Safety and Airspace Regulation Group

Unmanned Aircraft System Operations in UK Airspace – Policy and Guidance

CAP 722 | Ninth Edition Amendment 1

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The latest version of this document is available in electronic format at www.caa.co.uk/cap722

Contents

Revision History

Note: Changes made since the previous published edition are notified in red underline. Content that has been moved, but not changed, is not notified in red underline.

The full revision history can be found in Annex A.

Edition	Date	Summary
First Edition	May 2002	First Edition
Second Edition	November 2004	legal, certification, spectrum and security updates
Third Edition	April 2008	General regulatory updates and updates to layout
Fourth Edition	April 2010	Updates from the Air Navigation Order 2009
Fifth Edition	August 2012	Updates in terms, definitions and procedures
Sixth Edition	March 2015	Complete re-structure and introduction of the Operating Safety Case (OSC)
Seventh Edition	July 2019	Updates in accordance with Air Navigation Order amendments and split of CAP 722 into CAP 722 main body, CAP 722A and CAP 722B
Seventh Edition Amendment	September 2019	A number of small updates to CAP 722 following publication.
Eighth Edition	November 2020	Implementation of the new EU regulatory package, and complete restructure of CAP 722.
Ninth Edition	December 2022	Amendments following ANO and UK Regulation (EU) 2019/947 amendments, and removal of AMC/GM and Annex A,B, C and D.
Ninth Edition Amendment 1	December 2022	Some formatting updates to improve readability, and correction of some inconsistencies between documentation, Updated URLs following website re-structure.

Foreword

Aim

CAP 722 provides policy and guidance in relation to the operation of UAS to assist in compliance with the applicable regulatory requirements.

The regulatory requirements are supported by *Acceptable Means of Compliance and Guidance Material (AMC/GM)*. This formally sets out how to comply with the regulation. CAP722 provides some further guidance and clarification, in addition to the AMC/GM, including for regulations that do not have AMC or GM.

CAP 722 is not, in itself, regulation but summarises, and references regulation throughout. Any requirement described within CAP 722, is either a regulatory requirement, or is set out within Acceptable Means of Compliance to a regulatory requirement.

CAP 722 is the primary UAS policy and guidance document, and is supported by a suite of other CAP 722 series documents as well as other UAS publications, which can be found on the CAA website here.

In advance of further changes to this document, updated information can be found on the CAA website.

How to use this document

This document is divided into 6 Chapters which provide generalised information which is relevant to all forms of UAS operation (recreational and non-recreational or employing simple or complex technologies) and 3 Annexes which provide more detailed information for operators.

CAP 722, sits within the CAP 722 suite of UAS guidance and policy, which can be found here.

Page and section headers are also colour coded in order to assist the location of text associated with particular topics as follows:

Chapter 1 - General Information

Chapter 2 - Operational Guidance

Chapter 3 - Airworthiness and Certification

Chapter 4 Aircraft Systems

Chapter 5 - Personnel

Chapter 6 -Human factors and safety management

The terms below are to be interpreted as follows:

- '**Must'** / 'must not' indicates a mandatory requirement.
- '**Should'** indicates a strong obligation (i.e., a person would need to provide clear justification for not complying with the obligation).
- '**May'** indicates discretion.
- '**Describe'** / '**explain'** indicates the provision of logical argument and any available evidence that justifies a situation, choice or action.

Units of measurement

The units of measurement used within this document are expressed in accordance with those used in normal aviation practise within the UK:

- Vertical distances of aircraft (heights, altitudes) are expressed in ***feet (ft)***
- Heights of obstructions are expressed in ***metres (m)***
- