS equipped with certain technical features, in particular remote identification systems or geo awareness systems.

2. On the basis of a risk assessment carried out by the competent authority, Member States may designate certain geographical zones in which UAS operations are exempt from one or more of the 'open' category requirements

3. When pursuant to paragraphs 1 or 2 Member States define UAS geographical zones, for geo awareness purposes they shall ensure that the information on the UAS geographical zones, including their period of validity, is made publicly available in a common unique digital format

UAS Geographical Zones - Click on this link to bring you to the Aeronautical Notice on the IAA website.

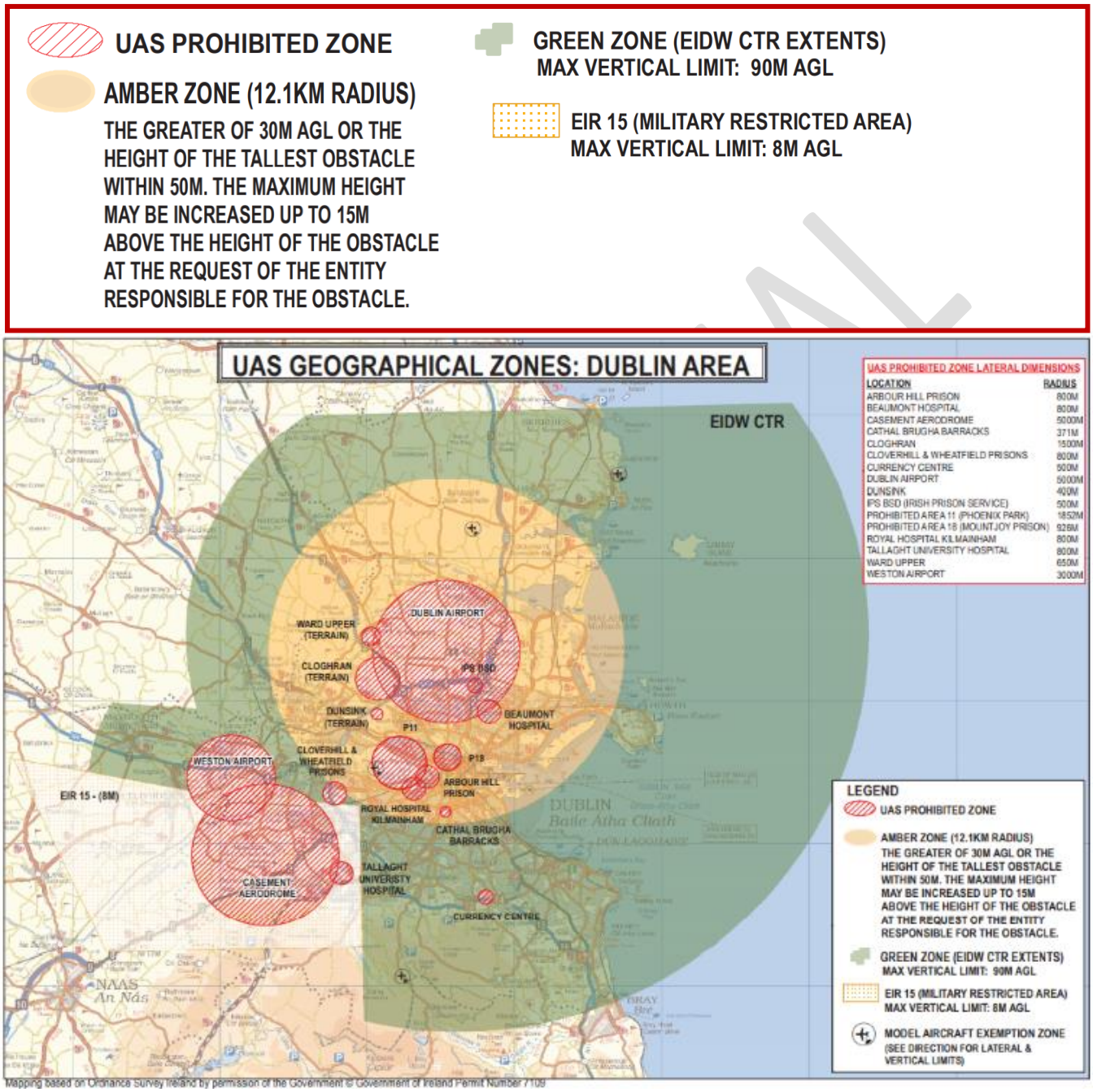
The Irish Aviation Authority are known as the Competent Authority and the Drone Training Schools are known as Recognised Entity.

Be mindful that this Geographical Zone Notice can be updated at any time so from time to time it is important to check the IAA website for any updated version. Here is the current version of this Geographical Zones U04 version 18. Regularly go to the IAA website to check for updated versions.

Irish Aviation Authority The Times Building 11-12 D'Olier Street Dublin 2, Ireland www.iaa.ie **Safety Regulation Division**	**Údarás Eitlíochta na hÉireann** Foirgneamh na hAmanna 11-12 Sráid D'Olier Baile Átha Cliath 2, Éire **Rannán na Rialachán Sábháilteachta**	**AERONAUTICAL NOTICE** NO. U.04 ISSUE 18 DATE 01.06.21	IAA

Below is an example of how Dublin CTR is broken up for some Drone operations under the Open Category. The other CTR's will soon have the same level in the next versions of the U04 – Geographical Zones.

The following Legend explains the parameters of the Zones.



UAS Geographical Zone ID: a unique reference alphanumerical association assigned to each UAS geographical zone, the boundary of which is defined by co-ordinates and data in Appendix 1 e.g. EIU1.
Top AMSL (FT): Maximum vertical extent of an area of airspace above mean sea level in feet.
Top AGL (FT): Maximum vertical extent of an area of airspace above ground level in feet.
Max UAS Height (FT AGL): Maximum allowable height for UAS aircraft operating above ground level in feet.
Base: Minimum vertical level of an area of airspace.
UAS Geographical Zone - Area Dataset: a name attributed to a collection of data defining the boundaries of UAS geographical organisation components as described in the dataset interpretive material in Appendix 1.
Note: Where an Area Dataset already exists defining a portion of airspace this is listed in Appendix 2 with reference to the specific legislation containing same.

14. EU Rules and Regulations 2021 Open Category.

Article 4 of the EASA Rules and Regulations explains and outlines Drone Operations in the Open Category:

(a) the UAS belongs to one of the classes set out in Delegated Regulation (EU) 2019/945 or is privately built or meets the conditions defined in Article 20;
(b) the unmanned aircraft has a maximum take-off mass of less than 25 kg;
(c) the remote pilot ensures that the unmanned aircraft is kept at a safe distance from people and that it is not flown over assemblies of people;
(d) the remote pilot keeps the unmanned aircraft in VLOS at all times except when flying in follow-me mode or when using an unmanned aircraft observer as specified in Part A of the Annex;
(e) during flight, the unmanned aircraft is maintained within 120 metres from the closest point of the surface of the earth, except when overflying an obstacle, as specified in Part A of the Annex
(f) during flight, the unmanned aircraft does not carry dangerous goods and does not drop any material;

UAS operations in the 'open' category shall be divided in three sub-categories in accordance with the requirements set out in Part A of the Annex.

