SWEDISH TRANSPORT AGENCY

A2

Drones - Educational Material

SWEDISH TRANSPORT AGENCY

Content

Please note that this educational material will continuously be subjected to revisions.
The latest revision will always be readily available to download from Transportstyrelsens webpage.
Current revision of the educational material is based on the latest revision of the legislations that are published on EASA`s webpage https://www.easa.europa.eu/regulations
NB EASA rules and regulations have precedence over this training material. You should always read and follow instructions in drone's user manual.
The below listed chart indicates upcoming revisions of the educational material.
During certain circumstances additional revisions might be introduced between the already planned revisions.

Revisions

Planned revisions	Information
1st Quarter 2021	The revision is based on suggestions of improvements from users of this training material.
3rd Quarter 2021	Revised remote pilot age requirement.
1st Quarter 2022	Change in planned revisions.
2023	Planned annual revision.
2024	Planned annual revision.
2025	Planned annual revision.
2026	Planned annual revision.

Changelog

Revision	Chapter	Previous Version	Current Version
1st Quarter 2022			Planned revisions are changed to once a year.
2023	2	You can find R- and D-areas on Ddrönarkartan (drone chart) and Naturvårdsverket's chart (Swedish Environmental Protection Agency). There are also temporary R- and D-areas. that are usually active less than two weeks. They are published in NOTAM and AIP SUP. In some places, such as military or non-military restricted areas, there canis also be a photo ban in place.	You can find R- and D-areas on Drönarkartan (drone chart). There are also temporary R- and D- areas. They are published in NOTAM and AIP SUP. In some places, such as military or non-military restricted areas, there can also be a photo ban in place.
2023	2.1		New chaper 2.1 regarding U-space and geographical UAS zones.
2023	7		Figure on page 60 removed.
2023	7	If, after all, you are going to	If you are going to
2024	7	The Swedish Data Protection Authority	The Swedish Authority for Privacy Protection (Integritetsskyddsmyndigheten)

1

Section 1: To fly as safely as possible – Air Safety

Your safety and the safety of everything around you and your drone are absolutely essential. The drone must work properly in all respects. And as the remote pilot, you must be alert and attentive to your surroundings during each flight. This training material will take you through everything you need to know to be able fly as safely as possible.

1.1 What is important to consider for a safe flight?

In aviation, **situational awareness** (SA) is often discussed. Situational awareness refers to the pilot (in your case, the remote pilot) being in control of the entire situation – the flight, the aircraft, the surroundings, the airspace, and etcetera. You must be able to understand what happens during the flight and what may affect it: other pilots, weather conditions, the drone's and the remote pilot's limitations, etcetera. The better the situational awareness, the safer the flight.

Taking the environment into account

You are not allowed to fly your drone as you please. There are many areas and airspaces that are closed, either during certain periods or constantly. You may be able to unlock some of them through the use of an app or via air traffic control towers, while some of them will always stay closed.

It is important that you are very familiar with the environment and the route in order for the flight to be as safe as possible. Don't forget to notify people nearby that the flight will happen. You can read more about this in Section 5: Operational procedures.

Be healthy and focused

As a remote pilot, you must be sober and well-rested. Drinking alcohol or using drugs or medications that may affect your performance during flight, is prohibited. It is important that you understand how external and internal factors may affect you and your ability. You can read more about this in Section 4: Human performance limitations.

Always fly within your visual line of sight

One concept that you may come across when flying drones is **visual line of sight (VLOS)**. In addition to being able to see your drone while flying, keeping the drone within your visual line of sight means that you must also keep a safe distance to people, animals, buildings, vehicles and other aircraft. You are never allowed to fly higher than 120 metres.

Don't carry dangerous substances, gases or liquids as payload

In the context of drone flight, you may also come across the concept of **dangerous goods**. This refers to such objects or substances carried by the drone, which could be dangerous in case of a crash or an accident. Flying with dangerous goods without a permit is prohibited. Explosive, flammable, toxic, radioactive, corrosive or contagious substances, gases or liquids are all examples of dangerous goods.

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Section 2: Airspace restrictions – are you aware of the rules?

While planning a flight you must become familiar with the airspace. There are many types of restrictions that prevent you from flying as you please. Such areas are control zones (CTR): the controlled airspace around airports, helicopter airports (often near hospitals), national parks, nature reserves and nuclear power plants. Different airports and heliports may have different conditions which can be found on Drönarkartan.

There are other areas where flying is prohibited or has certain conditions. They are called restricted areas (R-areas) and dangerous areas (D-areas). You need a permission from either Swedish Transport Agency or Air traffic control to fly in restricted areas. Such areas are jails, national parks, nature reserves, military firing ranges and nuclear power plants. You don't need a permit to fly in D-area, but be aware that flying is at your own risk and you have to find out what activities are taking place in that area. An example of such activity is blasting at quarries.

Restriction areas are imposed with regards to order and security or for environmental reasons. You can find R- and D-areas on Drönarkartan (drone chart). There are also temporary R- and D- areas. They are published in NOTAM and AIP SUP.

In some places, such as military or non-military restricted areas, there can also be a photo ban in place. As a remote pilot, you are obliged to know these things, and take them into account.

2.1 Geographical UAS zones and U-space

In this chapter, we will go through what geographical UAS zones and U-space are and how they are related.

Geographical UAS Zones

So far, we have talked about restricted areas, dangerous areas and protected objects. Soon there will also be geographical UAS zones (also called GEO-zones) in the airspace. This airspace structure applies only to drones and the zones can have three different characteristics. The purpose of GEO-zones is to explain what applies in a certain area to those who will be flying drones there. The three properties GEO-zones can have are:

- Permissive (marked green on the Drone map)
- Restrictive (marked yellow on the Drone map)
- Prohibitive (marked red on the Drone map)

Permissive GEO-zones are often what they sound like; they allow drones according to the rules of the open category. Permissible GEO-zones can also be zones where the Swedish Transport Agency has decided to exempt requirements from the open category, for example that you may be allowed to fly a drone that weighs more than 25 kilos or operate beyond visual line of sight. Restrictive GEO-zones limit how, when or with what type of drone you can fly within the area. For example, over a school drones may only be allowed between 18:00-06:30 with drones weighing under 2kg, and thus prohibited between 06:30-18:00. Another example could be that drones are prohibited March 15 – May 15 due to nesting birds at a wetland. Restrictive GEO-zones may also require that you operate a drone that is C-rated and equipped with technical features such as geo-awareness and Remote-ID. Prohibitive GEO-zones prohibit all drone traffic over an area, at all hours of the day, year-round. These areas can be over industries where drone traffic is inappropriate or over areas where personal privacy or environmental values are extra important to protect.

You, as a drone pilot, are obliged to take the same consideration of GEO-zones as of restricted areas, dangerous areas and restricted areas before flying and ensure that you know where these areas are, possible restrictions that apply and follow them.

U-space

U-space is a concept of new services and procedures that, in an automated and digitized way, will enable the integration of drones in the airspace.
A U-space airspace is a geographic UAS zone where drones may only fly with the support of U-space services. A U-space service is a digital service that uses automation of functions designed to support safe, secure and efficient access to U-space airspace for a large number of drones. U-space also enables dense traffic and complex beyond visual line of sight operations (BVLOS) in densely built-up areas. What also distinguishes a U-space airspace

from a GEO-zone is that manned aviation is allowed to fly there, as long as they can use and communicate via the U-space services. U-space is to be implemented in Sweden in four different stages, called U1, U2, U3 and U4 with full implementation expected in 2035.

As a remote pilot, you must relate to each U-space airspace and its specific rules or restrictions. Before you can fly there, you need to ensure that you can use the services offered by one or more service providers, so-called U-space Service Providers (USSP). The primary contact with a USSP is through an application in your mobile phone, tablet or similar portable device. In the application, you simply make an application or a request to fly in the U-space airspace by electronically, digitally, submitting a flight plan. The USSP you have chosen as service provider will then inform you and communicate with you through the application whether your request has been approved, rejected or approved with changes or limitations, possibly with a changed start time, changed maximum height or similar.
The U-space services that will be offered in a U-space airspace are divided into mandatory and voluntary services. A USSP or the Swedish Transport Agency can also decide that other services must be mandatory in a certain U-space airspace if it is deemed necessary to achieve a high level of air traffic safety. There are four services that are mandatory for all U-space airspaces, these are briefly described here.

- Network Identification Service - enables a continuous remote identification of the drone throughout the flight. The identification service communicates the drone's position, direction, altitude and speed with relevant USSPs, air traffic control, the public and relevant authorities.
- Geo-awareness Service – your selected USSP delivers information to you and the drone, through this service, regarding operational conditions, airspace restrictions, which GEO-zones are available and temporary restrictions or changes in airspace.
- Flight Permit Services – this service processes your request to fly in U-space airspace and then notifies you if the request is approved or denied. The service also tells you which deviation from the approved flight plan that is acceptable, i.e. the flexibility you have as a remote pilot.
- Traffic Information Service – this service tells you as a remote pilot of any other visible traffic that may occur near the drone's position or your intended flight path. The service provides information regarding both other unmanned aviation and manned aviation.

Two examples of voluntary services that may be offered by the service providers in a U-space airspace are weather information service and compliance control service.

U-space is continuously developed until 2035, when the goal is for the U-space concept to be fully developed and integrated into the airspace. Feel free to go to the Swedish Transport Agency's website to keep up to date with developments in Sweden.

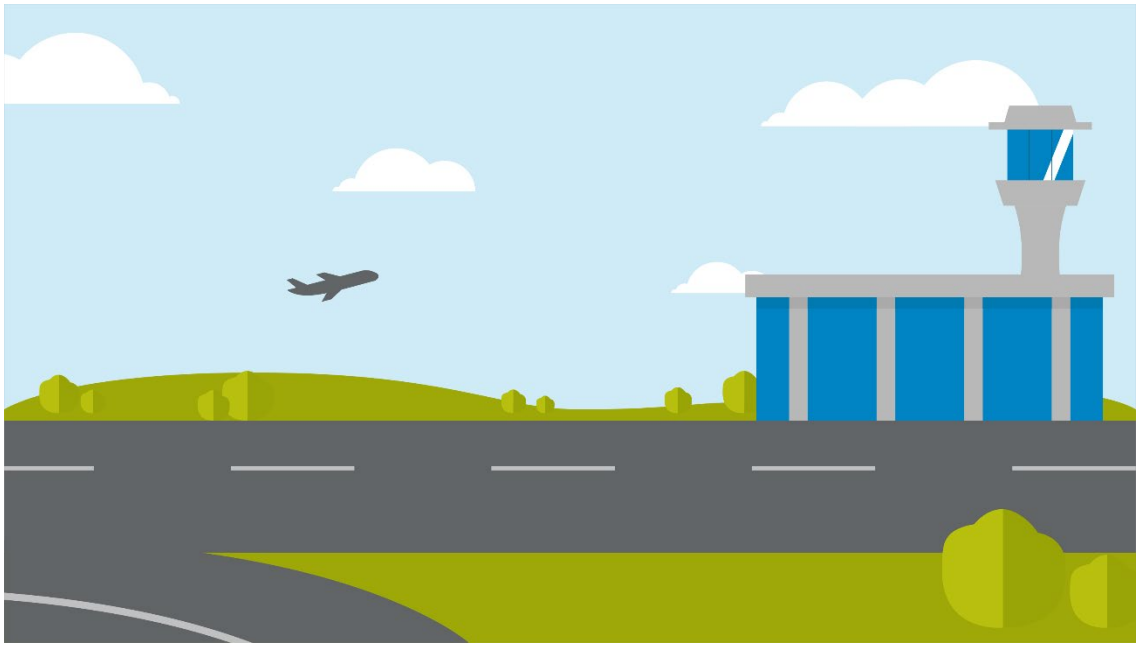
2.2 Geo-awareness in all types of drone systems

After 1 July 2020, all types of unmanned aerial systems (UAS) in the open category within classes C1, C2 and C3 must be equipped with a **geo-awareness-function**. The idea of this function is that you, as a remote pilot, shall be able to get information about restrictions in the airspace in relation to your drone's position and altitude. In addition, the geo-awareness function can alert you to violations of the airspace. However, as the remote pilot, you are always fully responsible for ensuring that your flight is carried out in a safe way and in accordance with the rules.

Geo-fence and geo-cage to protect

Some areas with flight restrictions are protected by a **geo-fence**. A geo-fence is like a virtual fence in the airspace, which simply cannot be crossed by drones.

A geo-cage works in the opposite way. Instead of keeping the drone outside the area, it keeps the drone inside, like a virtual cage in the airspace.



2.3 Services with important information about airspace

NOTAM – a must

NOTAM is short for **notice to airmen**. It is a service that regularly publishes important information about what is going on in the airspace, in order to alert pilots to risks that may affect their flight route or at a certain place. NOTAM is intended for all types of pilots, and a must also if you fly drones in the open category, allowing you to take into account any warnings and areas with flight restrictions while planning your route.

NOTAM can be found on LFV's (Air Navigation Services of Sweden) website https://aro.lfv.se/Links/Link/ViewLink?TorLinkId=161&type=AIS
NOTAM contains multiple acronyms. In order to understand them LFV have published two guides on their website. https://aro.lfv.se/Editorial/View/6779/ES_GEN_2_2_en and https://aro.lfv.se/Editorial/View/6961/ES_GEN_2_4_en

AIP – gives important information

AIP (Aeronautical Information Publication) is published by each state and contains information which is essential to aviation and will be relevant for some time. You should read the AIP before you start flying. Most countries publish a national AIP with information about the conditions of flying to, from or above the airspace and airports of different countries. In Sweden, AIP is published by LFV. You will find the AIP on LFV's website. https://aro.lfv.se/Editorial/View/IAIP.

AIP SUP (aeronautical information publication supplement) contains information of temporary changes in AIP that can be both short and long term.

Maps to read before and during flight

In addition to NOTAM and AIP, where you can check the current state of your planned route, you can also use LFV's "drönarkarta" (drone chart) as a complement. It is a chart specially intended for remote pilots that gives you an up-to-date status of the Swedish airspace and helps you decide where to fly without disrupting regular air traffic. By pressing highlighted areas on the chart, you will also get information on where to apply for a flight permit if needed. Remember that there may be more information in NOTAM and AIP SUP that may affect your flight.

Another important map is the one found on Naturvårdsverket's (Swedish Environmental Protection Agency) website https://skyddadnatur.naturvardsverket.se/. It shows all national parks, nature reserves and other protected areas where you are not allowed to fly or where there are flight restrictions. A common example is that is prohibited to start or land any aircraft within national parks.

2.4 Exercise

The following example is an exercise so that you can learn how to find and interpret the information in NOTAM, AIP and AIP SUP. Let's take an example where you want to find out what is going on in the air in an area around Norrköping. Which airports are in vicinity? Kungsängen is Norrköping airport, but there might be other smaller airports nearby.
Start by searching airport code for Norrköping airport. You can find this information in AIP GEN 2.4. The four letter code is important for the next step. Use your web browser and go to NOTAM Sverige -

Sverige FIR (lfv.se) and search (CTRL + F) airport code you have got in previous step. Your search result will be in AERODROMES, a list of airports and airfields that are published in NOTAM.
Click through the next result.

```
+  AERODROME CONTROL TOWER (TWR) HOURS OF SERVICE ARE NOW MON-
FRI
0700-1330, SAT-SUN CLSD
FROM: 15 FEB 2021 00:00   TO: 28 FEB 2021 23:59
ES/B0237/21
```

Text above is a simple example of NOTAM for ESSP. When is the Control tower open between 15 FEB and 28 FEB? Remember that all time is UTC.

Let us look at another example. Search for ”restricted” or ”trigger” by using CTRL+F.
If there are any temporary restricted areas or warning issued they will be published as below:

```
-  TRIGGER NOTAM - AIP SUP 5/21 WEF 01 FEB 2021. TEMPORARY
RESTRICTED AREAS GODEGARD AND ASKERSUND DRONES ESTABLISHED.
LOWER: GND
UPPER: 1400FT AMSL
FROM: 01 FEB 2021 07:00   TO: 14 FEB 2021 14:00
ES/A0050/21
```

In this example NOTAM has been published together with AIP SUP, which means that there is more information in AIP SUP 5/21. What does NOTAM says? Two temporary restricted areas GODEGARD and ASKERSUND established. Let’s browse to IAIP – AIP SUP (lfv.se) and look at AIP SUP 5/21 to find out more.

Efter tillstånd från Stockholm ACC och Karlsborg ATS är följande trafik undantagen: svenska militära luftfartyg, svenska luftfartyg som används av Polismyndigheten, Säkerhetspolisen, Kustbevakningen, Lantmäteriet och luftfartyg som används i räddningsinsatser enligt bestämmelserna i lagen om skydd mot olyckor (2003:778). För område Askersund DRÖNARE kan även Örebro ATS ge tillstånd.	After permission from Stockholm ACC and Karlsborg ATS the following traffic is exempted: Swedish military aircraft, Swedish aircraft used by the Police, Swedish Security Service, Coastguard, National Land Survey Office and aircraft engaged in rescue operations in accordance with Civil Protection Act (2003:778). Örebro ATS can also give permission for area Askersund DRÖNARE

GODEGÅRD DRÖNARE/DRONES 583929N0150001E - 583250N0150239E - 583331N0150630E - 583946N0150358E - 584437N0150816E - 584942N0150814E - 585206N0150026E - 583929N0150001E.	Gräns i höjdled/Vertical limits: 1400 ft AMSL GND
ASKERSUND DRÖNARE/DRONES 584621N0144604E - 584646N0150034E - 584911N0150657E - 585502N0150218E - 585426N0145118E - 584621N0144604E.	Gräns i höjdled/Vertical limits: 1400 ft AMSL GND

Tider/Hours:

1 FEB – 14 FEB 0700 – 1400

Figure 3 Example of AIP SUP

In AIP SUP 5/21 conditions are published for the temporary restricted areas GODEGÅRD DRÖNARE and ASKERSUND DRÖNARE. Use the coordinates and plot them using the LFV drönarkartan. Does the restricted areas affect your flight? Which conditions apply in that case for the area?

This was a short introduction of how you can use NOTAM and AIP SUP. Try to search for your nearest airport, what do you have to keep in mind prior to your flight today?

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Section 3: What rules exist in the air? – Aviation Regulations

When you fly a drone, you must follow the rules that apply to aviation. With the support of the European Aviation Safety Agency (EASA), the European Commission has drawn up new regulations for drone flights: https://www.easa.europa.eu/newsroom-and-events/news/eu-wide-rules-drones-published. These new rules apply to everyone within the EU.
EASA has also drawn up guidance material, to make it easier to follow the new rules.
In addition to these EU regulations and other international regulations, Sweden has national rules that you have to follow, such as the Aviation Act (2010:500), the Aviation Ordinance (2010:770) and the Swedish Transport Agency's regulations. In this chapter, we will go through some of these rules and the requirements that apply to manufacturers, owners and pilots of drones.

3.1 The new rules in brief

The purpose of the new rules is to facilitate the fast development of drone use and at the same time maintain safety as the traffic increases.
The new rules are stricter for the **drone operator** (the one responsible) as well as for the **remote pilot** (the one who flies the drone). The operator can be a natural or legal person – and when it comes to private use of drones, the operator is often the same person as the remote pilot. You can read more about the operator's responsibility at the end of this section.

Owning or flying a drone comes with certain obligations, but there are also new requirements regarding the drone itself and its systems. If you fly within your visual line of sight, with a drone under 25 kilos, a maximum of 120 metres above the ground and not over people, this flight belongs to the **open category** and therefore does not require a permit.
If you fly a drone over 25 kilos or are flying beyond VLOS (excluding flying in follow-me-mode or are using an observer) the flight belongs to the **specific** or the **certified category** and a permit from the Swedish Transport Agency is required. The same applies if you fly higher than 120 metres and if you fly close to people.

New technical requirements now apply to drones – they must be built in a certain way. A drone that meets these requirements is CE rated, which means that a manufacturer or the importer attests that the product conforms to EU basic health, environmental and safety requirements. A drone must have a C marking according to its technical specifications. These specifications are defined in following classes: C0, C1, C2, C3 and C4. An example of a requirement is that it must be possible to identify a drone from a distance. It has to be possible to determine the drone's geographical position, altitude, speed and flight path.

3.2 What applies to flying drones in the open category?

This training material applies to drones in the open category, and so if you pass the theoretical exam following the training, you may fly drones with a maximum weight of 25

kilos. However, to fly in accordance with the rules, passing the exam is not enough. There are many requirements to keep in mind if you wish to fly drones belonging to this category, and the requirements look different depending on which type of drone you are to fly.

Based on their characteristics, the drones are divided into three subcategories (A1 – A3). The subcategories include several C classes (C0 – C4). Each class has specific requirements for the drone and its remote pilot. Below, we will first go through what applies to each subcategory, and then continue with the C classes.

If you intend to fly drones in subcategory A1 or A3, you need to possess sufficient knowledge of air safety, airspace restrictions, aviation regulations, human performance limitations and operational procedures. General knowledge of drones is necessary too.
If you intend to fly drones in subcategory A2, you have to be sufficiently familiar with meteorology. You also need further knowledge of how to manage the risks posed by flying close to the ground and near people.

3.3 What characterizes the different subcategories?

Simplified, subcategory A1 includes the very lightest drones: those that weigh a maximum of 900 grams. Primarily, the C0 and C1 rated drones are included, but also home-built drones that meet the requirements. These drones are so light, that they may be flown over occasional individuals. But drones weighing more than 250 grams may not be flown in areas where people are likely to move about. If you happen to fly your drone in such an area, you must steer the drone away as quickly and safely as possible. However, no drone – regardless of weight – in the open category may be flown over crowds, ”crowd” meaning a gathering of people so tightly packed that it is impossible to move through it.

If you are going to fly a drone over 250 grams in the open category, you must make sure a number of requirements are met. First of all, drones within classes C1, C2 and C3 manufactured after 1 July 2020 must have systems updated for direct remote identification and geo-awareness. You can read more about this further down in this section. Another requirement is that you, as a remote pilot, must have passed the examination and had your drone license issued. You must always carry your license during your flights. Think of it as a driving license.

Never over – but beside

Subcategory A2 includes almost exclusively C2 rated drones. These drones weigh a maximum of 4 kilos and may not be flown over occasional individuals nor over crowds. However, they may be flown close to people at a horizontal distance of 30 metres or, if the low-speed mode is activated, 5 metres.

In addition to the knowledge you need to fly drones in subcategories A1 and A3, you also need to know enough about meteorology, your drones performance and segregation of overflown area. This knowledge is important, as these drones may be flown close to people despite their high weight compared to C0 and C1-drones.

This applies to the subcategories
A1: C0 rated drones may be flown over uninvolved individuals, but never over crowds. *C1 rated drones are prohibited to fly over uninvolved individuals and crowds.* *A2: C2 rated drones (unless home-built) under 4 kilos, may be flown at 30 metres horizontal distance from people (or 5 metres, if low-speed mode is activated) but never over people. Requires further knowledge of meteorology, your drones performance and segregation of overflown area.* *A3: C2, C3 or C4 rated drones (unless home-built) with a maximum weight of 25 kilos, may not be flown over, close to or in places where there will most likely be people.*

The heaviest drones in the open category

In subcategory A3, the heavier drone types belonging to the Open category are included – those weighing up to 25 kilos. These are either C2, C3 or C4 rated drones, or home-built drones that meet the requirements. This means that C2 rated drones can be included in both A2 and A3 subcategory. But regardless of C rating, it is always prohibited to fly any subcategory A3 drone over or close to people who are not involved in the flight. In addition, you must keep your drone at a minimum of 150 metres distance from residential, commercial, industrial or recreational areas.

Please note that there might be areas where flying in all categories are limited in regard to people, animals, environment and property. If you are unsure it is important to assess the situation based on regulations and common sense, but remember that the operator is responsible for decision making.

What is a recreational area?

It can be exactly defined what a recreational area is (mentioned in UAS.OPEN.040). It is an area where public has access to and use it for recreational activities. Such areas doesn't have to be permanent. They can be temporary depending on number of people or presumed number of people visiting such area. An example is a beach that can be a recreational area during summer time but not during off season. Assessment has to be made depending on a particular situation and the operator is responsible for decision making.

3.4 Drones divided into C classes

If your drone belongs to the Open category and is factory made – not home-built – it must be CE marked (attest of product safety). Is must also be marked with C-class. There are four different classes, and your drone's marking depends on its characteristics, such as its size, how much energy it will transfer in case of a collision, or how fast it is allowed to fly.

To fly **C0-rated** or home-built drones that weigh less than 250 grams,
no training is required, and there is also no age limit. Therefore, these drones are not included in this material. It is worth mentioning though, that neither these drones, nor any other drones in the Open category, may ever be flown over an altitude of 120 metres or over crowds. It is important to note that if the drone is equipped with a sensor that can capture personal data you have to register as operator.
However, in order to fly drones that weigh over 250 grams, the remote pilot must have turned 15, the drone must be identifiable and the operator must be registered and identifiable.

If your drone is **C1 rated**, it may be flown at a maximum speed of 19 metres per second and must not transfer more than 80 joules in the event of a crash. As a general principle, **C1-class** drones may weigh less than 900 grams as long as they don't transfer more than 80 joule in a crash at maximum speed. For example a drone weighing 899 grams may fly at 13.3 m/s maximum speed in order not to transfer more than 80 joule in a crash.

You can calculate how many joules your drone will transfer using a "kinetic energy calculator" that you will find easily on the internet. By entering your drone's weight and its maximum speed, you find out how many joules it transfers. Here is the formula for such a calculation:

KE = joule (J)
m = kg
v = m / s

KE = ½ (mv2)

Remember that you as a remote pilot must not fly in areas where people are likely to be present. If you happen to fly your drone over people, you must steer the drone away as quickly and safely as possible.

This applies to C1 rated drones

- Are not allowed to fly faster than 19 metres per second.
- May weigh less than 900 grams and transmit less than 80 joules in the event of a crash.
- May not be flown intentionally over uninvolved persons. If that happens you must steer the drone away as quickly and safely as possible.

C2 rated drones may weigh a maximum of 4 kilos. They are included in subcategory A2, which means that you are not allowed to fly such drones over anyone, but close to people if you keep a horizontal distance of more than 30 metres. If you have the low-speed mode activated, you may even fly as close as 5 metres from people at a horizontal distance.

This applies to C2 rated drones

- May weigh a maximum of 4 kilos.
- May not be flown over people or crowds.
- May be flown close to people at a horizontal distance of at least 30 metres, or 5 metres if low speed mode is activated.

This applies to C3 rated drones

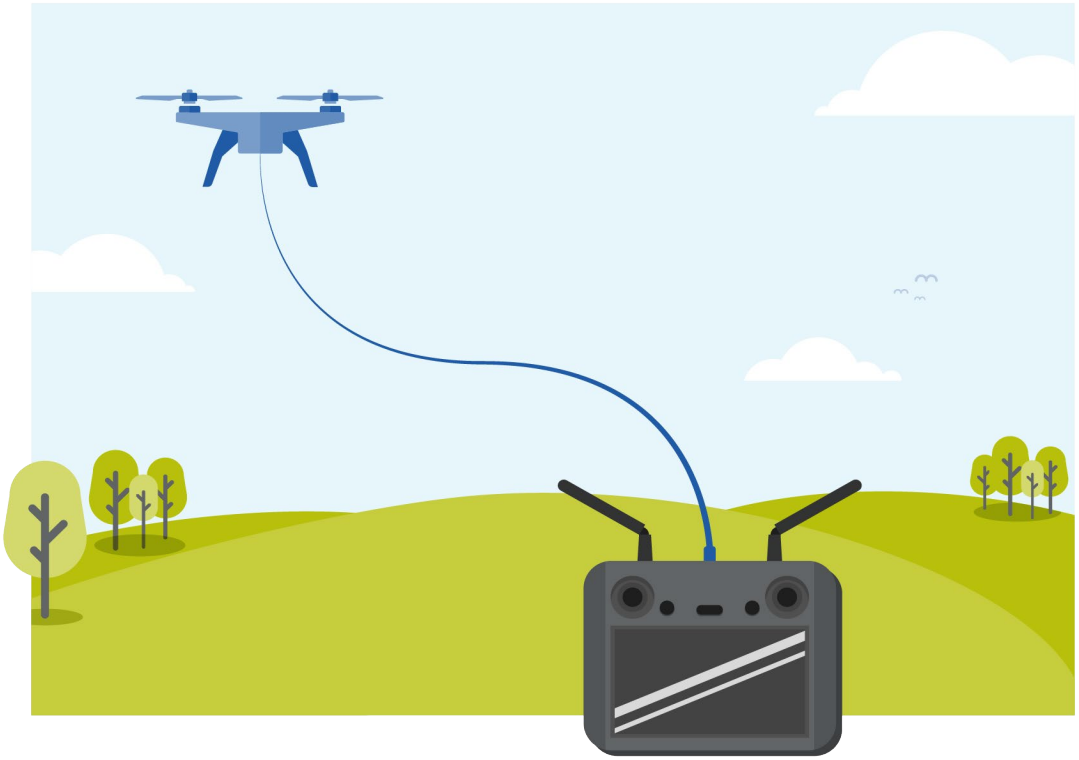
- May weigh a maximum of 25 kilos.
- May be a maximum of three metres wide.
- May not be flown over or close to people.
- Must be kept at least 150 metres from residential, commercial, industrial or recreational areas.

Drones that are C3 or C4 rated are not allowed to weigh more than 25 kilos. They belong to subcategory A3, which means that they may only be flown in areas where people are not likely to be present. For this reason, it is crucial to keep these drones at least 150 metres away from residential, commercial, industrial or recreation areas. A specific requirement for C3 rated drones is that they may not be wider than three metres, and a specific requirement for C4 rated drones is that they may not be controlled automatically.

This applies to C4 rated drones

- May weigh a maximum of 25 kilos.
- May not be controlled automatically.
- May not be flown over or close to people.
- Must be kept at least 150 metres from residential, commercial, industrial or recreational areas.

C2 and C3 rated drones are all covered by the same specific rules regarding tethering. If you need to secure your drone or use wired power transmission if the flight is long and requires more energy than a battery can provide, the tensile strength of your tethering must be more than ten times the resistance of the drone's weight. If the drone weighs ten kilos, the tethering's resistance must be more than 100 kilos. In addition, the tethering must not be more than 50 metres long.



3.5 What is required by drone users?

What responsibility does the drone operator have?

To use a drone weighing over 250 grams, the operator must be registered. It is important to note that if the drone weighs under 250 grams and is equipped with a sensor that can capture personal data you have to register as operator. This is done via the Swedish Transport Agency's website.

When it comes to private use the operator is usually the same natural person as the remote pilot. In that case the operator doesn't have to make own operating procedures, it is sufficient to follow drone manufacturers procedures. But if a company is responsible for the drone, the operator is usually a legal and not a natural person.

The operator has following responsibilities to mention a few:

- Develop operational procedures to coordinate activities amongst its employees
- To create and maintain a list of its employees and their responsibilities
- Ensure efficient use of radio spectrum
- Designate a remote pilot for each flight
- Ensure that the remote pilots are familiar with the user's manual provided by the manufacturer and operator's procedures
- Update the geo-awareness system when applicable
- Ensure in the case of an operation in subcategory A2 or A3, that all involved persons present in the area of the operation have been informed of the risks and have explicitly agreed to participate.

What responsibility does the remote pilot have?

If you read this, you probably want to fly drones. In other words, you will become the remote pilot. Even if you are not the operator and responsible for the operation, you as a remote pilot are responsible for the flight. There are a number of requirements that you have to meet in order to fly. First and foremost, you have to pass the examination.

Then, the focus is mostly on the flight itself. For example, you must not be under the influence of alcohol or any other psychoactive substances, nor be tired, injured or affected by other factors that may have an effect on your ability to fly. If you realize that you pose a risk to other aircraft, people, animals or the environment, you must abort the flight.

You must also be well aware of the rules and restrictions that apply in the areas where the flight takes place, and you must use the drone system according to the manufacturer's user manual and not fly near emergency operations – unless the emergency service approves of it. Remember that you have to be certain, always, that the drone's system works properly throughout the flight.

Which operator information must be registered?

- *The natural person's full name and date of birth or the full name and identification number of legal persons.*
- *The operator's address*
- *The operator's email address and phone number.*
- *Confirmation from a legal person that the remote pilots who are going to fly the aircraft have the proper qualifications.*
- *Insurance number for drone operators that are obliged to have an insurance, i.e. if the drone weighs over 20 kilos or is being used commercially.*

Registration of the drone and its operator

All drones covered by the new regulations must have contact information linked to the responsible operator. Regardless of whether you own the drone you are flying or not, the person (natural or legal) responsible for the drone must be registered with the Swedish Transport Agency, with full name, personal identity number or identification number, address, email and phone number.

How do you report an accident or incident?

If an accident or incident occurs while you are flying, you must report it to the Swedish Transport Agency https://transportstyrelsen.se/rapportera-handelse-med-dronare.

Why should I report an occurrence with my drone?

By reporting an occurrence you are helping to improve flight safety. The point of collecting the information about occurrences is to improve flight safety. In order to identify risks and dangerous situations that are hard to discover at single events, Swedish Transport Agency is collecting and analyzing occurrence reports. That is how an early discovery of patterns is made and measures are put in place to improve flight safety. The reports are only used for flight safety improvement (only when serious risk taking is made or if someone does something on purpose to jeopardize flight safety the occurrence report can be used outside the scope of flight safety improvement work).

Is it mandatory to report occurrences with drones?

Following events are mandatory to report by anyone who flies the drones:

- If someone is seriously injured
- If there has been an accident with fatal outcome, or
- If occurrence involves maned aircraft (airplanes, helicopters etc.)

There are rules that explains when it is mandatory to report and which occurrences needs to be reported.
Even if an occurrence is not mandatory to report or if the reporting person is not obliged to do so, Swedish Transport Agency is encouraging to voluntarily report an occurrence in order to improve flight safety.

If have reported to the Swedish Transport Agency do I have to report to the Police as well?

If there is suspect criminal act during an occurrence or an accident then it should be reported to the Police.
When someone is seriously injured or if someone dies or when an aircraft has sustained extensive damage the Police should be contacted since an investigation may need to take place.

If I have reported to the Swedish Transport Agency do I need to report to State Accident Investigation Board as well?

If someone has been seriously injured or if someone dies or when an aircraft has sustained extensive damage then the occurrence shall be reported to both Swedish Transport Agency and State Accident Investigation Board. These type of events are covered by regulations 376/2014 and 996/2010 that govern reporting of occurrences and accidents within EU.

4

Section 4: How humans work – human performance limitations

In this section, you will read about things that affect and impair human performance – and what you can do to stay in control of your flight. Each of us is unique, we handle differently and are affected differently by various situations and conditions. Therefore, it is important that you can assess your own abilities and limitations in order to make responsible decisions. Most of the time it is all about common sense!

4.1 How do you perform under stress?

We are often told that a little amount of stress can be good. That is correct. The body releases energy in the form of stress hormones, so that you can act quickly in emergencies. A moderate level of stress can increase concentration and improve your ability to react.