A1 – Open Subcategory

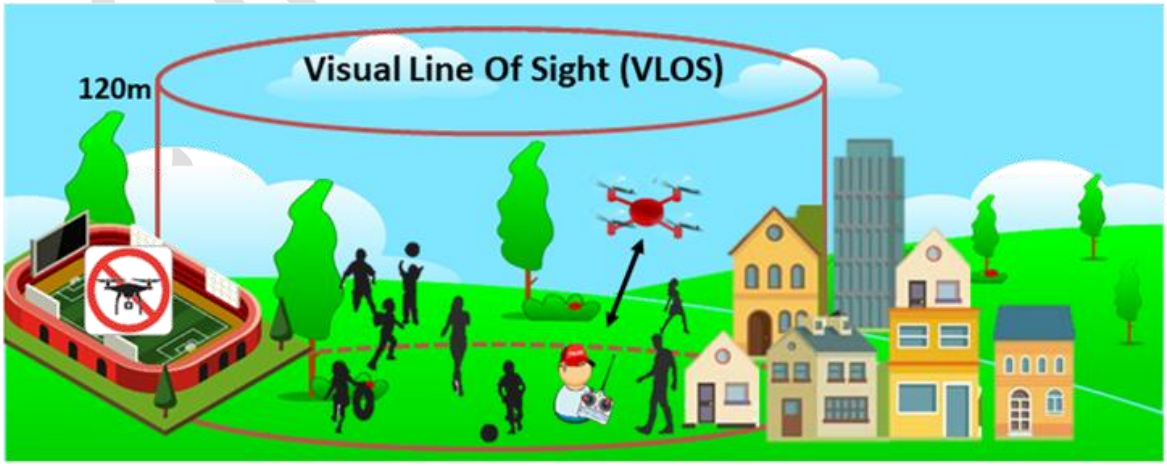
A2 – Open Subcategory

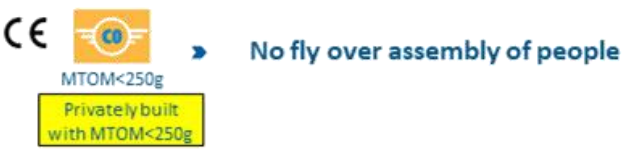
A3 – Open Subcategory

14.1. A1 – Open Subcategory - fly over people but not over assemblies of people..

Drone Weight less than 250grams or 900grams with Energy Transmitted of ≤80 joules. The limit of 900grams is a drone with the CE C1 Marking.

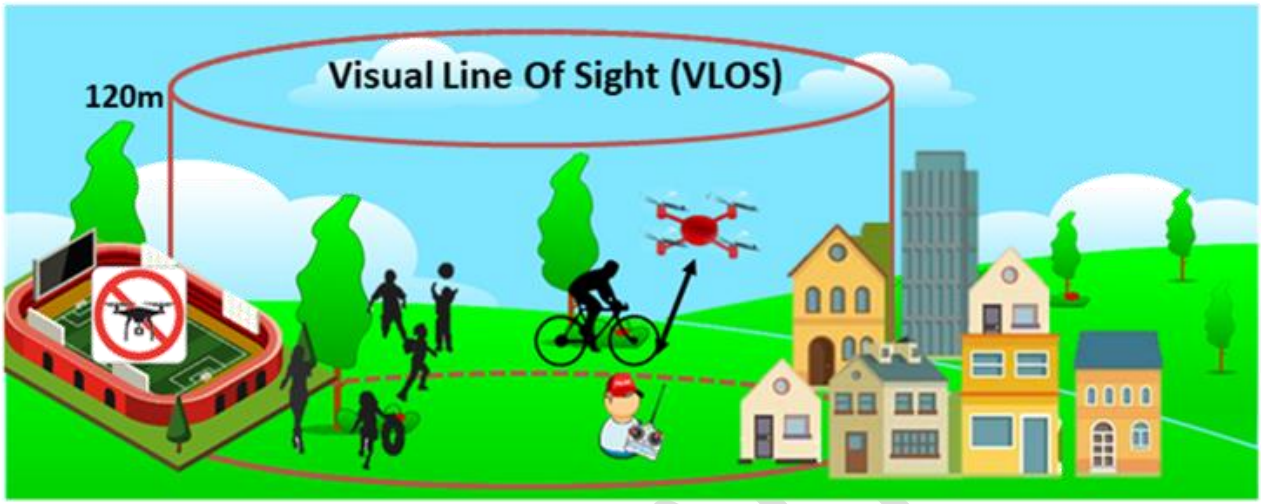
- Maximum flight speed can be no more than 19m/s
- No Flying above 120meters AGL.
- No Flying over assemblies of People
- Maintain Visual Line of Sight with your Drone. (Safely).
- Check Airspace where you can and cant fly. No Mention if Open Category can fly inside Controlled Airspace. This will be reviewed by the IAA.
- You Can fly over uninvolved Persons but only for a short period of time.
- Will not carry any dangerous goods and will not drop any material.





The Drone Type with the Following CE markings can only fly in this Category are as Follows.

- C0 With Camera
- C0 Without Camera
- C0 Toy
- C1



CE C1 MTOM<900g

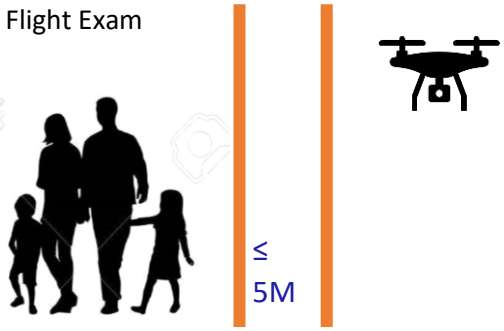
- **No fly over assembly of people**
- reasonably expect that no uninvolved person is overflown. In case of unexpected overfly over uninvolved persons, the remote pilot shall reduce as much as possible the time during which the unmanned aircraft overflies those persons

14.2. A2 – Open Subcategory - fly close to people.

Sub-Category A2

Allows you to fly close to people

- Operations in subcategory A2 can only be conducted with a drone that is compliant with a specific product standard, but this drone can be flown to a minimum safe horizontal distance of 30 meters from uninvolved people, or down to 5 meters horizontally when its low-speed mode is selected.
- The remote pilot must have successfully completed and additional competency examination in order to operate in this subcategory with one of the DUTO's (Declared UAS Training Organisation) online courses, a written Exam with pass mark of 75% & Practical Flight Exam
- Weight of the Drone ≤4 kg
- Fitted with e-ID & Geo Awareness
- Low Speed Mode Required
- Risk Assessment to include
- Weather Conditions
- Performance of the Drone
- Segregation of the overflown area



At Present all drones are known as legacy drones and you can fly under the A2 Subcategory of the Open Category, but you must have a minimum Horizontal distance of **50meters** from persons. The maximum weight for a legacy Drone in this category is **2kg**. This will change when the CE markings comes into effect on 1st January 2023.