However, too much stress can have the opposite effect. It may paralyze you, slow you down, cause panic or even blackouts. You may get confused and find it difficult to solve situations. For this reason, it is important to learn how to cope with stress while flying drones.

How to avoid stress

Speed: *Fly your drone slow rather than fast.*
Flight style: *A defensive way of flying gives you better control of the drone as well as the surroundings.*
Environment: *Try to fly in areas with little, and more quiet, activity.*
Good foresight: *If you are well prepared for the flight, you will feel calmer. (Check Section 5: Planning and performing a flight – operational procedures)*
Sleep: *Be well rested before and during flight!*

One way of keeping stress at bay is to keep the speed down and fly defensively. This will give you better control, and time to react if an obstacle suddenly pops up – such as a bird, another aircraft and so on.

Good foresight also makes you a calmer remote pilot. If you have a good overview, if you are familiar with the surroundings, if you are updated about the weather and the activities in the area, and if you know all you need about your drone and its functions, you will feel calmer and thus fly safer. Being well rested and alert also reduces the risk of stress.

4.2 Don’t drink and fly

Never drink alcohol or use any other kind of intoxicants that will affect your abilities during a flight. If you do, you can have your certificate of competence revoked.

All use of drug-classified substances, unless prescribed by a doctor, is illegal and can result in imprisonment.

How does alcohol affect us?

It does not take much to be affected by alcohol, often less than we think. That is the reason why there is a zero tolerance against alcohol consumption while flying drones. Many of your important capacities will suffer, such as your visual ability, responsiveness and ability to move. You will also find it more difficult to estimate distances, you will have tunnel vision and you will not notice signs of fatigue in time.

There is no way to increase the breakdown of alcohol. Sleep, movement, coffee or whatever - none of it can make the process go faster, even if it appears so. The speed of the breakdown depends entirely on one's personal capacity. If you have been drinking a lot, you should not fly the next day either.

What is “one per mille”?

In Sweden, blood alcohol content (BAC) is measured in per mille (“promille” in Swedish). Per mille, Latin for “in each thousand”, can be compared to one drop of alcohol per thousand drops of blood. Because of our different capacities, it is very unlikely that two people who drink exactly the same amount of alcohol will have the same BAC. Weight, age, health, gender or how much we have eaten before drinking, are all factors that will determine how quickly we are affected by alcohol and how long it will stay in our blood.

Why you should not fly under the influence of alcohol

Distance estimation: You will find it difficult to estimate distances.
Vision: Your night vision will become poorer, and you will be more sensitive to glare. Also, you are more likely to experience tunnel vision and double vision.
Reactions: You will not react as fast as when you are sober.
Movement: You will find it more difficult to make precise and soft movements.
Fatigue: It will make you tired and drowsy, and you will not notice these signals as quickly as when you are sober.

The BAC is measured using a breath alcohol test. You can buy your own meter, but they are not always as reliable as those used professionally by the police and others.

4.3 Do you use medication that affects your abilities?

Some medicines have an effect that is similar to that of alcohol and other intoxicants. If you are on medication, it is important to make responsible assessments of your abilities and limitations.

You should not fly if your medication makes your performance dangerous or risky. This goes for prescription medicines too. Examples of common side effects are decreased attentiveness, longer reaction time and impaired judgment.

If you are using medication

- *Medication can have the same effect on your performance as alcohol and drugs.*
- *Medication can affect your attentiveness, reaction time and judgment.*
- *Combined medications or alcohol combined with medication can increase the effect.*

Medications affect you in different stages – some only at the beginning, others constantly or only when you quit. In addition, combined medications or alcohol combined with medicine can increase or alter the effect.

4.4 Getting enough rest?

It is important that you are well rested during flight in order not to pose a safety risk. Fatigue will degrade your concentration as well as your ability to react, make decisions, coordinate and perceive sensory information. Flying tired is just as serious and can have the same consequences as flying drunk.

The risk of accidents due to fatigue is bigger at night, in the dark, at the end of the flight or under the influence of alcohol, drugs or other intoxicants.

To avoid fatigue and its consequences

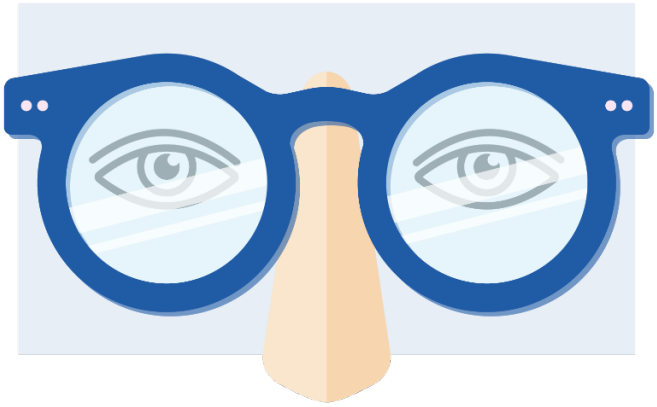
- *Fly well rested and make sure you get enough sleep.*
- *Respect fatigue signals. Pay special attention to these signals at the end of the flight or if you fly at night or in the dark.*
- *Fly short rather than long passes.*
- *Take breaks, 20 minutes of rest can suffice as a recovery.*

If you fly for a long period of time, your commitment may decrease over time – you may start to think about other things, daydream or even doze off. These are common fatigue signals that you should take seriously. Make sure to pause if you notice that you are starting to lose concentration – resting for 20 minutes can be sufficient.

If you have not slept enough, you may fall into micro-sleep. Micro-sleep is extremely short episodes of sleep that can occur anytime and anywhere. If they happen at the wrong time, they can have major consequences, not least with a drone in the air.

4.5 Eyesight – our most important sense

We perceive most of the information we need with our eyes, and eyesight is also the sense that is most useful to you during your flights. Many of us have some type of visual impairment, which may develop unnoticed. For this reason, it is good to have your sight checked at regular intervals, preferably once a year. If you need glasses or contact lenses, you must use them during flights.



The two sharp percent

The **direct vision** is the part of your sight that is in focus in the visual field. Normally, the visual field is 180 degrees, of which the direct vision constitutes only one to two percent. This means that only two percent of your vision is sharp, everything else is blurred.

Activity in the periphery

The **side vision** enables you to perceive also that which is out of focus - the blurred parts of your vision field. The side vision enables you to notice movements and detect obstacles or dangers that are outside your focus while you are flying.

The vision gets worse in the dark

Darkness is not only making us tired, but also impairs our vision. Therefore, we need to be more attentive during flights in the dark. Many suffer from nearsightedness in the dark, as it is difficult for the lens of the eye to adjust when there is not enough light. It is also common for the lens to lose its elasticity over the years, which means that our **night vision** can become worse as we get older. Some people don't have night vision at all, usually from birth. This is called **nyctalopia** or **night-blindness**.

The likelihood of becoming dazzled increases when one's night vision is poorer. Therefore, be careful of strong light if your night vision is poor. Your eyes will have trouble switching from darkness to light and vice versa.

Make sure the technology is adapted to the environment. If it is dark outside when you fly, you can reduce the brightness of the radio transmitter's display. And if it is very bright outside, you may need to use a monitor hood.

Visually scan the sky

When we fly drones we are doing it within visual line of sight and besides seeing the drone clearly we should also keep our eyes on the airspace around us. This means that it is important to visually scan the airspace in a proper way.

Our eye sees as best when we focus our sight and can use all the visual cells tightly grouped in "macula of retina". (cone cells are more tightly spaced here than at the rest of the eye and can register details much better than the rod cells. We are best perceiving motion when we are not looking around but using our peripheral vision. (Rod cells used for peripheral vision makes picture blurry but are more sensitive to motion than cone cells).

In order to make a good visual scan of the airspace it is best to systematically move visual focus between several different points in the sky than just looking around.

You have to practice your visual scanning to look at the drone and your instruments as well so that you scan all three parts in regular intervals. The drone - control unit - surroundings. This method is used by airline pilots and it implies looking for a short period of time at your control unit before looking at the sky again. If you need to look at your control unit a bit more than you do so and then you look at another part of the sky and so on. This requires a bit of practice but when you get it right it makes you a much safer pilot which is good for you as well as others.

What do I need to pay attention to?

- *Don't sweep around with your eyes when watching out for other aircrafts*
- *Focus your vision and move it between several different points in the sky*
- *Practice your scanning and get good at it*
- *Remember – when another aircraft shows up it can fly really fast and it's crucial to spot it as early as possible!*

Practice makes perfect

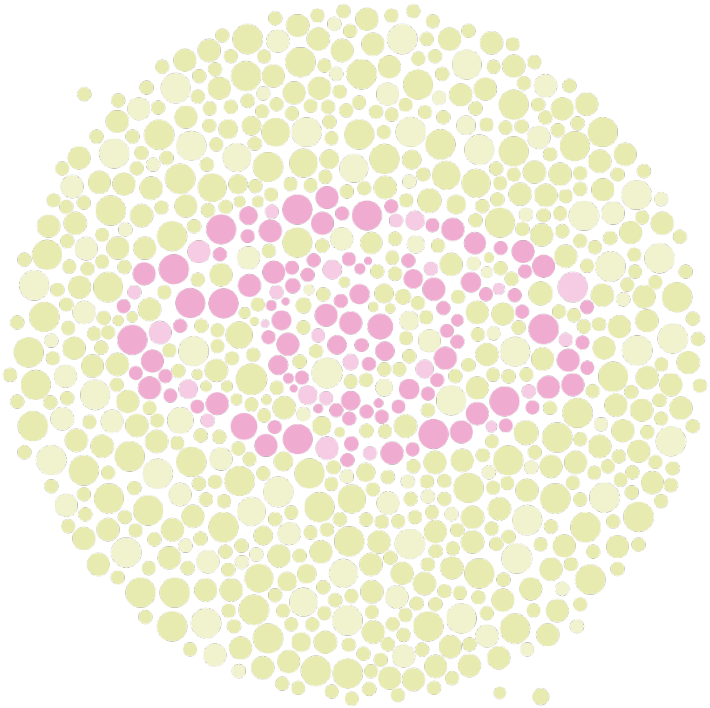
The more experience you get from flying drones, the better your **visual scanning ability** will be. This makes it easier for you to perceive risks and solve difficult situations.

Interpreting information incorrectly

If the visibility during flight is poor or if you suffer from fatigue, there is a risk that your brain misinterprets information. These **optical illusions** make you assess situations or distances incorrectly. This is another reason to be well rested when flying!

Different types of colour-blindness

The most common type of colour-blindness is called **red-green colour blindness**. It is often congenital. This form of colour blindness not only makes it difficult to differentiate between red and green but also between colours containing red or green. For example, you may have difficulty distinguishing between brown and green because brown is a mixture of red and green, or between blue and purple because purple is a mixture of red and blue.



Another form of colour-blindness is **blue-yellow colour-blindness**. It does not, as it may sound, make it difficult to separate yellow and blue. Instead it makes it hard to see the difference between the colours belonging to the section from yellow to blue on the colour scale. Yellow may be perceived as pink, and blue as green, etc.

A third and very rare form of colour-blindness makes you see everything in **greyscale**.

4.6 Other senses of importance while flying a drone

Hearing is important in order to hear things that might interfere with your flight or route, such as emergency services, other aircraft, birds, wind, water and so on. And, of course, odd noises that indicate failure leading to breakdown or some other accident. Therefore, don't listen to music or similar in headphones while flying.

The sense of feeling is important for you to be able to feel that all parts of the drone are properly fastened. Some radio transmitters also have warning vibrations if something should happen while the drone is in the air.

The sense of smell is important if there is a sudden smell of burning.

4.7 How are you affected by others?

One way or another, almost everyone is affected by being part of a group. This is called peer pressure, and it can be both negative and positive. But regardless, it is essential that, as a remote pilot, you trust your own skills and fly responsibly.

Negative peer pressure

In some social contexts you may feel that you don't dare to stick out or seem like a coward, or that you just have a hard time saying "no". This is called **negative peer pressure**. This pressure can cause you to fly more risky and do things that you know are not right, for example drinking alcohol before or while flying a drone.

Positive peer pressure

Social contexts where you can be sincere with yourself and others, are characterized by **positive peer pressure**. You don't have to feel that you are under pressure to do something that you know is wrong, and you might even make better decisions.

How are you acting yourself?

It is important that you too act responsibly and do not try to push people to do things they don't want to during flights.

4.8 Different methods of learning give different results

To understand in depth what you learn

As its name implies, **deep structured learning** means that you understand in depth the things you learn and read. You will be able to understand the logic behind particular rules, but also context and causes as a whole. The knowledge will stick and become a natural part of your flying when you are out in the field.

To forget as soon as you have learnt something

The opposite of deep structured learning is **surface learning**. If you just quickly cram enough to pass the theoretical examination, the facts will probably not stick. It will result in not having the knowledge of rules and regulations when you are going to fly.

Inevitable role models

Learning unconsciously by observing other people's behavior, is called **imitation learning**. In many cases, this is inevitable – therefore, being a good role model is also important.

Experienced or just too comfortable?

Often, experience will give you the best competence. By flying enough you will eventually be able to operate automatically. This is called **overlearning**. It is mostly positive – you can fly the drone without paying too much attention to the operation itself. Instead, you will concentrate on the surroundings, discover hazards and plan the next step in time.

But if you become too comfortable, you will also become less alert since you trust a bit too much in your own competence and ability. Besides, if you fly often in the same area, you may take too much for granted and become less vigilant. This is called **probability** learning. However, it is not only negative: you will also learn what is expected and required in the area.

4.9 Automation – how it affects you as a remote pilot

Rapid advancement in technology within aviation and UAS has led to advanced automation which has changed the pilot's way of work. Instead of flying the drone manually the pilot monitors periodically different systems and the flight, which has its pros and cons. Automation has improved efficiency and safety but it provides a challenge for human performance. You as a remote pilot need to know how automation can affect your ability to fly the drone in a safe way.

What is the benefit of automation?

The general benefit of automation is that it can reduce work load for you as a remote pilot, both mentally and physically. For example, the RTH function can aid you in both return- and landing phases so that you can shift your focus on making sure that the landing area is clear to land. Follow-me-mode is another function that can relieve you. Another positive effect is that automation improves precision in navigation.

How automation does affects my performance?

Automation relieves you of piloting but you still have to be involved in flight and always ready to act if something goes wrong. We are poor at supervising the routines as humans. Supervising the drone can be under-stimulating and negatively affect your attention. In case something goes wrong and it affects the drone for example a failing RTH, you have to quickly assess the situation, make a decision and take over manually which can be a heavy burden for you as a pilot.

Manual skills are getting worse when they are not used (such as your ability to fly the drone) and it can have a negative impact at your situational awareness. For example an RTH landing takes care of braking distance that you have to account for under different circumstances when you make a manual landing. Use the automation when appropriate but don't forget to fly manually now and then so that you don't lose your flying skills.

What do I need to pay attention to?

- *Don't lose your **flight skills** – switch between manual flight and automation*
- *Stay up-to-date with your drone's **automation functions** (a.k.a. modes) – possibilities and limitations*
- ***Don't trust** automation blindly – monitor your flight. Take over if in doubt!*
- *Be **mentally prepared** for emergencies and how to deal with them in best possible way*
- *Automation is not **responsible** for a safe drone flight, you are!*

It can be hard to detect fault in automation, depending on how advanced automation functions your drone has. A lot of automation functions are taking place in the background and are not always visible. That is why it can be hard to understand the logic behind the automation's behavior making it harder to predict its next move. Different alarms can also be discovered too late if you are not alert during the flight. Good knowledge of

your drone's automation functions is very important.
Automation can give you a false sense of safety. It can be tempting to relax and let the automation that is faultless most of the time, take over. Always be aware of your drone's position, where it is going and what could happen next. Keep in mind that your awareness and your manual flight skills are important for a safe drone flight. Remember that it is always you who is responsible for a safe flight and not the automation. You as a remote pilot are a very important piece of puzzle in aviation safety!

4.10 Risk awareness – a skill that takes practice

What can influence my risk awareness?

Several factors affects our risk taking, for example our experience of being in control of a situation, our drone or the environment has a huge influence. It is important for you as a remote pilot to think in terms of risks and be aware of what can affect your risk awareness and ultimately your decisions.

We as individuals have a tendency to underestimate risks where consequences are known a bit later, for example a slight change in wind direction which turns into a strong headwind on your way to a home position can result in a lower battery level than expected and can limit your options.

It is quite common to (unknowingly or on purpose) deny or diminish risks because of the strong sense of completing something that you already started. An example of such a situation may be a huge focus on completing a mission with a consequence of not aborting the flight when you should. In order to avoid getting stuck in willingness to complete a mission and return home it is very important to have clear operating procedures and follow them. For example you should always go for landing when reaching a certain level of battery charge and never exceed it, no matter how much is left of the mission. Something unexpected can always happen. It is also important to set your personal limits and never exceed them.

What do I need to pay a special attention to?

- *Be aware of your **limitations** – don't exceed them and take no unnecessary risks*
- *Follow current **operating procedures** – they are there for yours and others safety*
- ***Personal limits** – set a level that doesn't exceed your abilities or operating procedures*
- *Remember – even if the mission is important, **flight safety** is the most important!*

We tend to be more self-confident after getting some experience which can lead us to start bending the limits and finally taking exaggerated and unnecessary risks. If you have often been in risky situations and nothing bad happened, there is a high

probability that you will take even bigger risks that can result in situations that can be very demanding and have a negative impact on safety. It is important to try to have an oversight of the situation to be able to decide if there are less risky options. Previous successes doesn't guarantee safety in the future, each flight is unique and has its risks and challenges.