14.3. A3 – Open Subcategory - fly far from people.

Sub-Category A3

- A3 Fly Far from People
- Covers the more general types of drone operations. The intent is that the drone will only be flown areas that are clear of uninvolved persons and will not be flown in areas that are used for residential, commercial, industrial or recreational purposes.

14.4. Registration in MySRS

Under the new EASA Rules it states that your drone must be registered with the Irish Aviation Authority. Drones that are not classed as a toy and have a mass take-off weight of ≤250grams but are equipped with a sensor able to capture personal data, shall be registered. You don't register your Drone you are going to be registering yourself as a pilot through the Irish Aviation Authority website, IAA.MySRS.ie No matter how many Drones you own this number should be displayed on all of them.

YOU must register in the Member state that you are residence or your main place of Business.

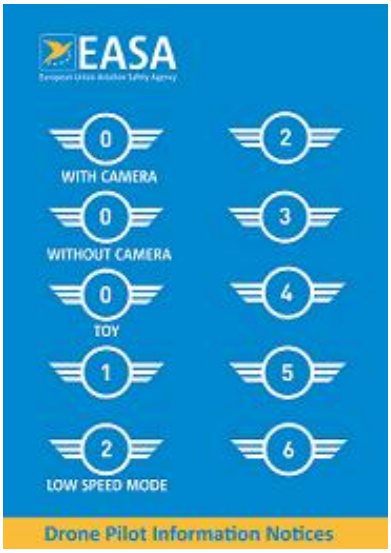
You cannot register twice. E.g in two different EU countries.

https://iaa.mysrs.ie/ here is the link to the website.

14.5. CE Marking on Drones.

At present the manufacturers of Drones have until 2023 before they place any CE markings on Drones that are sold within the European Market. If your Drone does not have a CE marking it will be known as a 'Legacy Drone'. Legacy Drones right now have a place in Drone Operations. Each of the Categories have a Maximum weight restriction associated to it. After January 2023 the CE Markings will be broken up into Classes.

C0 - With Camera, Toy & Without Camera.	*(A1 Subcategory)*
C1,	(A1 Subcategory)
C2 & C2 Low Speed,	(A2 Subcategory)
C3,	(A3 Subcategory)
C4,	(A3 Subcategory)
C5,	(Specific Category - VLOS)
C6,	(Specific Category - BVLOS)



Weights for Drone categories

A1 – less than 250grams no more than 500grams

A2 – Less than 2kg (Without a CE Marking – 4 Kg with one)

A3 – Less than 25kg

Specific Category – less than 25kg

15. Risk Assessment

The UAS SOP holder (or representative) acknowledges the limitations as detailed in **2019/947 & 2019/945** and have mitigated to an equivalent level of safety where necessary. The UAS SOP holder is responsible for all aspects of the UAS flight operations proposed herein (This is statement that is part of the U.F 101 application for permission to fly in Controlled Airspace). The risk assessment starts at the planning phase and continues through the whole job / project, it never stops.

		Likelihood				
Consequence		1. Rare	2. Unlikely	3. possible	4. Likely	5. Almost certain
	1. insignificant	Low	Low	Low	Low	Low
	2. Minor	Low	Low	Low	Medium	Medium
	3. Moderate	Low	Low	Medium	Medium	Medium
	4. Major	Low	Medium	Medium	High	High
	5. Extreme	Low	Medium	Medium	High	Extreme

The traffic light systems are the preferred method to be used, an example is seen above:

What you create in your risk assessment you must reflect that in your method statement. The risk assessment is the safe planning and the method statement is how you conduct the plan from start to finish. That includes from the time you leave the office until the time you land back and put the data on to your computer.
The main phase that you should use when writing up your risk assessment is 'What If?'.

Use whatever programs or tools you have, to get a very good understanding of the ground you are going to fly in. Check to see how old the data is on google earth check to see how old the maps you are using, if you can conduct a recce on the area before you go to fly. This can be conducted on the same day that you intend to fly but do allow enough time to it. Risk assessments & method statements can be updated at any time.
It is a legal requirement to have a risk assessment for every job you under take.

Example of a Risk Assessment Form:

Risk Assessment Form											
Site Location:							**Job Number:**				
Flight Operation:							Job Date:				
Flight Team	Pilot-In-Command:						Observer:				
	Payload Operator:						Aircraft:				
1.Hazard (Something with the potential to cause harm, how will it be realised and what is the potential injury?)	2.Risk	3. Existing Control Measures	RISK 4. Severity	RISK 5. Porbility	RISK 6.Risk	7.Further Control measures	RISK 4. Severity	RISK 5. Porbility	RISK 6.Risk		
Further Actions (Further control measures which could be implemented at the planning stage to improve safety)											
Additional Comments (Actions identified by personnel on-site, to make the operation safer)											
Authorised by Accountable Manager	Name: (Print)		Signature:								

At Risk.	Severity (Column 4 & 8)		Probability (Column 5 and 9)		RISK RATING (Columns 6, 8 and 10)
E - Employees	1	No injury, property damage	1	Extremely unlikely	Severity X Probability - 1 to 5 MIN Y - Acceptable Risk
C - Client	2	Minor injury	2	Remote possibility	Severity X Probability - 5 TO 10 LOW Y - Acceptable Risk
V - Visitors	3	Reportable injury	3	Will possibly occur	Severity X Probability - 12 TO 15 MED? - Needs further consideration
P - Public	4	Major injury or fatalities	4	Will possibly occur	Severity X Probability - 16 TO 20 HIGH N - Unacceptable Risk
A - All			5	Almost certain	

16. Method Statement

A method statement is written by you and it is in conjunction with your risk assessment. The method statement is your plan of action from the moment you leave your office to how you conduct yourself on site and get back to the office with the data. It is a very detailed plan, which is also flexible enough for change to happen at any given moment.

Example of a Method Statement:

Method Statement

Date: 05/10/2016
Reference Number:
Created by: *"pilots-name"*

A. Work Scope

"Company name" project ''. (Orthophotography)
This will be flown over the proposed 1km of N101 national roadway for topographic imagery capture and data collection. Orthophotography imagery for the entire 1km national roadway project including surrounding buildings and agricultural land.

B. Time Scale

Date of job:25/10/2016Days (No):1Start Time:0800hrFinish Time: 1800hr
Date of job:26/10/2016Days (No):1Start Time:0800hrFinish Time: 1800hr
Date of job:27/10/2016Days (No):1Start Time:0800hrFinish Time: 1800hr

C. Logistics

All equipment and personal will arrive on the day.
"pilots-name" will be using a van to transport the equipment.
"pilots-name" will be the primary contact for the logistics of this job.

All data of this location will be checked and uploaded to *"Company Name"* head office and ensure all data is received. Once the job is finished the equipment and all persons will move on to the next location on the movement List.

D. Attendance

Name: *"pilots name* "Contact No:086XXXXXX
Email: XXXXXX@Companyemail.ie
Name: *"Observers-name"* Contact No:086-XXXXXX
Email: XXXXXX@Companyemail.ie

E. Equipment

1x UAV system – *"UAS type and model"*;
All Equipment for this system will be controlled by ***"pilots-name"***
1x Company Car
1x GPS & Rover
x Ground Control Markers
1x Communications Device (Mobile Phone)
1x USB internet dongle
1x Laptop/Tablet

F. PPE (Personal Protective Equipment)

High Visibility Jacket / vest
Steel toe Boots
Protection Eye Glasses
Hard Hat
Protective gloves

G. Operating Method

This UASs (Small Unmanned Aircraft Systems) method statement forms the procedure for Inspection & Survey demonstrations and/or projects for prospective customers/events and/or workshops. ***"Company name"*** *developed and approved UASs SOP's (Standard Operating Procedures) will be used.*

1. Before any flights are to be conducted a discussion between all involved parties takes place to ensure all hazards & risks are understood using the risk assessment generated (includes changes i.e. weather)
2. The UASs method statement is used to show how the operation of the system will take place this (includes flight planning).
3. Only ***"Company name"*** approved RP's (Remote Pilots) can conduct any flying tasks.
4. An OB (Observer) will be present at all times.
5. All equipment is check prior to travel and on arrival at the proposed flying site.
6. Clear communication between the OB / RP and Customer to ensure safe understanding of the task.

Communication;

Mobile phone communication between all relevant agencies (e.g. Police) if applicable. If other agencies are needed to be informed, then communication will be conducted prior to arrival on site. Verbal communication
between the OB and Customer (any personnel involved).

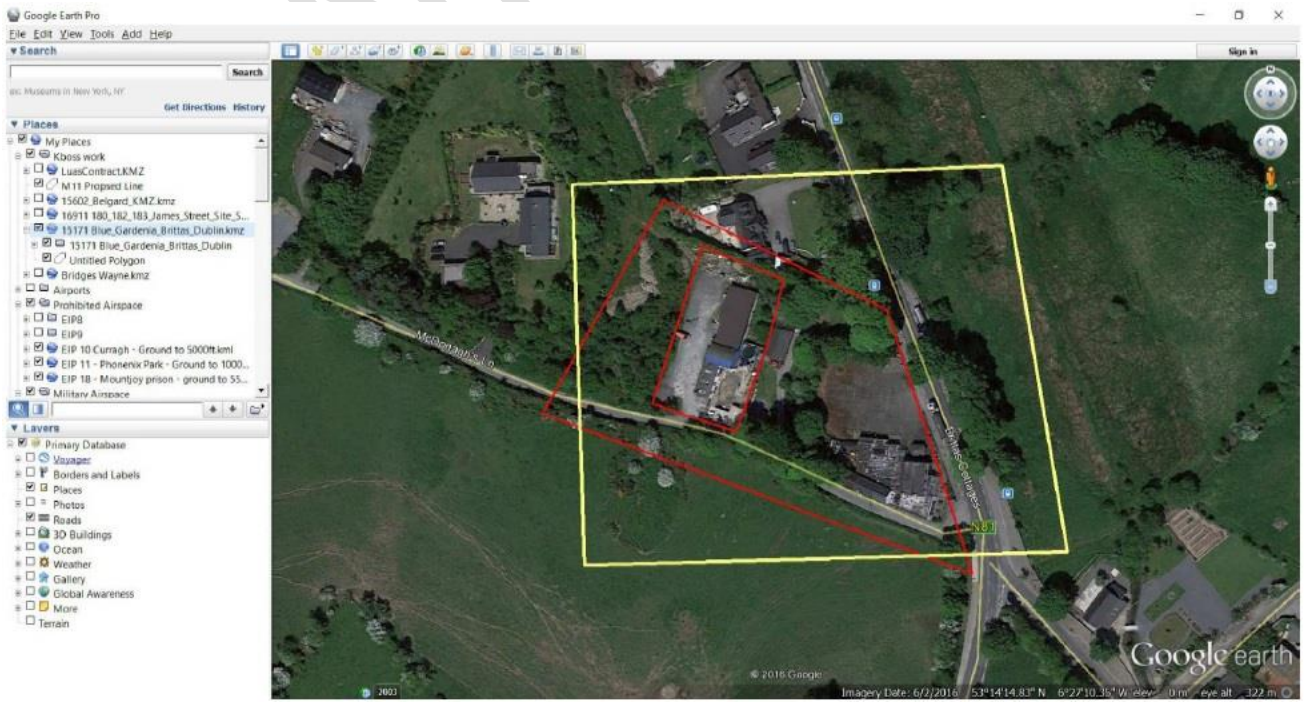
GoalThe method statement's goal is to ensure that all parties involved understand the breakdown of the task step-by-step and to define other additional control measures. This document is generated for every demonstration and / or project unless;
1. The demonstration / project has been flown within a 6month period, a dynamic risk assessment must still be conducted on site prior to flight to identify any changes.
2. The site is used regularly for UASs training purposes.

Pre-Op Flight Team;
A pre-site assessment is generated prior to any task utilising various other map facilities (i.e. Google / Bing). The RP then generates a flight plan (Survey) and detail step by step (Survey & Inspection) on how the task will
be conducted then placed into the Method Statement.

Survey Team:
The ground Control points/Markers will be placed 24hours prior to the flight being conducted. The RP will liaise with the Survey Dept as to when and where the flights will be conducted.

Precautions:
The RP Monitors the weather conditions and environment every day for 5 days prior to the task. The RP will inform 72hrs in advance relevant parties on weather changes thus meaning any changes can be made. The RP has full authority and responsibility of the system and if he deems the flight to be unsafe will not conduct the task. The RP will be UAV site manager for the duration of time on the ground. Observer will inform the RP of any site changes during the time on the ground.
Personal Documents Required:
IAA certification and flight log book.

H. Method of Operation
Flight Plan; *"using Google Earth Place Screenshots of your Area and your intended Flight Plan"* Operation.



The flight will be conducted by a competent Remote Pilot from ***"Company name"***. The operation will be utilising a 2 man team which consists of;

- 1 x Remote Pilot
- 1 x Observer

Outside the Flight team

- 1 x Surveyor

The OBs during the flight will securing the safe area and assisting the remote pilot by checking the environment constantly. If anything changes and has safety implications to the safety of the flight, the OBs will communicate back to the RP and the RP will land the system ASAP. The Surveyor will be there to record GCP's laid out before the flights commence. He will have no part in flying the aircraft. If he notices or hears another aircraft in the airspace he will notify the OBs.

Hazard Distances:

- A = "List hazards here and distance from hazards"
- B =

Please note all of these distances are estimates from google earth.

We are working in ***"Say what type of Airspace it is"***, we will ring ATC and ATC to find out if any VFR flights are schedule in or out of ***"NAME"*** airport.