5

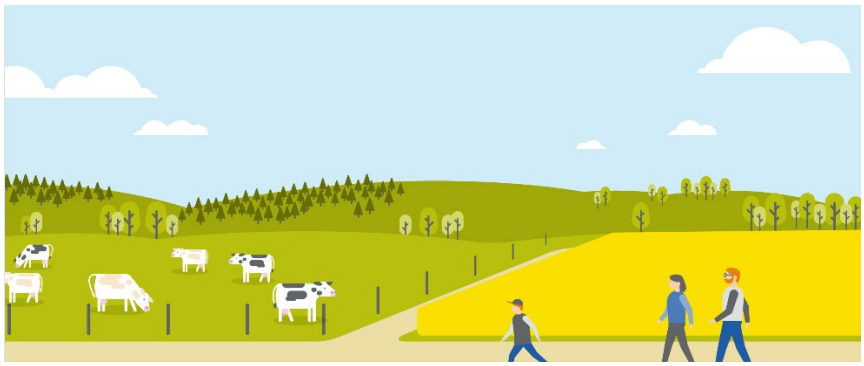
Section 5: Planning and performing a flight – operational procedures

In this section, you will find out how to plan and perform a safe drone flight. For this reason, it is a good idea to learn certain routines to avoid making mistakes. As the remote pilot, you have specific obligations before, during and after the flight. Also, you need to know where to find information about things that may affect your flight.

5.1 What are your responsibilities as a remote pilot?

Before your flight, make sure that you have brought your **certificate of competence**, then carry it throughout the flight. You get your certificate of competence when you have passed the theoretical web based examination. The certificate is valid for five years from the date of issue.

Before every new flight you have to get an overview of the surroundings where you are going to fly. Are there any obstacles or people? What do the area and the airspace look like? Are there any restrictions or is it free to fly? You will have to check all of the above before your flight and be aware of it during the flight.



Something that may seem obvious, but is crucial for the prevention of accidents, is to ensure that the drone really works properly. At the end of this section, you will find examples of practical checklists – customize these lists to your specific type of drone and go through them both before and after each flight.

Keep this in mind before the flight

- *Bring your certificate of competence.*
- *Make sure you are aware of any restrictions in the area where you are going to fly.*
- *Observe the surroundings in which the flight is to take place and check for obstacles or people nearby.*
- *Make sure the drone system works properly.*
- *Make sure that the weight of the drone does not exceed the maximum weight allowed for its class.*

During the flight you have to make sure that the drone is in your line of sight. Be observant of the area you are flying in, so that you don't collide with other aerial vehicles. Remember that you have to give a way regardless of which aircraft you encounter. If you and your drone in any way pose any risks or danger to people, animals or the environment, you must immediately abort the flight in the most secure and controlled way possible. It is important that you are well rested and do not suffer from any medical condition that may affect your control of the flight. You should not fly if you are under the influence of alcohol or other psychoactive substances. Always use the drone system according to the manufacturer's user manual.

Your obligations during flight

- *Don't use alcohol or any other psychoactive substances*
- *Make sure you are well rested and unaffected by anything else that might influence your ability to fly.*
- *Abort the flight if it poses a risk to other aircraft, people, animals or the environment.*
- *Make sure you are familiar with the rules and restrictions in the areas where you are flying*
- *Use the drone system according to the manufacturer's user manual.*
- *Don't fly near or within areas where an emergency operation is in progress, unless you have been given permission by the emergency services.*

5.2 What do you need to do before you start flying?

Go through the mission

Go through the planned route with all participants. Make sure that the start area is free of obstacles and people and that there is information available that flying will take place. The remote pilot should wear a safety vest and if possible place a sign with information about the flight. If you are several people, it is important that you clarify each person's role before start. Next to the remote pilot, for example, it may be good to have an observer who is paying extra attention to the surroundings. The observer can help the remote pilot detect hazards and ensure that no one is in the area – but also answer questions from passers-by, take phone calls etcetera, so that the remote pilot is not disturbed.
Regardless of the role, it is important to fly well rested and without being under the influence of alcohol or other intoxicants or substances that will affect your judgment or watchfulness.

Check the drone system

Before you start, it is important to ensure that your entire drone system has the correct settings and that both hardware and software work properly.

First and foremost, you need to check the battery levels – both radio transmitters and drones should be fully charged before each new flight.

Make sure that there are no frequency interferences that could affect the video and receiver, and that memory card (SD card) and photo and video equipment are in place and functioning properly. If a compass calibration is needed, make sure this is done.

Start the radio transmitter first, and then the drone. (If you do the opposite, the RTH function might in rare cases be activated, if the drone cannot communicate with the radio transmitter.) Finally, you can start any other equipment.

Once the drone is switched on, it is time to start the camera and make sure all camera settings are correct: stills camera, video, FPS (frames per second), colour system (NTSC/PAL), etc.
Are all controls in neutral position? If the answer is yes, you are ready to fly!

It is important that the drone and all equipment are checked carefully before each start. It might be a good idea to appoint a technically responsible person if several users fly the same aircraft. Under “Checklists” below, you will find an example of how you can carry out an ocular inspection of your drone before each new start.

Check the area where you are going to fly

If you have no local knowledge, you must check in advance what the area looks like on a map or satellite imagery, and check what applies to the area in NOTAM. The main thing to check is that you will not fly near any animals and, if possible, that you will be able to keep a distance to people. A good rule is to avoid areas where people sometimes gather, such as parks, recreational areas and areas where sports competitions or other events are organized.

Always check actual and temporary information In AIP, AIP SUP and NOTAM for the actual area.
Don’t fly without permission over people who are not related to your flight, in control zones (CTR) or in R areas (restricted areas), and do not, in any way whatsoever, break the rules. If the flight is to take place in a control zone, you must get permission via the Air traffic control. You can either call the Air traffic control directly or email your request in advance with attached map, coordinates, flight radius, altitude, times and phone numbers where you can be reached throughout the flight.

To avoid that the transmission of flight data is blocked and to prevent accidents, you must take the topography into account and be able to see your drone at all times. Read in drones user manual how to switch off the engines in the air during an emergency situation, a so-called “planned crash”, to be prepared if it is needed.
Remember that the drone's IR sensors can be disturbed by reflections from shiny surfaces, such as water, glass or mosaic. This may result in the drone losing control of its own position and altitude, which, in turn, may result in a crash. If you are going to fly over lakes, sea areas, ponds or other water accumulations, you should turn off the sensors located on the underside of the drone.

How to choose the take-off position

Be careful when you choose the location of take-off position so that both take-off and landing can be performed safely. The surface should be even, there must be plenty of space, and the place must be located far from obstacles and people. Surfaces with gravel should be avoided. If this is not possible for some reason – use a launch pad.
Check out and select alternative landing areas, in case you have to make an emergency landing.

Check the weather

Before you start, check temperature, wind, fog and cloudiness, and keep in mind that if the temperature falls below the freezing point, this may have a negative effect on the batteries. In temperatures below the freezing point, you will need detailed knowledge of the batteries, make sure you are familiar with how your batteries are affected. Also, make sure you keep them heated before start. At freezing temperatures and humid air, ice may build up on the propellers, dramatically increasing the risk for crash.
Keep in mind that wind speed often increases with altitude.

5.3 What do you need to consider during the flight?

Starting the flight

If you are flying a multirotor drone you should, first of all, check it while it is in the air at low altitude. Do this by lifting it around five metres above the ground and then let it hover in that position. Listen for unusual sounds and check that the steering is responding normally and that the battery levels are adequate. Finally, make sure the GPS is working properly.

Before take-off

Go through the mission: *Who is the remote pilot and what are the roles of any other people involved in the flight? What do you want to achieve with the flight?*

Check the drone system: *Propellers, battery levels, transport protection, gimbal and compass calibration. Set the RTH and its altitude if there is such a function and check for any error messages.*

The area of the flight: *Carry out a risk analysis. Are there any masts, trees or people nearby? Are there any sources of interferences like metal or aerials? When flying over water – turn off the sensors. You also need to be able to ensure safety distances to people and buildings according to the rules for the particular class you fly. You should also consider if you need to put up fences or signs, or if you need help from other people to maintain safety.*

Take-off position: *Make sure you have plenty of space around the take-off position, and start from an even surface.*

Weather: *check the temperature, the direction and speed of the wind, and the risk of turbulence and fog.*

While flying

As the remote pilot, it is important that you keep your fingers on the radio transmitter at all times. Also, make sure that the radio transmitter's aerials are pointed correctly to the drone for the best reception capability. This is especially important for long distance flights.

Never fly more than 120 metres above the ground and always keep your drone in sight. You must also be aware of the area under and around the drone at all times. Try to rise to optimum altitude to reduce risks and noise, and avoid flying over animals, electrical lines and buildings. In most cases, you are not allowed to fly over people. Check what applies to the class your drone belongs to.

Also, you must not interfere with ongoing activities or emergency operations, unless you have been granted permission from the emergency services. Immediately land the drone if a helicopter or other low flying aircraft approaches the area. If people or animals move toward the area, fly away from them to a safe place and wait until all is clear. If this is not possible – abort the flight and land the drone.

Be prepared for emergencies

Emergencies can occur when you least expect it, and therefore you must be prepared. Emergencies may be the result of errors in the drone's system or construction, but they may also be caused by natural forces. Below are some examples of what might happen.

- Compass interferences

The compass function may be disrupted in areas with high **electronic interference**, for example where there are electrical wires, aerials or larger metal objects. Let the drone rise. The interference may then decrease and the drone find its magnetic heading. But remember never to fly above the maximum altitude.

- Engine malfunction

Different drones have different numbers of engines, and therefore react differently during an **engine malfunction**. It is more likely that a smaller drone with fewer engines crashes if one engine fails, while drones with many engines (six or more) might be able to continue flying, and land safely. A fixed wing drone can use its wings to land smoother without engines in case of a failure.

Some types of drones have an auto rotation function that is activated in case of an engine failure. This means that the drone will start to rotate instead of falling straight down to the ground – and thus land more softly. It also gives you and others in the area more time to seek protection from the falling drone. So find out how your drone works and what it can handle.

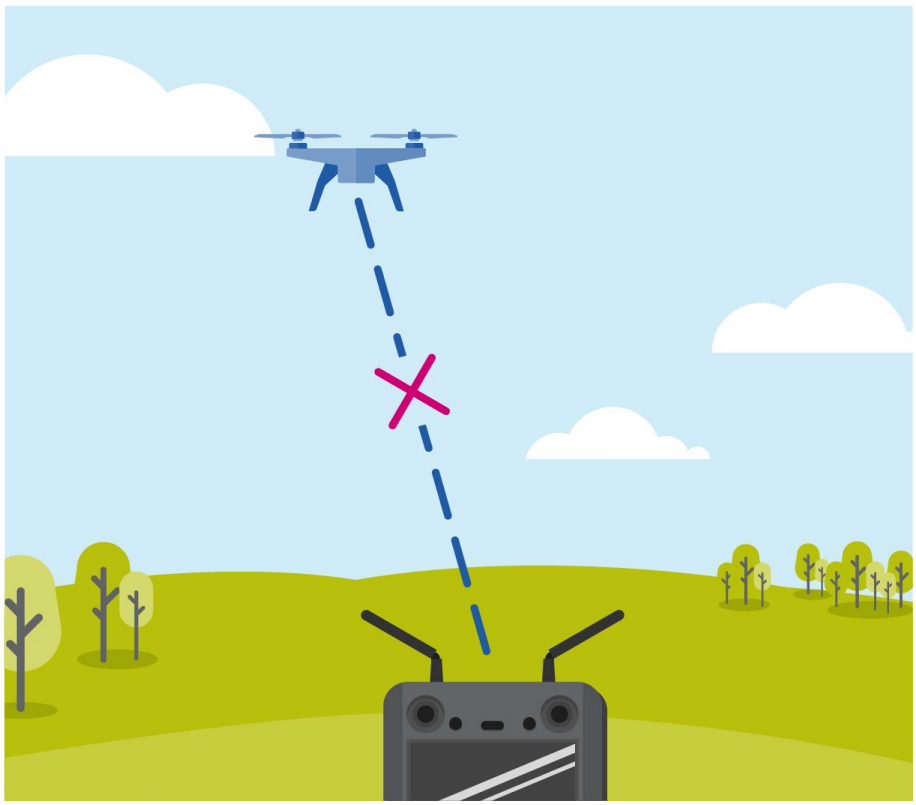
Icing

- Icing may cause crash

Icing is the build-up of ice on the propellers. If this happens, the propellers will not create the power necessary for a safe flight, which may, in the worst-case scenario, result in a crash. Some drones have safety functions that are activated in icing conditions. The drone will then auto-land. It is not possible to control the drone's vertical speed during an auto landing, but you can control its flight path to avoid obstacles.

- If the radio transmitter loses contact with the drone

Contact between the radio transmitter and the drone can be lost. If RTH is activated, it is important that you have set a safe altitude for an **automatic return to home position**.



In addition, it is important that you have the settings for RTH and start position that are best suited for the specific occasion. For example, if the drone is flying over water while you are in a moving boat, it may be advisable not to let the drone fly back to its start position, which would mean it will land in the water. In this case, a better idea would be to have the drone follow the radio transmitter. This is done by placing out new home positions during the flight. A good idea is to include this in a checklist before the flight, so that you are always prepared for what happens if the RTH is activated.

- Curious birds on collision course

Not only is it important to be attentive to other aircraft in the airspace, but also to birds. Birds are often curious, sometimes even aggressive, disturbing the flight and posing an actual hazard. If you are flying over water, you should also keep in mind that birds like to fly low, close to the surface of the water. If your drone is surrounded by curious or aggressive birds, you should consider landing and aborting the flight.

Landing

You can land both automatically and manually. A common way is to activate RTH and let the drone fly back automatically to the starting position or the radio transmitter and then land automatically – or to choose to take over and land manually.

You must check if there are any obstacles or risks in the landing area. Once you have done this, land the drone at a safe distance from any obstacles and people. If you land with a fixed wing drone, a larger area without trees and houses is required.

Finally, switch off the power of the drone and the landing is completed!

During flight
***Starting the flight**: listen for unusual sounds, check that the radio transmitter and GPS are working properly and that the battery levels are adequate.* ***While flying**: hold the radio transmitter properly, don't fly higher than 120 metres above the ground, or over animals, people or buildings. Don't interfere with emergency operations.* ***Be prepared for emergencies**: Fly higher if the compass has interference. Find out how your drone works if an engine fails or if ice builds up on the propellers. Make sure you have the right settings for RTH and keep a safe distance to birds.* ***Landing**: land either manually or automatically, at a safe distance from obstacles and people.*

5.4 After flight

After landing

When you have landed and switched off the power of the drone and other equipment, you should – if you have flown in CTR and got a permission from ATC – inform any air traffic control tower that the flight has been completed. You must also fill in the logbook or in some other way ensure that the flight has been registered. If accidents or crash have occurred during the flight, you must report them to the Swedish Transport Agency.

Check the drone

Carry out an ocular inspection to look for damage and abnormal wear and tear on and around the fuselage, cables and propellers. All loose parts, such as screws, brackets and joints, must be securely fastened. If you spin the propellers, they should not make much of a sound. A crunching noise may indicate dirt in the engine's ball bearings. If the propellers are damaged in any way, they must be replaced.

Under “Checklist” you will find an example of checklist for an ocular inspection that you can follow both before and after flight.

Batteries

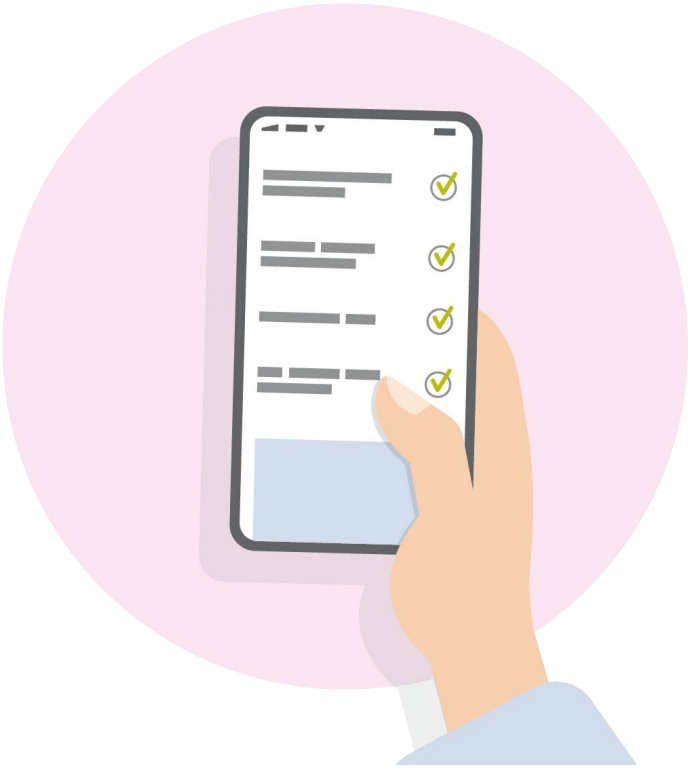
The batteries require careful maintenance. After each landing, remove them and charge them as soon as possible. The batteries should then be stored in a dark, cool and safe place on a fireproof surface. If you don't recharge the batteries so that they have a chance to discharge into "store mode", but instead leave them stored with too low charge (below 10 percent), they can take permanent damage and be dangerous to fly with.

After flight

***After landing**: inform any air traffic control tower that the flight is completed.*
***Check the drone**: clean the drone if necessary, check propellers and drone's general condition.*
***Batteries**: charge the batteries after flight, keep them in a dark and cool place, and don't leave them with a low charge.*

5.5 Checklist

Make a practice of going through checklists both before and after flight to make sure things go as smoothly and safely as possible. The lists look different, but you can customize them to your drone. Below we have provided examples of what they can look like.



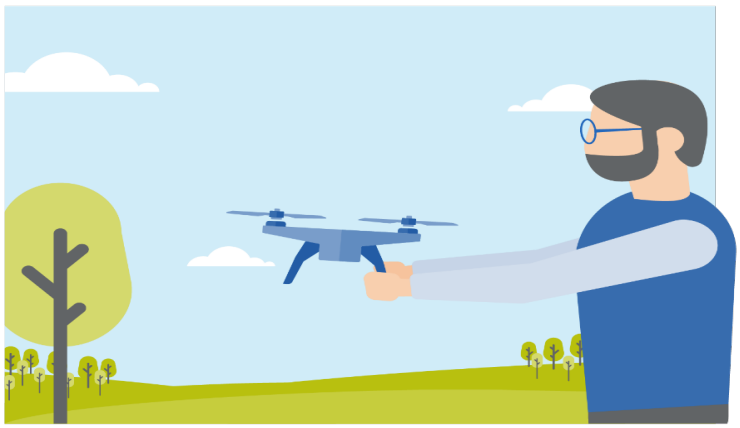
Ocular inspection

1. Are there any cracks in the fuselage or slack in the joints around the folding arms etcetera?
2. Does any unusual sound come from the propellers if you spin them with your fingers? A crunching noise may indicate dirt in the engine's ball bearings and should not be ignored.
3. Are screws, brackets, joints or fasteners loose or damaged? Replace if necessary.
4. Are the propellers damaged in any way, such as cracks? Never fly with damaged propellers.
5. Are there any loose or damaged cables?
6. Are there any loose or damaged connections?
7. Are the propeller brackets, screws and propeller locks tight? Make sure they are.

Compass calibration

You should always follow the manufacturer’s instructions for compass calibration in the drone’s manual. If you don’t have the access to the manual and you need to calibrate the compass you can follow the generic instructions below:

1. Remove watches and other metal objects from your clothing and body.
2. Turn on the radio transmitter.
3. Place the drone outdoors on a metal-free surface. Switch the power on.
4. Wait until at least six satellites are visible in the app or on the radio transmitter's display.
5. Start calibration in the app (if applicable) or via the radio transmitter.
6. Put the radio transmitter aside, stand behind the drone with the camera facing away from you, then lift the drone and hold it with straight arms.
7. Make a complete clockwise rotation in about 5–7 seconds.
8. "Tip" the drone forward so that the camera points straight down towards the ground. Complete a new rotation at the same pace as before.
9. Put the drone down and ensure that the calibration is completed.



Preparation before start

1. Are the radio transmitter and drones batteries fully charged?
2. Are there any frequency interferences that affect video and receiver?
3. Is a compass calibration needed?
4. Are the photo and video equipment mounted correctly?
5. Is the take-off position secured?
6. Are there any airspace restrictions (ref. chapter 2 for airspace restrictions, drone chart, NOTAM, AIP and AIP SUP)?
7. Start the radio transmitter first, then the drone and at last any other equipment.
8. Start the camera system (if applicable).
9. Are all control sticks in neutral position?
10. Does the direct remote identification system work properly?
11. Take-off!

During flight

1. Keep your fingers on the radio transmitter at all times.
2. Don't fly higher than 120 metres above the ground (in uncontrolled airspace) and keep the drone within your visual line of sight.
3. Rise to optimal altitude to reduce risks and noise.
4. Avoid flying over people, animals, electrical wiring and buildings.
5. Don't disturb ongoing rescue operations.
6. Immediately land the drone if a helicopter or other low flying aircraft is approaching.

Landing

1. Check the landing area for obstacles or any other hazards.
2. Land the drone at a safe distance from obstacles and people.
3. Switch the drone off.

After flight

1. If needed, inform the air traffic control tower that you have completed the flight.
2. Switch off the camera and any other equipment.
3. Carry out an ocular examination: look for damage and abnormal wear and tear.
4. Remove the batteries, recharge them and store them in a safe place.

6

Section 6: The drone and its functions – UAS general knowledge

6.1 What is a drone?

The word “drone” is an everyday term for **unmanned aircraft vehicle** (UAV) or **unmanned aerial system** (UAS) – an aircraft that is controlled either automatically, independently or by a remote pilot.

Drones come in all sizes and can weigh anywhere from a few hundred grams to several thousand kilos. They can be flown for different purposes – privately, commercially or for police work and other public operations. They can look different – some, like the common **multirotor** or **multicopter**, are similar to helicopters, while the **fixed wing drone** looks more like an airplane.

The two types differ in design and construction, and they are also used for different purposes. The multirotor drone is often used for photography and film work, while the fixed-wing drone is used to measure, map or monitor larger areas.

6.2 Services and functions that you must be able to manage

Learning how to manage a drone's system means learning to understand and maintain an entire apparatus with internal and external systems and services including various functions, settings and risks. Some of this may only be perceived as technicalities, while other parts are crucial. But regardless, you need to know all the parts and how to handle them to fly as safely and correctly as possible.

Drones with propellers

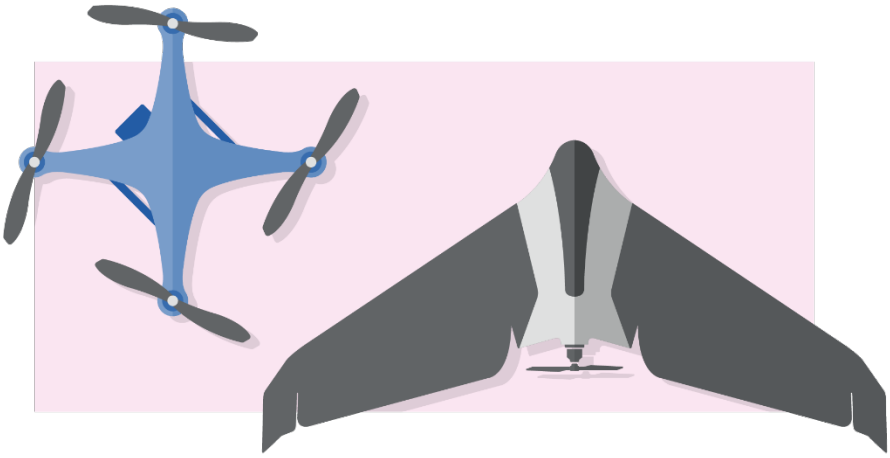
Drones can have several propellers, which, combined with the varying speeds of the engines, create lifting power and movement. Normally, the drone has four arms and four propellers: two propellers spin clockwise (CW) and two propellers spin counterclockwise (CCW). In this way, the total rotational force becomes neutral. If a drone has more than one propeller, it is classified as a multirotor drone.

It is important that the propellers are installed in the right place. Incorrect mounting will cause an immediate crash. In most drone systems, the propellers cannot be mounted in the wrong way, but it is still important to check that they are properly secured. The propellers are subjected to high loads, and may crack easily. Check the blades for cracks before start by bending them gently.

Fixed wing drones

Some drones have fixed wings. This type of drone often has one or two propellers. It has other functions and is used for other purposes than the more common multirotor drone.

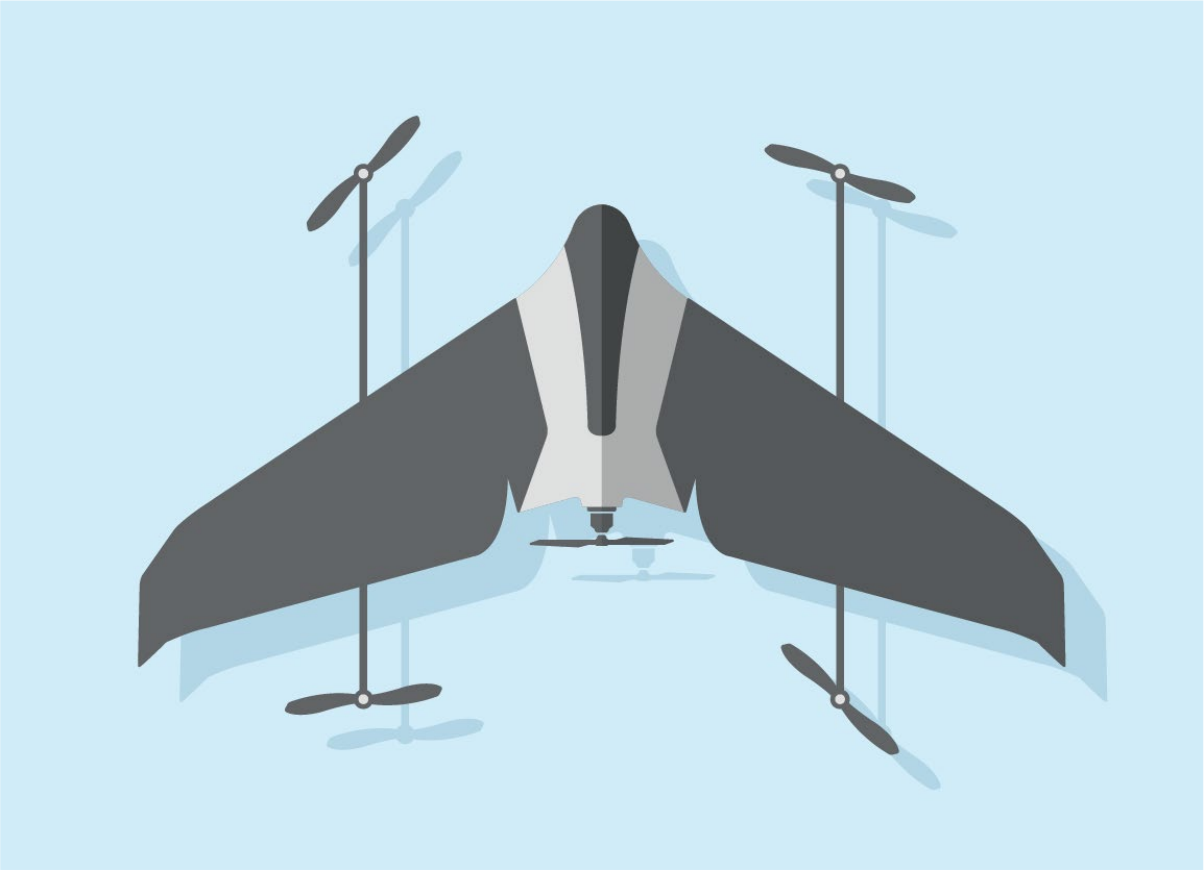
The main difference between a fixed wing and a multirotor drone is that the fixed wing type looks more like an airplane than a helicopter. These drones have longer range and flight time, and are also faster than a multirotor. Fixed wing drones often have to be tossed to start, and therefore require a runway.



The wings of a fixed wing mean the drone can handle a crash or engine loss better: the wings keep it sailing in the air, unlike a multirotor, which, if worst comes to worst, just falls straight down. However, the fixed wing cannot hover, nor can it evade obstacles as easily as the multirotor.

The camera on a fixed wing is often completely fixed or mounted in a two-axis gimbal, facing down, which can be good if you are mapping large areas. But if your purpose with the flight is to film or photograph, a multirotor with a movable gimbal is a better choice. You can read more about this further down in this document.

There are also hybrid drones with fixed wings and more than two propellers.



The radio transmitter – the drone's steering wheel

The **radio transmitter** communicates with the drone, and controls its movement and camera functions and more. If the contact with the radio transmitter is broken, many drones fly home automatically and land. It is often a default setting that can be changed.

The location of the antennas is especially important during long distance flights. It is the long side of the antenna that should point towards the drone, not the tip (the tips lack the ability to transmit and receive).

The radio transmitter communicates with the drone via radio waves on several frequencies

The drone and the radio transmitter are normally connected through radio links of 2,4 GHz and 5,8 GHz. The higher the frequency, the more data can be sent with short delay, but with shorter range as a result. A frequency of 2,4 GHz is sufficient to transmit control and HD video (1080i) at distances up to 4 km within a legal power limit of 125 mW. Longer range can be achieved with higher transmitter power and properly oriented antennas.

The GHz band is sensitive to physical obstacles, making it important to ensure unobstructed view between the radio transmitter and the drone. It becomes even more important and sensitive at longer distances.

In some cases the radio transmitter can communicate with the drone through 4G or a computer instead of the GHz-frequencies.

Identify the drone from ground

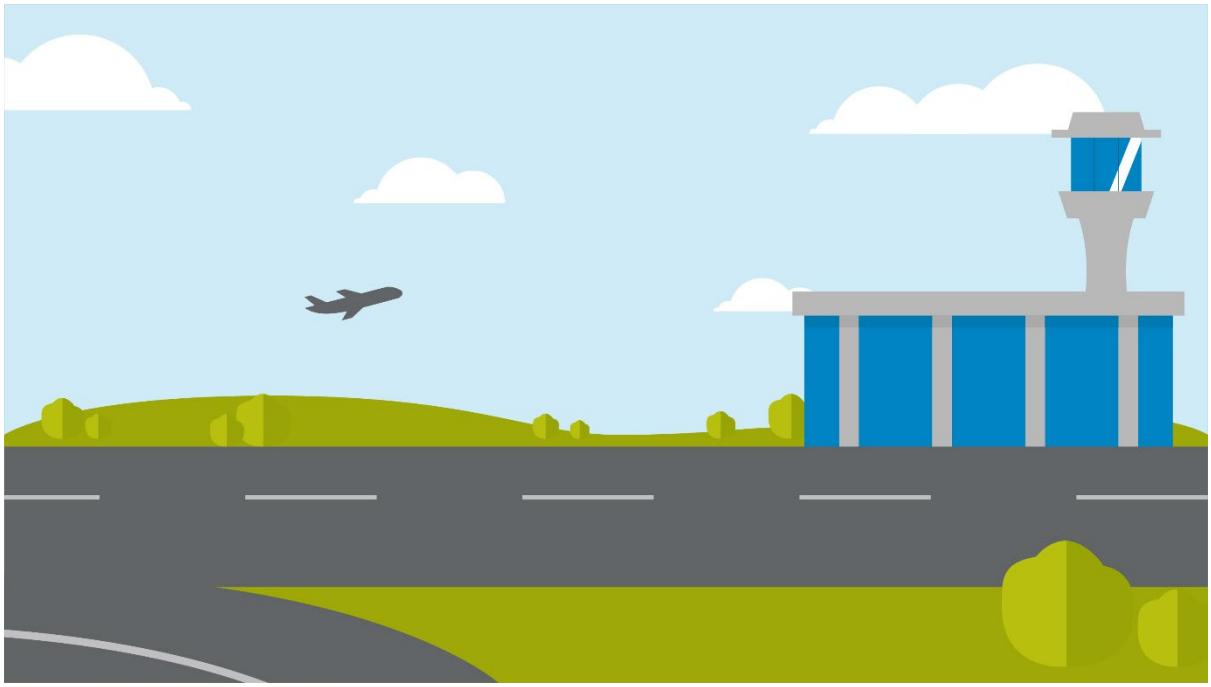
Direct remote identification can be used by the police and other authorities to identify the drone in the air and obtain information about its marking, registration, operator etc.

The drone follows you

Follow-me mode is a function available only for rotorcraft drones. Just as it sounds, the mode makes your drone automatically follow you or your radio transmitter. If you have the follow-me mode activated, your aircraft must be no more than 50 metres away from you in order for you to quickly take over the control.

Keeping track of boundaries in the airspace

After 1 January 2021, all types of open category drone systems, except C0 and C4, must be equipped with **geo awareness**. This function means that, as the remote pilot, you should be able to get information about boundaries in the airspace in relation to your drone's position and altitude etc. In addition, you should be warned of any boundary violations in the airspace.



NOTAM – information about what is going on in the airspace

NOTAM stands for “notice to airmen”. It is a service that continuously publishes important information about what is going on in the airspace. NOTAM is for all types of pilots. It is a must even for open category remote pilots to be fully aware of any warnings or flight bans while planning the route.

NOTAM can be found on LFV’s (Air Navigation Services of Sweden) website. If an area along your planned route is marked and you find it difficult to interpret the information, you can call the Flight Planning Center (FPC) and they will explain to you what it means. You can also tell the FPC when and where you intend to fly, and they will check NOTAM and AIP (see below) for you to plan your route based on that.

AIP

AIP (Aeronautical Information Publication) is a collection of data that you should read before take-off. Most countries publish a national AIP with information about the conditions of flying to, from or above the airspace and airports of different countries. In Sweden, AIP is published by LFV and you will find it on their website.