The flights will commence early morning approx. 0800hrs and signs will be placed on three sides ***"Company name"*** van. All "***Company name"*** staff will be wearing Hi-Vis clothing. Hazards lights will only be used when stationary. Rules of the road will be followed by the driver of ***"Company name"*** van. Orange traffic cones will be placed to mark landing and take-off area. The RP will conduct the following;

1. Update flight plan if required.
2. Upload flight plan to the system.
3. Prepare the system for take-off.
4. Check environment once system is ready, ensuring the observer is ready.
5. Ensure all persons are at a safe distance from the take-off site.
6. Launch the system maintain an altitude of 15m AGL and preform a functions test, once complete start flight plan at the determent AGL Height from Planning Software.
7. Through-out flight the observer will be constantly looking at the environment and remote pilot is to ensure the system is safe at all times.
8. Once flight plan is complete prepare the system for landing, ensure all persons are in a safe area, check environment and land system.
9. Conduct post-flight checks.
10. Geotag all imagery and pack system away.
11. Ensure PoC of ***"Company name"*** cleans site area of any rubbish.

Flight time: Approx. 10 min per flight
No of Flights: 20

Flt info: 20x Flight to Fly at AGL height determinant from planner software. Flight will gather all the data required that has been requested by the client.

Note: Once the flight is complete the UAS team will ensure all data has been collected as per the scope above.

I. Housekeeping

"Company name" will ensure upon departure of the site all rubbish is to be removed and the area to be left the same way it was found. Confirm with site escort / land owner that he / she is happy with the site before we leave.

J. Incidents/Accidents

If an incident or accident occurs ***"Company name"*** will conduct PCM (Post Crash Management) procedure. The PoC will be in touch with ***"Company name"*** head office. He will then complete the PCM form ensuring that all details are filled out. Statements will be required from parties on site. It is our highest priority to ensure
the safety of all parties involved.

K. Other Information, Attachments Documents

1. Pre-Auth form, ref: *"state if U.F 101 is required Here"*

1. Risk Assessment, ref: *"enter in risk assessment ref number here"*

Created by: *"pilots-name"* Read/Approved by: *Director Name*

Position: *Chief Remote Pilot* Position: *Director of "Companyname"*

Date: 02/09/2016 Date: 02/09/2016

Signed: Signed:

Party name:

Position:

Date:

Signed:

- You can use your own method statement this is just an example of one.
- You can request the method statement to be signed by the client and sent back to you for your records.

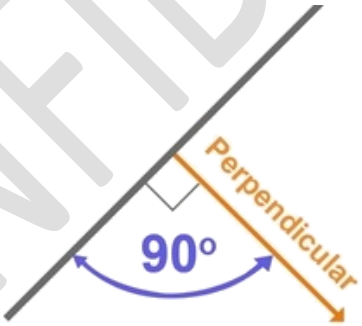
17. Aerodynamics

Lift Trust Weight Drag the four forces involved in Aerodynamics.

- Lift opposes the Weight.
- Thrust opposes the Drag.
- Lift & Drag are aerodynamic forces.
- Thrust & Weight are not aerodynamic forces!

Pressure (symbol: P) is the force per unit area applied on a surface in a direction perpendicular to that surface.

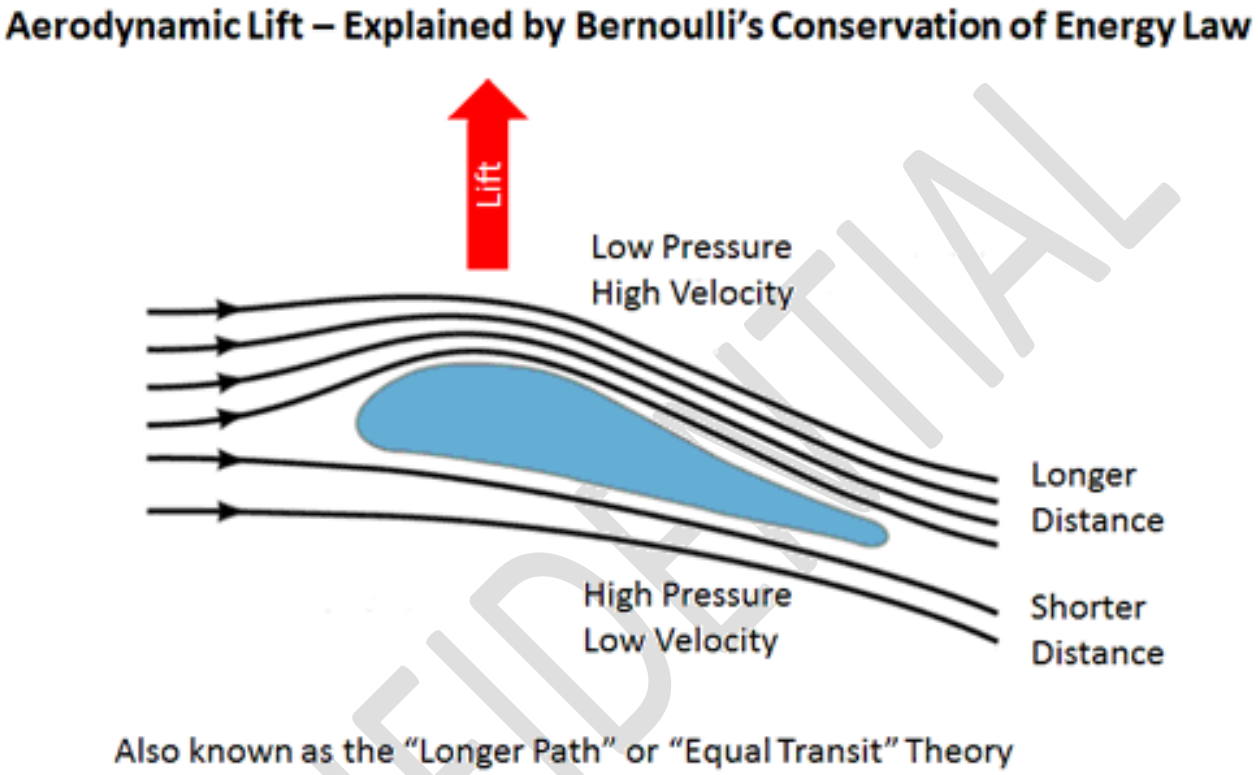
- Mathematically: P = F/A



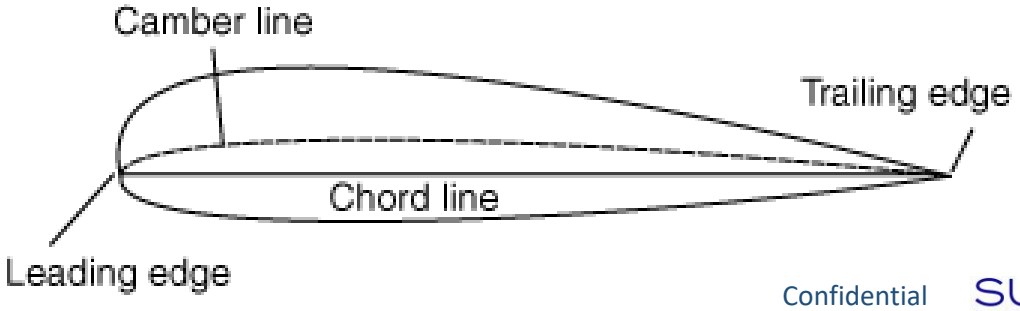
- Static Pressure – Air pressure perpendicular to the wing surface.
- Dynamic Pressure – Air pressure parallel to the wing surface.
- Bernoulli's equation states, it is a case of the first Law of Thermodynamics:
  - Energy cannot be created or destroyed. However, energy can be converted from one form into another.