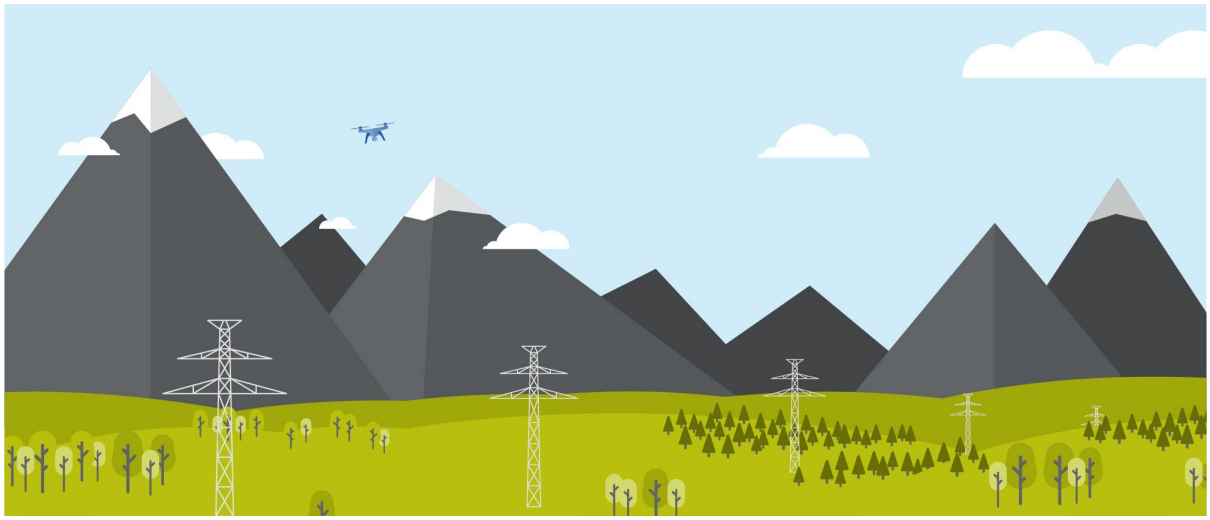
AIP SUP (aeronautical information publication supplement) contains information about both long and short term temporary changes of AIP.

RTH – drone flies to home position automatically

The RTH (return to home) function is frequently used when flying drones. RTH makes the drone automatically fly back to the start position or to your radio transmitter, depending on which setting you have chosen.

If the communication between the drone and the radio transmitter is interrupted for a number of seconds, RTH can be activated as a safeguard. The drone will then fly to the start position at the preset altitude and land automatically.

It is important to understand that the altitude at which the drone flies home is always in relation to its starting position. This means that the drone doesn’t understand the actual height from the ground – collisions with masts, high mountains etc. can occur on the way back to the start position. However, some drones have anti-collision sensors that can see and avoid obstacles.



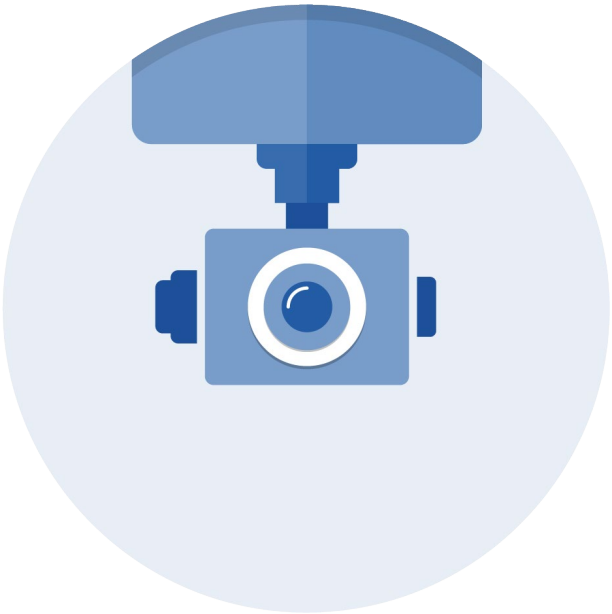
The RTH function can also be activated manually, if, for instance, you lose the orientation of the drone or if the video link breaks. Don’t use RTH if there is a problem with the compass.

Drone’s built-in compass calibration

Calibrating the **compass** is important for the drone system to sense the Earth's local magnetic field. If, at a new location, a calibration is performed incorrectly or not at all, this may result in a crash and the drone exhibiting irregular and unpredictable movements. Find out how you perform compass calibration under “Checklists” in section 5: Operational procedures.

Keeps camera stabilized

The purpose of a **gimbal** is to counteract the drone's movements and vibrations during the flight, in order to keep built-in or external camera stabilized. The result is a horizontally straight image without shaking. Fixed wing drones don’t always have gimbals, but may instead have a fixed camera facing down, depending on the purpose of the flight.



Maintenance of drone’s batteries

All C rated drones, except C4, have to be powered by electricity and therefore require batteries to be able to fly. In the case of privately built drones, there may be other requirements. Batteries are sensitive and require special treatment. Cold temperatures can be harmful so the batteries are best kept at room temperature before every flight. A piece of advice is to keep the batteries in your jackets inner pockets. A cold battery has a less capacity and can cause a crash in the worst case scenario. Some drones have built-in protection that measures the temperature of the battery, alerting the remote pilot to low temperatures and suggesting what to do during cold operation. Don’t ignore these alerts – take them seriously! Some drone systems can also preheat the batteries before flying.

You should charge your batteries according to user manual and store them cool and never in direct sunlight.

Many modern drones have a "store mode": if the next flight doesn’t happen within ten days from charging, the battery will automatically discharge to about 60 percent. This is done to protect the batteries, since they may be damaged if fully charged for an extended period of time.

If the batteries are stored with a low charge (below 10 percent), they can take permanent damage and be dangerous to fly with. Therefore, make sure you charge them as soon as possible after flight.
You should be aware that Lipo (lithium polymer) batteries – the most common type of battery in drone systems – require a special type of fire extinguisher. Therefore, find out what type of batteries your system has and what type of extinguisher is required.

The drone's motive power

All C rated drones belonging to the open category, except C4, must be powered by electricity. What is important then, is to make sure that the electricity generated inside the drone is not harmful to you or to anyone else. Therefore, specific requirements are imposed on the manufacturer, depending on the C rating of your drone. Check what applies to your drone. However, privately built drones do not have to be powered by electricity.

In addition, as the remote pilot, you should be alerted in time if the battery level starts to get low. This is essential to enable you to land as safely as possible.

Lighting is required

In order to improve the conspicuity of the unmanned aircraft flown at night, and in particular, to allow a person on the ground to easily distinguish the unmanned aircraft from a manned aircraft, a green flashing light must be activated on the unmanned aircraft.

7

Section 7: Spreading and handling data properly – integrity and data protection

With a drone, you can produce images of many things from the air. You have to be aware that there are things you are not allowed to photograph, monitor or spread and in some cases you need a permission to do so. In this section, therefore, we will go through everything you need to know as not to break any rules regarding privacy and data protection as well as protection of geographical and other sensitive information.

7.1 The regulation that aims to protect your integrity

The General Data Protection Regulation (GDPR) is a regulation for everyone in the EU. Its purpose is to protect everyone's integrity from being violated and to ensure that information about people is used properly.

When it comes to drone use, it is important to take the GDPR into account, because so much can be pictured from the air during a flight.

Those who handle personal data, such as companies, associations and authorities, have **accountability**. This means that they must comply with the GDPR principles – but also show how they comply.
Find out more about GDPR and the rules regarding accountability on their website.
https://www.imy.se/en/organisations/data-protection/this-applies-accordning-to-gdpr/the-gdpr-fundamental-principles/

The principles means among other things that data controller must be sure that GDPR supports handling of personal data. It is important to bear in mind that personal data can only be collected for specifically stated and legitimate purposes. You are not allowed to handle more personal data than what is needed for the purpose. Personal data shall be correct and shall be deleted as soon as it is not needed any more. Personal data must be protected of unauthorized access and must not be lost or destroyed inadvertently.

The Swedish Authority for Privacy Protection (Integritetsskyddsmyndigheten) is the authority that has regulatory responsibility and carries out inspections that GDPR rules are being followed.

What counts as personal data?

Personal data is anything that can be linked to a natural person who is alive. It is anything that can be used to identify a person, from names, addresses, e-mails, phone numbers and ID cards to different registration numbers, photos, voice recordings and character descriptions so that a person can be identified.

More sensitive information relating to a person's health, ethnic origin, political opinion and sexual orientation has special protection and may only be collected and used if the person concerned approves of it or if the country's law allows it.

7.2 Picturing objects from the air, and spreading the pictures

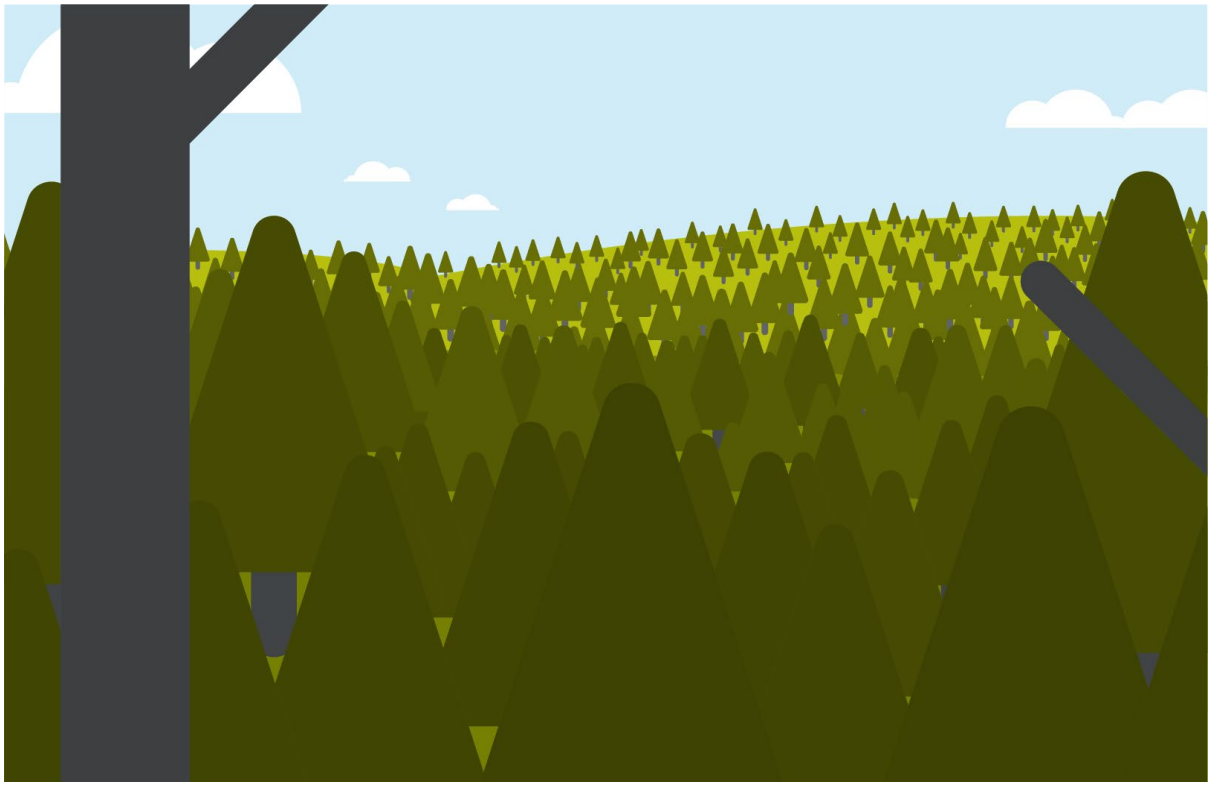
To avoid violating GDPR principles while flying, avoid taking pictures or video with the drone's camera until you are at a high altitude, so that people on the ground cannot be identified. Don't take any pictures or video when you are at a crowded places. Generally, it is good to fly at times when fewer people are out and to avoid flying in much frequented areas.

Data Protection Regulation is valid only if you make recordings of identifiable persons or other personal data. Taking pictures or video with the drone can be classified as CCTV if persons constantly or repeatedly are present on recordings and can be identified. Private persons have normally right to have CCTV of their property or house. This includes for example garden and other private buildings such as garage or storage. It is important to notify that area is covered by video surveillance.

If a video surveillance is allowed or not depends on cameras field of view. If the video surveillance is legal or not depends on what is captured by camera regardless of purpose. It is important to check the camera's field of view so it does not capture other people's backyards, pavement or the street outside your home or any other public place where people might be. You are not allowed to have video surveillance of buildings, cars or boats being used professionally or in the line of work.

There is protection against the dissemination of personal data as well as protection against the dissemination of geographical information.
In addition to complying with the GDPR, you must be aware that certain places, buildings etcetera are protected by photo bans. For example, you are not allowed to take photos of companies, protected objects, or private areas where photo bans prevail. This is valid for photographing or producing images using laser scanners, thermal cameras, radar or any other form of imaging function. There are signs posted with information about photo ban where you are not allowed to take pictures.

But keep in mind that forests are often private property. Of course, if you are yourself the owner of the forest you intend to picture, you can spread the material as you wish – as long as it doesn't contain images of the sky, the horizon, or buildings or other constructions that are not related to the forestry.



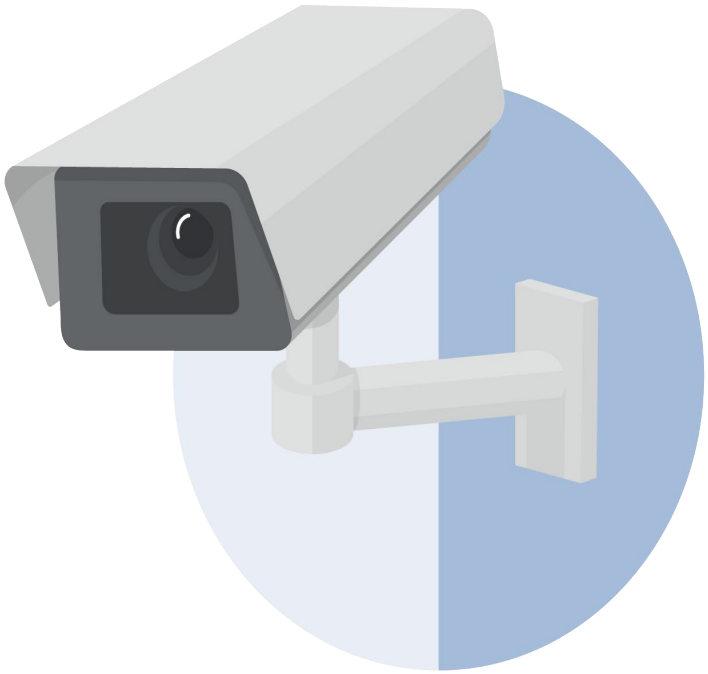
You may need to apply for a dissemination permit

If you are going to distribute or publish material you filmed or photographed during a flight, in social media, on websites or similar, you may need a dissemination permit issued by the Swedish mapping, cadastral and land registration authority [https://www.lantmateriet.se/en/about-lantmateriet/Rattsinformation/permit-for-dissemination-of-geographical-data/] or Swedish Maritime Administration [http://www.sjofartsverket.se/sv/Batliv/Sjokort/Copyright--nyttjanderatt/Spridningstillstand/]. If you accidentally spread material containing sensitive information, you run the risk of punishment. If you violate the Geographical Information Protection Act, you may be fined or imprisoned for up to one year. Keep in mind that you cannot store material that is confidential on cloud services: the companies that own these services may have access to the content, which means the storing is classified as dissemination.

What can be spread without permission?

Generally, it is not allowed to disseminate images or films, although there are some exceptions. If the horizon is not displayed in the image or the film, it may be possible to use one of these exceptions. [Undantag | Lantmäteriet (lantmateriet.se)]

Areas that you can photograph and spread without permission are public places, public events, residential buildings, arable land, golf courses and construction sites. But don't forget to follow the rules of GDPR regarding the processing of personal data!



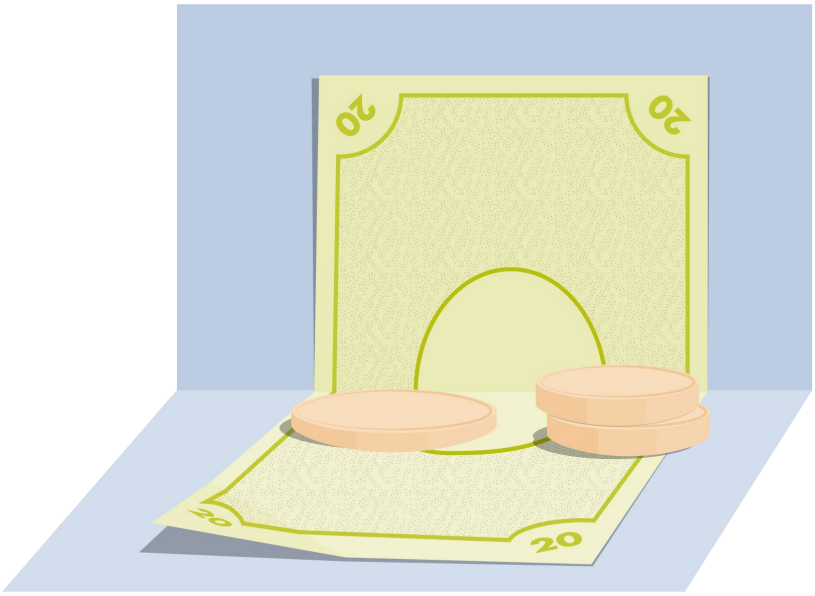
8

Section 8: How to be safe in case of accident – Insurance

In this section, you will read about insurance – what types are suitable, what they cover and why you might want to take out an insurance policy. According to the EU rules, every drone that weighs over 20 kilos must be insured. Even though insurance is not obligatory for most of the drones in the open category, it is a good idea to be insured in the event of an accident. If you are not the operator but only the remote pilot, it is a good idea to make sure you know if or how the drone you are going to fly is insured. Every operator is responsible to have its drones insured.

8.1 What is insurance?

Insurance is basically about spreading and sharing risks. That is, several people pay a smaller amount, a so-called premium. The premiums are then put together in a pot. If any of the insured people suffers an injury or accident, that person will receive an amount of money to compensate for the loss.



The amount payed for the premium depends on probability of accident, but also on the cost of the potential damage. Insurance is often optional, but it may also be obligatory, as in the case of third party liability car insurance. This is something that we will go deeper into in this section: liability insurance for drone operators.

8.2 Which insurance is suitable for drones?

There are many different types of insurance, but for those who fly drones, there are mainly two that are important to be aware of: liability insurance and non-life insurance. There is no requirement for drone operators to have non-life insurance – but liability insurance for those flying drones over 20 kilos is obligatory and, in addition, recommended for all weight classes. If an accident occurs while conducting an illegal or unapproved flight it will not be covered by insurance.

If you ruin it for others...

Liability insurance, or third-party insurance, covers what you cause to others but not what you cause for yourself. If an accident occurs – your drone might crash into someone else's property – the liability insurance covers the cost of the damage that the drone made on the other person's property, but not the cost of the damage on the drone itself.

If you don't have liability insurance, the cost of compensating what has been destroyed in an accident may be very high – so high that it can be difficult to cover for a single person. In some cases, you may even have to pay indemnity if you hurt or damage someone else or their property.

However, if you have been grossly negligent or in some other way violated the law, your liability insurance will not apply. In those cases, you have to bear the cost yourself.

... or ruin it for yourself

Non-life insurance, also known as general insurance or property insurance, covers what belongs to you. For example, if your drone breaks down in a crash, in a fire or gets stolen, the damage will be compensated by the non-life insurance except for the excess cost.

What is covered by the home insurance?

Often, both non-life and liability insurance are included in a **home insurance**. However, many home insurance policies may have limitations when it comes to flying drones –some policies do not cover drones at all. This means you should not take for granted that you are covered before checking what your home insurance covers.

Flying on behalf of someone else

If you get paid or receive some other form of compensation for conducting a flight, the home insurance usually does not apply. If you are self-employed, you will therefore need a business insurance. As with home insurance, the business insurance is often limited when it comes to drone operations. Choose insurance and insurance company carefully, or be sure to know what is included in your business insurance if you already have one.

If the drone is damaged during transport

If you need to engage a transport company to move your drone and it gets damaged during transport, you will usually only receive compensation in relation to the weight of the drone. This usually means a big financial loss. Therefore, it may be a good idea to take out a transport insurance. This can be done through some transport companies directly, or at various insurance companies. Also, many business insurance policies cover transport damage. Keep this in mind if you are planning to take out such an insurance or already have one.

8.3 Choose the right insurance company

Different insurance companies have different conditions regarding what damage is covered or limited in their insurance policies. Therefore, find out the conditions of the companies' policies and choose the one that suits you and your purpose best – especially since many companies have restrictions and limitations when it comes to drones.

8.4 Different rules in different countries

Different countries, even within the EU, may have their own rules and requirements for insurance. So, in addition to checking which laws apply in the country you are about to fly in, check where your insurance applies geographically.

To consider before choosing insurance

Requirements: *Every drone operator who has drones over 20 kilos must have insurance that covers the cost of damages to others. However, this is recommended even for operators of lighter drones.*

Fly privately: *Check the terms and conditions of your home insurance.*

Fly commercially: *Check the terms and conditions of your business insurance.*

Special insurance: *If you are not fully covered by your home or business insurance check out special insurances that are more suitable.*

Flying abroad: *Make sure your insurance covers any damage caused abroad and find out if there are any national rules in the country you are about to fly in.*

9

Section 9: Counteract crime against aviation – Security

Aviation security aims to prevent crime against aviation. Passengers, crew, ground personnel, the public and property must be protected against sabotage, hijacking, hostage-takings etcetera. Drone use is not currently affected by the aviation security measures, but as a remote pilot you must know what it is and why it is there.

9.1 The Swedish Transport Agency is responsible for the aviation security

In Sweden, the Government has appointed the Swedish Transport Agency to be responsible for and develop the **Swedish National Security Program** (NASP), which includes all rules and requirements regarding aviation security. [hyperlänk: https://www.transportstyrelsen.se/sv/luftfart/Luftfartsskydd-security]

Although this program contains Sweden's national requirements, the national requirements in turn are, to a great extent, governed by international rules and common EU rules. The common EU rules can be found in Regulation **(EC) No 300/2008** and Regulation **(EU) No 2015/1998**.

Different requirements in different countries

Because each country has its own authority responsible for aviation security, the rules and requirements may look different depending on where you are.

10

Section 10: How the flight is affected by the weather

As a remote pilot of category A2 drones, you will pose a greater risk to people and objects on the ground. Therefore, you must have extra knowledge about how the weather and meteorological conditions affect your drone and flight.

10.1 How is the flight affected by the wind?

Drones are sensitive to wind, and there are several factors, including the meteorological conditions of the flight, that affect the drone's performance. For example, the size of the drone can be crucial to its ability to withstand the wind. The wind has usually higher velocity at higher altitudes and changes direction (directional gradient).

For every drone, the manufacturer has recommended a maximum wind speed in which to fly. Make sure that you always follow the recommendations, so that your drone does not drift away in the wind or crashes.

If the drone carries a payload

If it is windy and your drone carries a payload, the settings of the **center of gravity** (CG) may shift as the weight distribution on the drone changes. It can get the drone out of balance and, in the worst-case scenario, cause it to crash. Make sure that the payload is properly fastened so it doesn't move during the flight, disturbing the drone system. In addition, the payload means the drone will have more drag, potentially making it harder to move forward.

You should always keep in mind that a drone carrying payload may not be able to fly in the maximum wind speed recommended by the manufacturer.

Wind can prevent the drone from returning home

As a safety measure, on some drones the RTH function will be activated if the system detects that the drone has only just enough power to return home (based on the distance to the home point). But the system's calculation doesn't include the force and direction of the wind. The drone might have a hard time moving forward in headwinds or strong winds – and as a result might not reach the home point in time, like the system calculated it would. It may then land in the wrong place. It may be wise to start on the leeward side of an area if the wind is strong.

10.2 Fog? Rainfall? Thunderstorm? Keep this in mind!

Many drones are not **IP rated** (classification of how well an electrical device can withstand dust and water) and are therefore sensitive to rain, heavy fog and snow. Also, avoid flying during thunderstorms, as metal parts and batteries in the drone can attract lightning at high altitudes.

Always check what your drone withstands according to the manufacturer's instructions before flying in humid or wet weather.

The sensors can be negatively affected

Many drones have IR sensors, which are also sensitive to water accumulations, snow, direct sunlight and any shiny and reflective surfaces. This may cause the sensors to miscalculate distances – in the worst-case scenario resulting in a crash.

In addition, drones often have sensors in the form of cameras, which may be sensitive to moisture. And because visibility is crucial to the function of these cameras, they also perform poorly during rainfall or fog.

Radar sensors are less sensitive to wet weather than other common sensor types.

Humans are also affected by the weather

Just like sensors, humans may perceive worse the surroundings in poor visibility. That is a reason to fly more cautiously or not at all in poor weather conditions.

10.3 Flying drones in cold temperatures

Different drones withstand cold differently. Just as mentioned in previous sections, you should read the instructions from the manufacturer to make sure you are aware of your drone's capacity – and act according to the instructions.

There are two important factors you must consider while flying in temperatures below the freezing point:

- the risk of ice building up on the propellers (icing)
- the risk of the batteries getting cold.

Ice buildup on the propellers can have major consequences, as the propellers will not produce the power they need for a safe flight. On top of that, cold batteries have a reduced capacity to supply the drone with energy (the batteries should preferably be heated before the flight). Also, keep in mind that the temperature is usually lower at high altitudes.

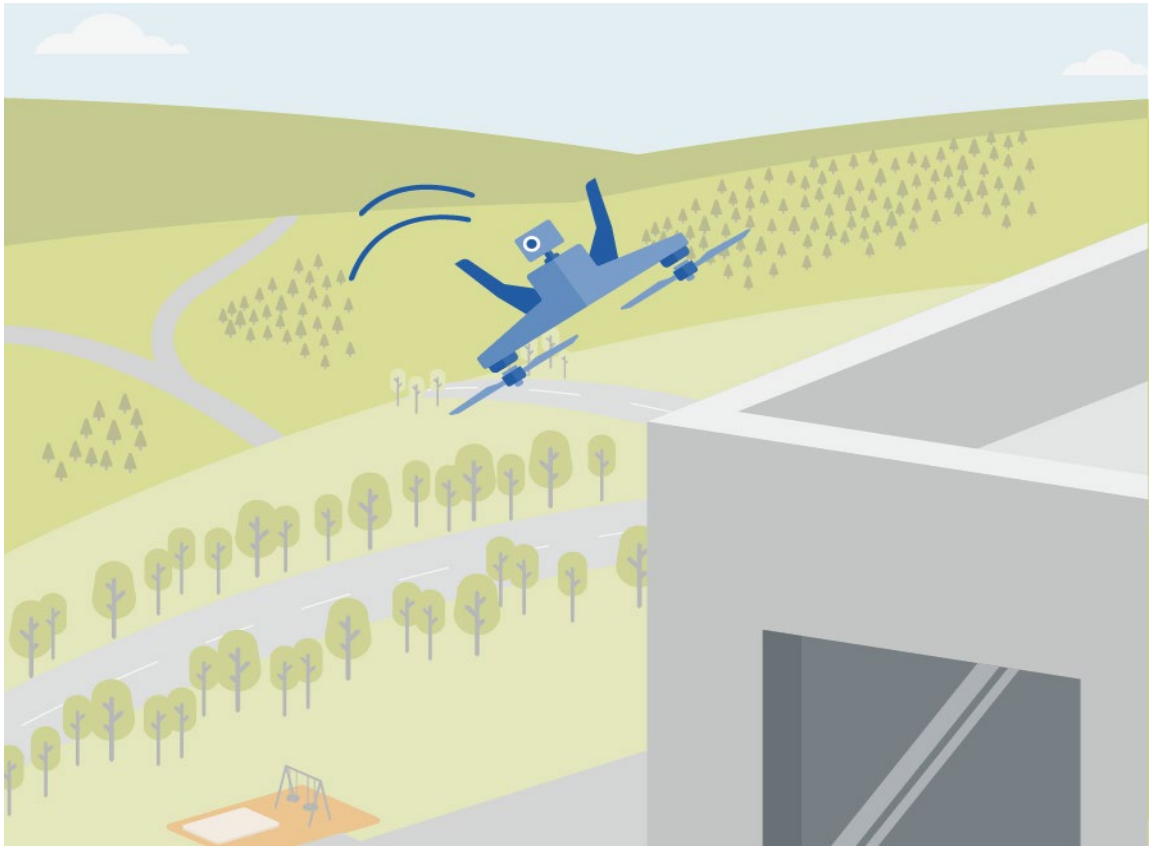
10.4 The air has different density at different altitudes

At higher altitudes the air is thinner, which may affect both the propellers' and the fuselage's movement through the air. The propellers produces less lifting force, the thinner the air is. Therefore, when flown at higher altitudes, some types of multirotor drones may need special propellers with another pitch and span.

10.5 Turbulence can affect your flight

Turbulence is caused by moving air that is prevented from having an even flow, instead swirling and fluctuating in force.

The disturbed flow can be caused by several factors. One of them is **thermals** – columns of rising air occurring when the sun warms the ground, which in turn warms the air directly above it, causing it to rise. However, thermals don't usually affect drones in the open category to any great extent; above all, it affects manned and unmanned aircraft flying at higher altitudes.



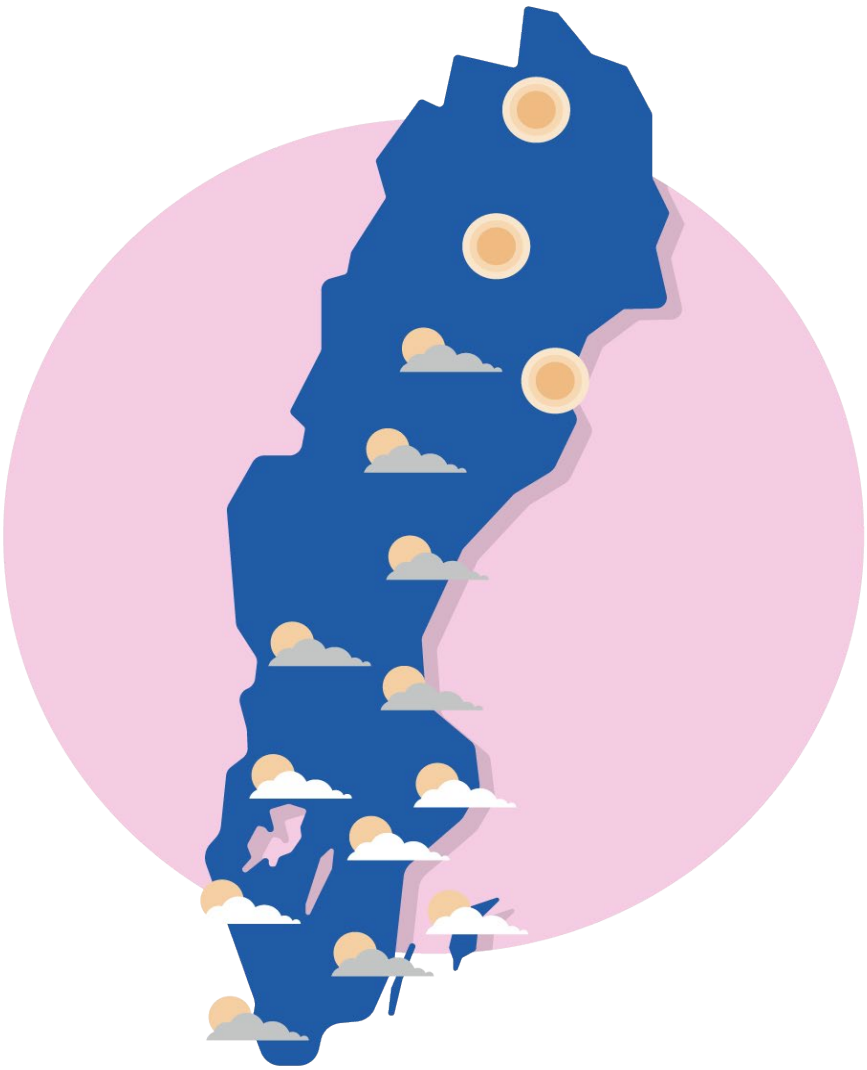
Mechanical turbulence decreases with altitude – there is basically no turbulence 50 metres above an object. The wind velocity, on the other hand, increases at high altitudes as explained in previous text.

How the flight can be affected by different meteorological factors:

- *Windy weather: Both the drone's ability to move through the air and its balance can be disturbed by strong winds. Always make sure to attach any payload properly.*
- *Humid weather: Many drones lack IP rating and are therefore sensitive to rain, fog and snow. Drones can also attract lightning and, in addition, some of the drone's sensors can be adversely affected during rainfall or fog.*
- *Cold temperatures: The risk of ice buildup on the propellers and batteries getting cold at freezing temperatures must be considered.*
- *Air density: The propellers has less air resistance, the thinner the air is. The air gets thinner at higher altitude.*
- *Turbulence: Mechanical turbulence may affect your drone if you fly between buildings, mountains or other high objects that interfere with the even flow of the air.*

10.6 Keep yourself updated on the weather

Regardless of the subcategory you fly in, before each flight you must check the weather forecast for the period when you plan to fly, and be aware of your drone's limitations.



11

Section 11: Flying a drone

In the previous sections, we have taken you through a lot of information about drone operations. Now we will present the remaining batch of facts necessary for category A2 drone pilots.

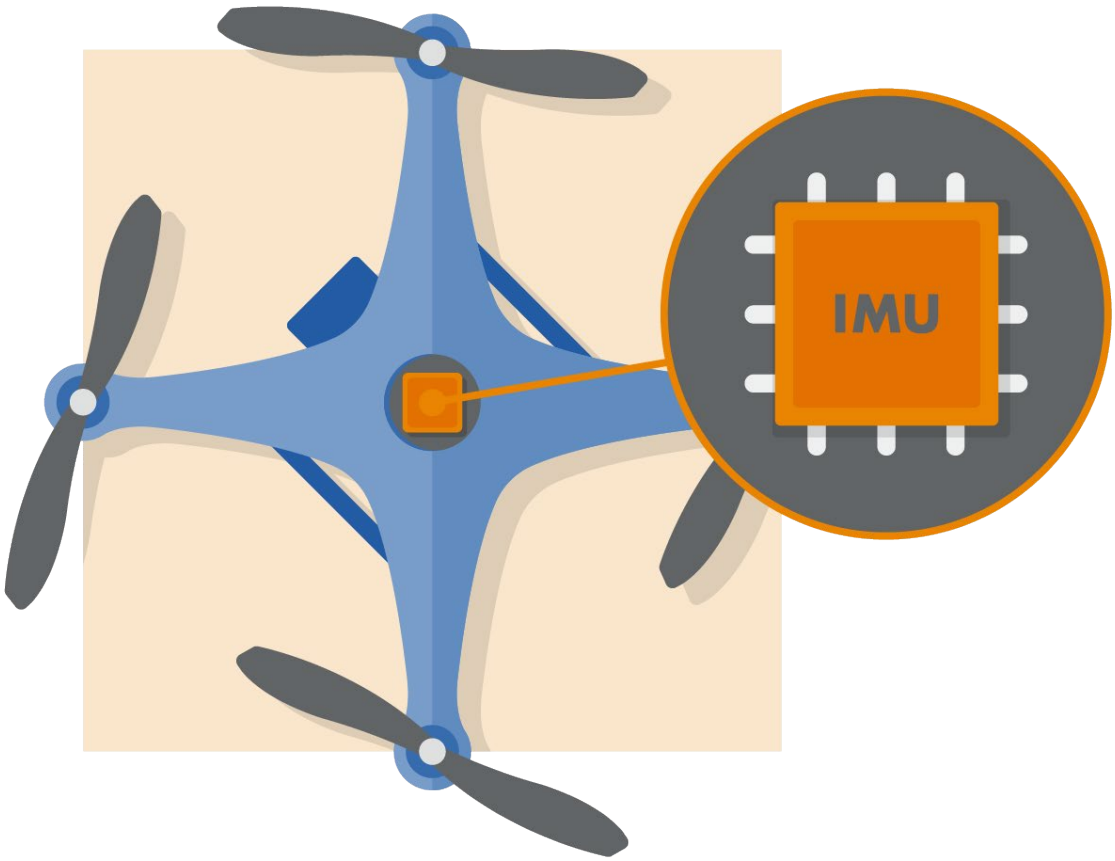
11.1 How the drone works

Drone's brain

All drones have a **control system**. This part of the drone can be described as its brain. It handles and takes into account information, then relaying this information to the drone's speed control and engines to maintain stability and position.