- The two forms of energy we see around the wing / airplane are:
  - Static Pressure / static energy.
- Dynamic Pressure / dynamic energy.
- Static Pressure + Dynamic Pressure = Total Pressure Ps + Pd = Pt
- Lift is needed to overcome the weight of the airplane.
- Lift is created by using Bernoulli's law:

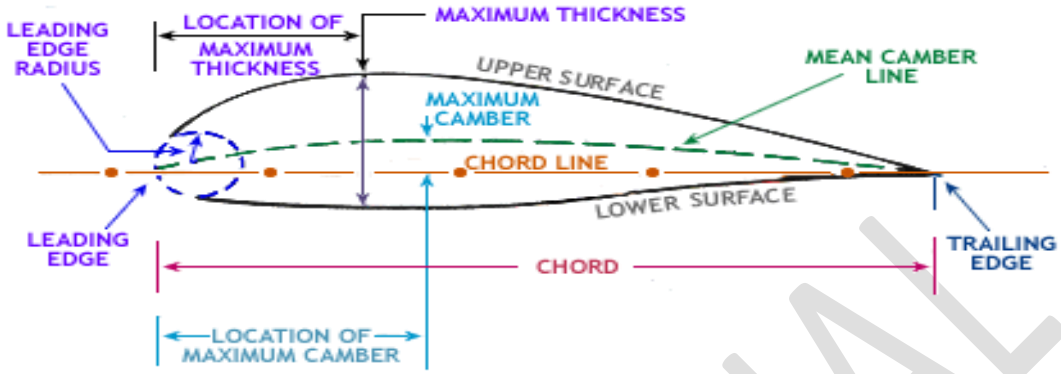
- When air flows around the wing.
- The air above the wing accelerates thus creating high dynamic pressure and as a result creates low static pressure.
- The air below the wing maintain its speed thus the pressures are not changing. Due to static pressure differences between the two sides of the wing - a force is created that pushes the wing towards up. The force is called “Lift”.



- The airfoils are different in many parameters:
  - Cambers - upper / lower, thus affects the mean camber line (the shape of the airfoil).
- Thickness - the maximum distance between the upper camber & lower camber.
- Length of the chord line.
- All aerodynamic characteristics of the wing are affected by the shape of the airfoil.
- Each airfoil is being tested in a wind tunnel to determine its characteristics.
- Airfoil terms:
  - Leading edge / trailing edge.
  - Chord line.



Camber line - Upper / Mean / Lower

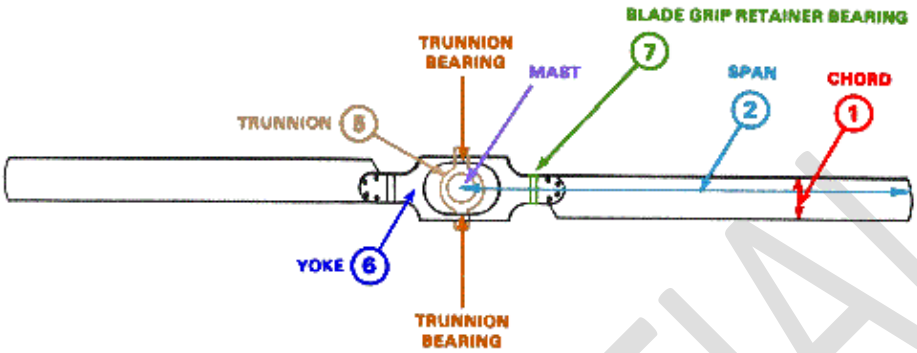


- The *chord line* is a straight line connecting the leading and trailing edges of the airfoil.
- The *chord* is the length of the chord line from leading edge to trailing edge and is the characteristic longitudinal dimension of the airfoil.
- The *mean camber line* is a line drawn halfway between the upper and lower surfaces. The chord line connects the ends of the mean camber line.
- The shape of the mean camber is important in determining the aerodynamic characteristics of an airfoil section. *Maximum camber* (displacement of the mean camber line from the chord line) and the location of maximum camber help to define the shape of the mean camber line. These quantities are expressed as fractions or percentages of the basic chord dimension.
- Thickness and thickness distribution of the profile are important properties of an airfoil section. The *maximum thickness* and its *location* help define the airfoil shape and are expressed as a percentage of the chord.
- The *leading-edge radius* of the airfoil is the radius of curvature given the leading-edge shape.

17.1. Rotary Section Components

- The chord is the longitudinal dimension of an airfoil section, measured from the leading edge to the trailing edge.
- The span is the length of the rotor blade from the point of rotation to the tip of the blade.
- The vertical hinge pin (drag hinge) is the axis which permits fore and aft blade movement independent of the other blades in the system.
- The horizontal hinge pin is the axis which permits up and down movement of the blade independent of the other blades in the system.
- The trunnion is splined to the mast and has two bearings through which it is secured to the yoke. The blades are mounted to the yoke and are free to teeter (flap) around the trunnion bearings.
- The yoke is the structural member to which the blades are attached, and which fastens the rotor blades to the mast through the trunnion and trunnion bearings.
- The blade grip retainer bearing is the bearing which permits rotation of the blade about its spanwise axis, so blade pitch can be changed (blade feathering).

- Blade Twist is a characteristic built into the rotor blade, so angle of incidence is less near the tip than at the root. Blade twist helps distribute the lift evenly along the blade by an increased angle of incidence near the root where blade speed is slower. Outboard portions of the blade that travel faster normally have lower angles of incidence, so less lift is concentrated near the blade tip.