An important part of the control system is the **Inertial Measurement Unit** (IMU). This unit senses the drone's attitude and movement in relation to the ground, and is crucial for the drone's stability.

Two other important parts in many control systems are the **GPS receiver**, which calculates the drone's position, and the **barometer**, which compensates for the GPS receiver's less accurate calculation of altitude. The barometer means the altitude can be more precisely established.



How do the engines work?

The drone's **engines** task is to drive the propeller which generates lifting force. By varying the engine speed, the engine will generate exactly as much lifting force as is required by each individual arm, so that together, the arms can keep the drone in the air.

The ESC controls the engine speed

The drone's **Electronic Speed Controller** (ESC) controls the engine speed. The rate of change of the engine speed is measured in Hz (Hertz).

The gimbal stabilizes the camera

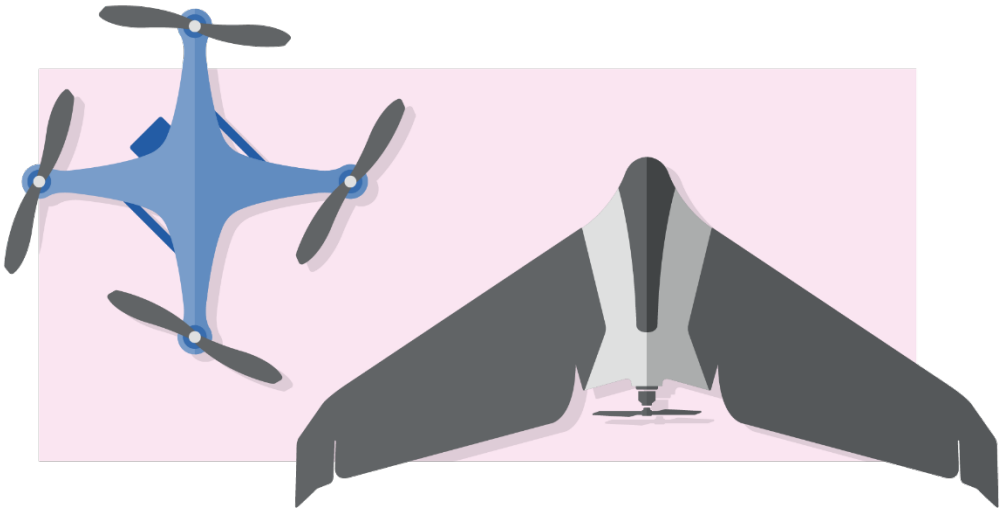
The drone stabilizes its camera using a "**gimbal**". The gimbal can be of a two-axis or a three-axis variety. With a two-axis gimbal the camera is stabilized vertically and horizontally, and with a three-axis gimbal the movements will soften if the drone rotates around its own axis.

The gimbal has engines on each axis to keep the camera stable and horizontal. These engines are often fragile and should be handled with care.

Drones with propellers

The most common drone is the helicopter-like **multirotor drone**. It is called multirotor because it usually has more than one propeller. These drones are often made of plastic, but the propellers can be made of carbon fiber.

Multirotor drones are distinguished by their ability to hover – which means they don't need a runway.

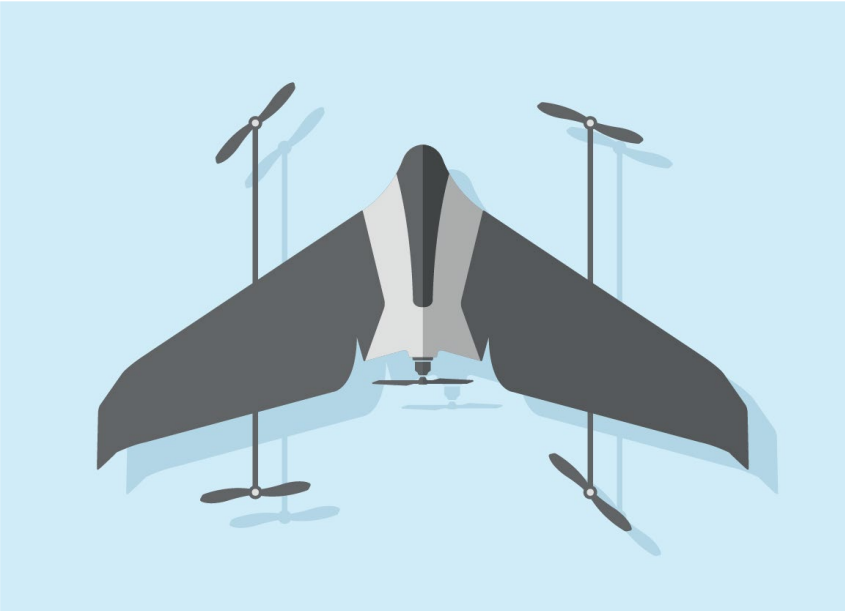


Drones with wings

One type of drone is similar to airplanes, because it has wings: the **fixed-wing drone**. The wings are often constructed of lightweight materials, such as styrofoam, to be as light as possible. The wings mean the drone is not entirely dependent on the electrical power generated by the batteries. Therefore, it can fly for a longer time, but also handle an engine failure better than a multirotor drone, which, if worst comes to worst, just falls straight down.
Unlike multirotor drones, fixed-wing drones usually have to be tossed or launched and they also require a runway to land.

Hybrids with both wings and propellers

Drones with wings are available both with and without propellers. Although drones with wings may have one or more propellers – those with two or more are often **hybrids**, with similarities both to multirotors and regular fixed-wing drones. To be classified as hybrid, the drone must be able to hover and thus start and land in a vertical straight line (just like the multirotor drone). Hybrids are more sensitive to wind compared to multi-rotor drones.



11.2 Flying with a payload? What you need to keep in mind

A **payload** is anything that is not originally part of the drone. The carrying capacity depends on what type of drone you fly –for some drones, the recommendation is not to fly with payload at all. An example is the fixed–wing, which cannot usually carry as heavy loads as a multirotor. Read the manufacturer's instructions about your drone’s capacity. It is also important to check that the total mass (drone plus payload) doesn’t exceed the maximum limit specified by the manufacturer or limit for the drone’s category.

Ordinary equipment also counts as a payload

You might think of payloads primarily as items or subjects to be transported between two points. But ordinary equipment attached to the drone, such as cameras, gimbals and propeller guards, counts as payload as well. Such equipment can result in decreased flight performance, because the air resistance and the total weight increase. Always keep this in mind when flying with payload.

The drone's center of gravity can be affected

A drone has a set **center of gravity** (CG), which cannot normally be changed or recalibrated manually. You must check it and take it into account when flying with a payload. Be sure to attach the load

- as close to CG as possible
- as tightly as possible, and as close to the fuselage as possible, since loose parts that move during flight can affect the drone's CG and thus make it lose balance.

The CG varies with the type of drone, and on some models, it is possible to recalibrate it. Sometimes, recalibration may be necessary – for instance, if the payload is attached to the rear part of the drone. Also, keep in mind that the drone's batteries can get hot during flight – if they are covered by the payload they can get overheated.

11.3 A drone is powered by its batteries

The **batteries** of a drone require careful maintenance. After each landing, you need to remove them and recharge them as soon as possible. The batteries must then be stored in a dark, cool and safe place with a fireproof surface. If you don't recharge the batteries so that they have a chance to discharge to store mode, but instead leave them stored with too low charge (below 10 percent), they might take permanent damage and be dangerous to fly with. Many batteries also require special fire extinguishers if they catch fire.

It is important to keep in mind that

- a battery is a consumption article and cannot be recharged indefinitely
- the capacity of the battery decreases with each charge.

The manufacturer's user manual contains a recommended maximum number of charging cycles.

How many cells do your batteries have?

Batteries consist of a number of **cells**. How many cells a battery needs depends on the mass of the drone. The battery may work, but that doesn't mean all cells are working properly. It is not possible with the naked eye, to check whether a battery cell is damaged, but most drone systems will warn you if this is the case.

Most of the time you can check the condition of the cells on the radio transmitter's display. The cells electric potential are measured in volts and all should be at the same level. If the power of one cell differs from the others', you should charge the battery to the max (100 percent) to check if all cells can reach the full level. If they cannot, you should not fly using that particular battery.

The most common battery type for drone flying

Lipo batteries (lithium polymer) are the most common drone batteries. Although there are other types of batteries, lipo is the one that can best withstand high rate of discharge. In smaller drones – which don't need the high discharge rate of lipo batteries – less powerful batteries may suffice. This, instead, means longer flight time. Find out below how to calculate the effect.

How to calculate the energy

By multiplying the voltage by the capacity, the **electrical energy** of the battery is calculated. The unit of energy is watt hours (Wh). For example, if a cell has 3,5 V in voltage and 3 Ah in capacity, its electrical energy is 10,5 Wh.

V x Ah = Wh

How to calculate the effect

The **effect** of a battery's cell is measured in watts (W) and calculated by multiplying the voltage by the electric current, whose unit is amperes (A). The effect is time dependent, and if the cell is discharged at high electric current it will have high power – but the capacity will be consumed quickly and the discharge will not last that long:

- If a cell is discharged with 3 A, the power will be 10,5 W, and the discharge can last for one hour.
- If the same cell is discharged with 10 A, the power will be 35 W, but the discharge will only last for about 18 minutes.

V x A = W

12

Section 12: What can you do to reduce the risks on the ground?

12.1 Learn how to handle the drone's low-speed mode

Some drones have a **low-speed mode**. When this mode is activated, the drone system may act in a number of different ways, depending on drone model and manufacturer. In some drones, more sensors are activated, and in other drones movement is softened for a finer and more controlled flight. In some cases the only difference is the lower speed.

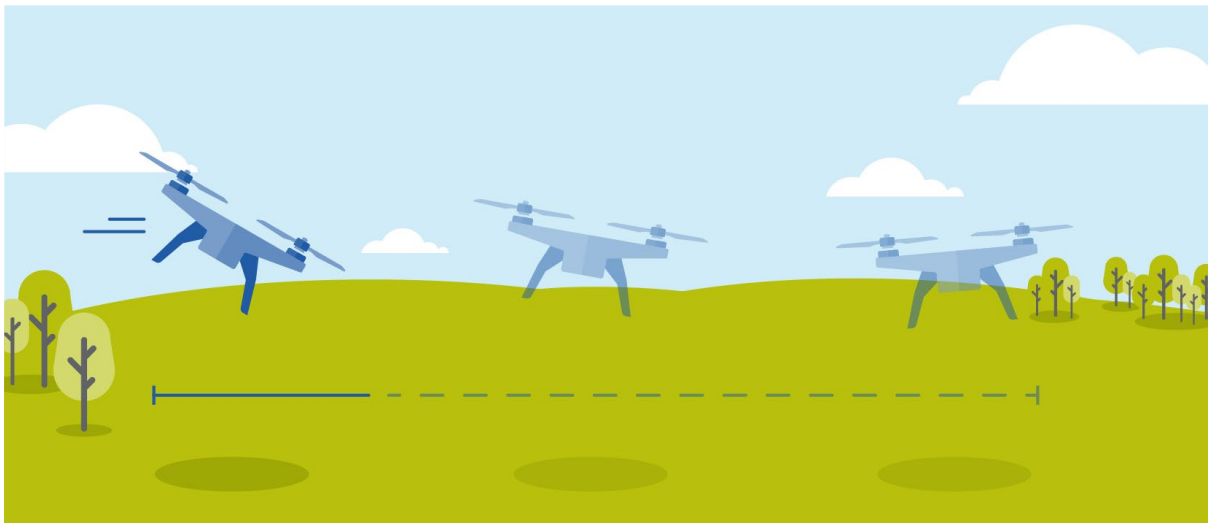
If you are going to fly drones in subcategory A2, it is important that you learn how to handle the low-speed mode of your drone properly and that you understand that the low-speed mode works differently in different drones. Since you are allowed to fly as close to people as 5 metres with this mode activated, you pose a great risk, which must be compensated for by good skills. You set the low-speed mode's maximum speed via the radio transmitter. Any speed below 11 kph (3 m/s) is allowed.
But remember: even though you get to fly close to people, you are never allowed to fly over the crowds!

12.2 Make the right risk assessment when flying close to people

Before posing a risk to people, animals or objects on the ground by flying close to them, you must have a good understanding of how your drone is acting in the air.

Take the braking distance into account

One of the things you need to do is check the maneuverability of the drone. This includes finding out how fast the drone brakes and the **braking distance** it requires. Even if you brake abruptly, you must keep in mind that the drone will continue to move in flying direction. How far it will continue depends on its size, mass and air resistance.

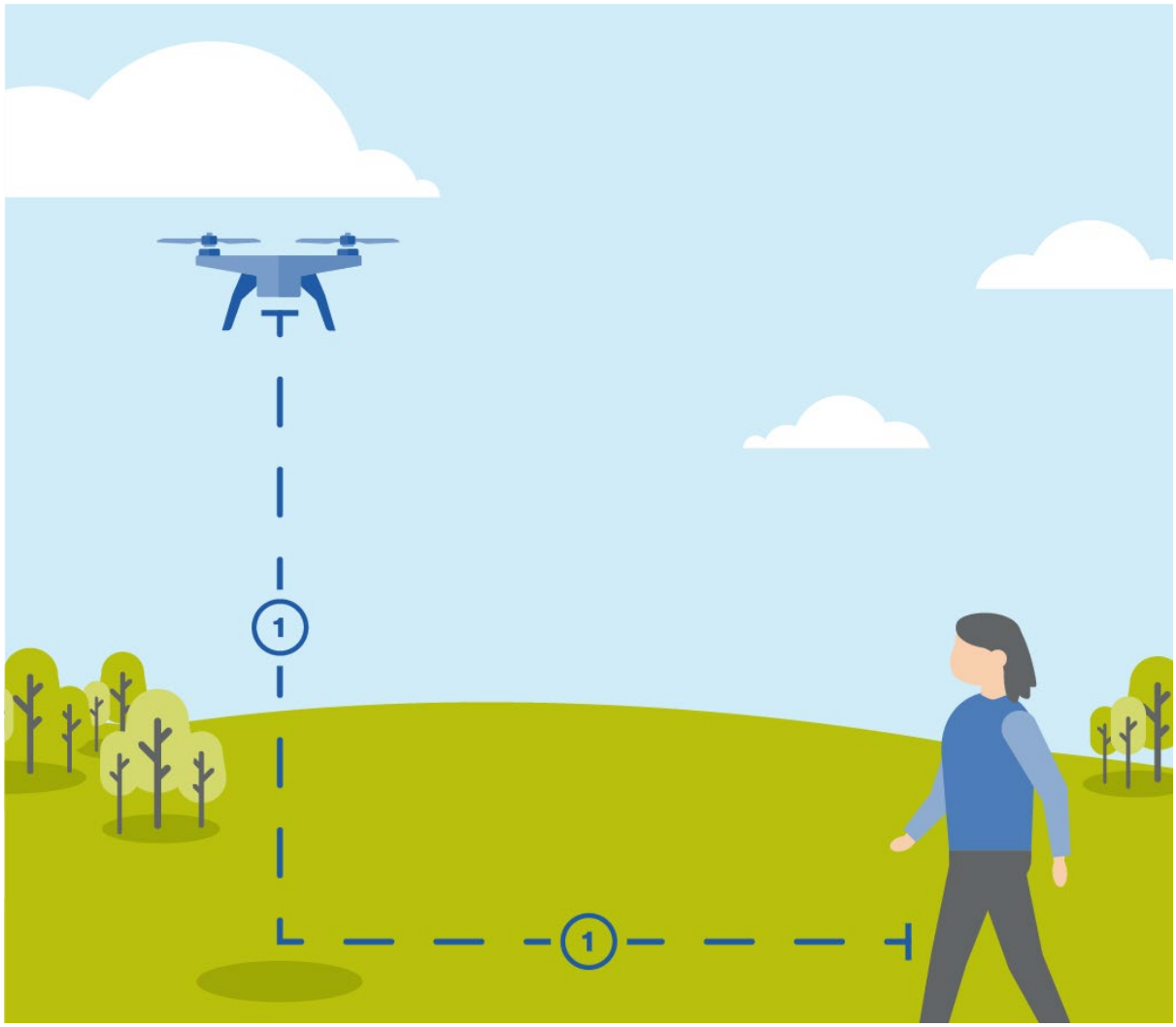


If the drone hovers

When you let your drone **hover** in the air, it is important that you pay attention to the activities on the ground. People in the area who are not involved in your flight never carry any responsibility and should never have to adapt to you and your drone – not even if the drone just hovers in the air. For this reason, it is important to take action immediately if you notice people moving towards the drone – to prevent anyone from getting hurt.

12.3 What does the 1:1 rule mean?

When the drone is operating in close proximity to people, the remote pilot should keep the drone at a lateral distance from any uninvolved person that is not shorter than the altitude. I.E. if the drone is flying at a height of 5 m, the distance from any uninvolved person should be at least 5 m.



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