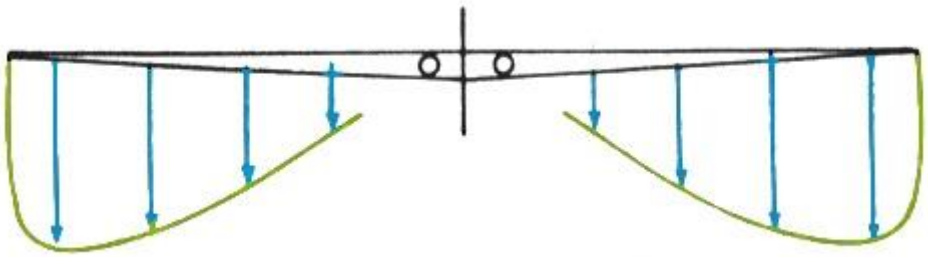
17.2. Rotary Drag

- Drag is the force that opposes the motion of an aircraft through the air. Total drag produced by an aircraft is the sum of the Profile drag, Induced drag, and Parasite drag.
- Total drag is primarily a function of airspeed. The airspeed that produces the lowest total drag normally determines the aircraft best-rate-of-climb speed, minimum rate-of-descent speed for autorotation, and maximum endurance speed.
- Profile drag is the drag incurred from frictional resistance of the blades passing through the air. It does not change significantly with angle of attack of the airfoil section but increases moderately as airspeed increases.
- Induced drag is the drag incurred as a result of production of lift. Higher angles of attack which produce more lift also produce increased induced drag. In rotary-wing aircraft induced drag decreases with increased aircraft airspeed. The induced drag is the portion of the total aerodynamic force which is oriented in the direction opposing the movement of the airfoil. Think of it as lift which is in the wrong direction.
- Parasite drag is the drag incurred from the non-lifting portions of the aircraft. It includes the form drag and skin friction associated with the fuselage, cockpit, engine cowlings, rotor hub, landing gear, and tail boom to mention a few. Parasite drag increases with airspeed.

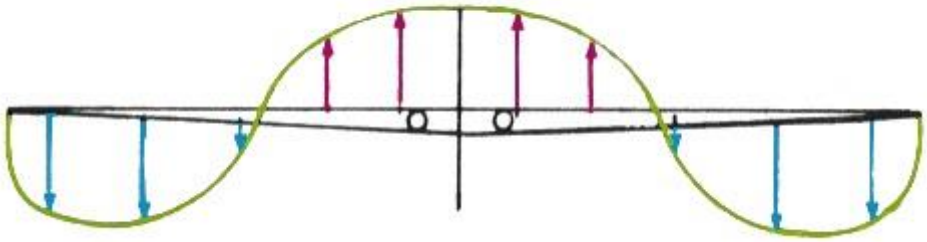
17.3. Rotary Downwash

- This flow of air is called an *induced flow* (downwash). It is most predominant at a hover under still wind conditions. Because the rotor system circulates the airflow down through the rotor disk, the rotational relative wind is modified by the induced flow. Airflow from rotation, modified by induced flow, produces the *resultant relative wind*. In this illustration, angle of attack is reduced by induced flow, causing the airfoil to produce less lift.

The figure below shows the induced flow along the blade span during normal hovering flight:



- Downward velocity is highest at the blade tip where blade airspeed is highest. As blade airspeed decreases nearer the disk centre, downward velocity is less. The figure below shows the induced airflow velocity pattern along the blade span during a descent conducive to settling with power.



- The descent is so rapid that induced flow at the inner portion of the blades is upward rather than downward. The upflow caused by the descent has overcome the downflow produced by blade rotation. If the helicopter descends under these conditions, with insufficient power to slow or stop the descent, it will enter the vortex ring state.
- Vortex ring state will make your aircraft turn and lose aerodynamics. Hence this will make your aircraft fall out of the sky

18. Meteorology

- Weather has a great influence on all aircrafts.
- Weather conditions that can endanger the flight are usually accompanied with specific cloud types.
- It is important to recognize weather threats and clouds in order to assess their implications on the flight.
- Temp drops 3 degrees every 1000'.
- Inside a cloud temp drops 1.5 degrees every 1000'.
- Dew point
  - The temperature in which the air reaches saturation = holding the max amount of water vapour possible (at temp and pressure).
- If outside temperature falls = moisture must be removed = condensation = cloud, fog, rain.

18.1. Clouds

Definition: A visible accumulation of tiny water droplets (over 0 degrees) and/or ice crystals (0 - -30 degrees).
Condensing seed: Any object (as small as dust) around which the vapour condenses and creates a drop or ice.

Two ways to define a cloud:

1. Shape and appearance
2. Cloud base altitude

Latin names according to characteristics:
Cirrus (Hair), Cumulus (A heap), Stratus (a layer), Nimbus (rain bearing).

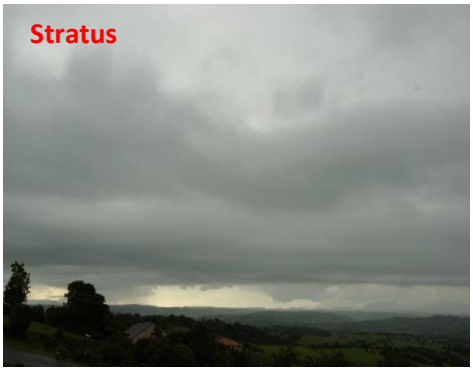
Cirrus (Hair):

- Signed **CI**
- High altitude ice clouds
- Usually thin
- Has a hair like / filament / feather appearance

Cumulus (Heap / Pile):

- Sign **CU**
- Usually puffy with distinct edges
- Has a popcorn-like appearance
- Can appear in different altitudes
- Indicates to unstable air

Stratus (Layer):



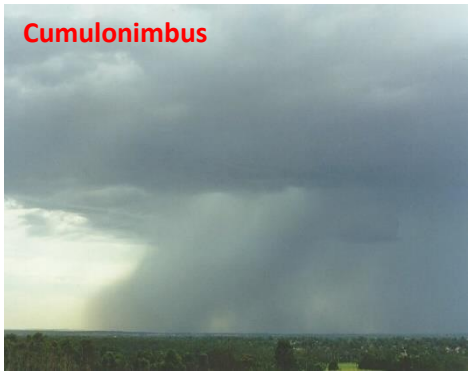
- Signed **SU**
- Appears as thick or thin layers
- Can cover large areas
- Usually not dangerous
- usually Indicates stable weather
- Flat clouds, rather like blankets, these are generally too shallow to produce much precipitation themselves and are usually the forerunner of bigger clouds

Stratocumulus:

- Signed **SC**
- Usually in clusters
- Very little vertical development
- Has a stable air layer above lightly unstable air

The addition "Nimbus" to a cloud type name indicates to a rain cloud.

Cumulonimbus:



- Signed **C**
- Tallest of all clouds, may extend above 60,000 feet
- Appears like a huge tower or mountain
- The upper layer usually spreads like a blanket and is made partially of ice
- The base is usually dark and stormy
- Can produce lightning, thunder, heavy rain, hail and winds
- Danger to UAV

18.2. Icing

On the UAV

- A combination of low temperature - above freezing altitude and in high humidity it can create particles on the UAV (condensing seed).
- The icing on a UAV can effect:
  - Aerodynamics (increase drag) –Wings, Gear, Body, Hook
  - Avionics
  - Engine
  - Servo movements

18.3. Wind

- Effects mainly the take-off and landing.
- Always try to take-off and land heading into the wind.
- Measure the wind speed before your take-off and if outside the limitations of aircraft do not fly.
- Effects the UAV's nose direction while maintaining course.

18.4. Thunder Storms

Thunder storms create unstable flying conditions.

- High intensity of humidity in the air
- Unstable air in a very thick layer (10000')
- Elevation forces that will lift the air flow
- Elevation forces can stem from: hot air on low altitude that cools rapidly; mountain block; block of pressures

What they are made up of:

- Produces very dangerous weather conditions for the UAV
- Strong turbulence
- Wind shear
- Icing
- Hail damage
- Lightning and thunder – electric interference
- Low base and visibility

To think of when Flying:

- Always keep in mind UAV weather limitations
- **DO NOT** fly inside clouds – exit as soon as possible
- **DO NOT** fly next to a **CB** cloud

19. Pre & Post Flight Deployment Planning

- Why are pre-flights procedures and checks conducted?
- Pre-flight procedures are undertaken to ensure that all operations that are due to be carried out are done so to avoid the most amount of **risk** associated with the set operations.
- These practices are employed and used as a "Best Practice" to ensure that operators are prepared for worst case scenarios.
- It is best practice that all persons involved in any assigned operation are briefed both before and after flight Ops have been conducted in order to best understand the tasks at hand and how tasks were completed.

19.1. What is involved in Pre-Flight Procedures?

- Equipment Checks – Compile Mission Checklist:
- Craft Inspection
- Payload Inspection
- Batteries
- Accessories
- Maps
- GPS
- Kestrel
- Back up Craft Required
- Binoculars
- Aerial Permission:
  - Flights Zones – Controlled Uncontrolled
  - Land Owner Permission
  - IAA Permits
  - ATC Confirmation
  - Allocated Flight Time Slots
- Weather Verification:
  - Regional/Local Check
  - ATC Forecast – METAR & TAFF
- Points of Contact - Details:
  - Contractor
  - IAA
  - Nearest ATC
  - Land Owner(s)
  - Emergency Services
  - On Site Personnel
- Additional Staff:
  - Is there a requirement for additional flight crew to ensure the safety of this flight operation?
- Pre-Flight RISK ASSESSMENT Conducted on site:
  - Weather Conditions
  - Possible Obstacles
  - Persons on site
  - Telegraph Poles / Pylons / Turbines etc
  - Aerial Permits Required
  - Low Flying Craft
  - Magnetic Interference

- Nearby Structures
- What is the mission:
  - Survey
  - Photography
  - Inspection etc….

19.2. Post – Flight Planning General

What is involved in Post Flight Checks?

- Equipment Check:
  - Battery Status
  - Fuselage Check
  - Rotor Check
  - Data Collection Verified
  - Payload Check
  - Craft Maintenance Required?
  - IAA/ ATC Notification of Completion Required?

Why are Post Fight procedures and checks conducted?

- Post flight procedures and checks are conducted to ensure that all equipment is has been functioning correctly during operations.
- After every flight operation/mission has been concluded, an After-Action Review should be conducted by company personnel to ensure that all equipment & procedures have been met with the highest regard to flight safety and the safety of the public.
  - After Action Review - Site Review:
  - Was the site free from aircraft interference?
  - Was the site free from personnel interference?
  - Was there any vehicle interference?
  - Was the site controllable?
  - Was the mission achieved?
  - Did the weather have an impact on flight operations?
  - Was there a requirement for additional flight crew to be present on site?
  - Emergency Procedures:
  - Was there a need for a forced landing?
  - Has the IAA POC been informed?
  - Were there any injuries incurred during forced landing procedures?
  - What is the extent (if any) of the damage to the UAV?
  - What is the extent (if any) of the damage to property on / off site?
- As best practice, each commercial operator should compile an After-Action Review (AAR) to be completed with all relevant staff involved in the pre / flight / post deployment of the mission undertaken.
- This AAR should be revised by senior management and any underlining issues encounter should be addressed in order to ensure continued safety and risk precautions for all future operations.
- This AAR may be shared with the contractors to review and an input into operations may be requested to support customer service and feedback to IAA officials should there be a requirement.

20. Emergency Procedures

Why we have emergency procedures? Having a good robust plan in the event of a UAS emergency is important for an operator. Recognising and identifying that you are or have had a fault and having in place a procedure that is unambiguous is paramount in making a situation go from bad to worse. There for it is important that

every UAS pilot fully understands and knows their emergency procedures inside out. Being able to diagnose an emergency and reacting in the right manner comes with time and practice. The following list is just some of the types of emergencies that you should know and fully understand.

1. Fail Safe
2. Force Landing Procedure
3. Software Malfunction
4. Transmitter Failure/Frequency Interference
5. Loss of Propulsion/Motor or Propeller Failure
6. Aircraft Battery Failure
7. Loss of GPS Signal
8. Low Magnetic Field
9. Public Encroachment
10. Aircraft Incursion
11. Fly Away
12. Pilot Incapacitation
13. Fire Ground Equipment
14. Fire in Flight

The way we stop any ambiguity from creeping into our emergency procedures is by having a systematic approach with the following 4 steps.

1. DETECTION - This is where we identify what is going wrong with the aircraft while it is still flying.
2. SIGNIFICANCE - This is where we know what the error is and how it is going to affect the aircraft while it is still flying.
3. IMMEDIATE ACTIONS - This is where our knowledge of the type of emergency we are having comes into its own. We immediately react to the error while the aircraft is still flying. These actions are known off by heart, these actions will help prevent the situation from going from bad to worse.
4. AFTER ACTIONS - This is where we check the aircrafts functionality.

Here is an example of an emergency procedure written using the four steps:

LOSS OF PROPULSION

1. DETECTION
   The RPAS/UAV is not responding to climb command.
   The main current is not responding to climb commands.
   RPAS/UAV fails to maintain altitude.
2. SIGNIFICANCE
   One or more engines have stalled.
   The RPAS/UAV will Drift in a very dangerous manner.
   The descend will be very rapid.
3. IMMEDIATE ACTIONS
   Heading……Return to take off site
   Battery voltage……..Check
   Stick Action……Command up to, try to maintain altitude

Altitude……Monitor
Stick Action……Controlled decent when over take off site
Landing……Forced landing procedure

4. AFTER ACTIONS
   Camera.....Check for free movement
   UAS Icon.....Check for location

It is good practice that a pilot goes through their emergency procedures regularly. It's important that the pilot can react and handle the emergency without reference, professionally and without hesitation. The emergencies by nature require you to know them by memory.

21. Conclusion

Once you have completed your ground school phase your next step would be to attend a flight training course. Don't take it for granted that the aircraft you just bought is easy to fly. Knowing how to control the UAS is just one aspect of flying a UAS in safe manner. Everything else that goes on when your aircraft is in the air makes you a better flyer. You will achieve this by attending a flight training course. Once your flight training course is complete and your operations manual is written you then can sit your flight exam. Once you pass this then you can apply for your company's SOP and you can apply for your PCC. This is all done through the IAA. Expect about 30 days for the process to be completed. Summit all documentation in PDF format to the IAA. It will only slow down your application if a different format is sent in. They cannot except wee transfers / Dropbox or Google drive methods of delivery.

The images below are a comparison view from a photo captured using a DJI Inspire 2 and the dense point cloud produced from a controlled flight path in the area using Pix4D.

Remember to fly safe and to expect the unexpected at any moment.

All the information contained within the document was correct on the date that this document went to press.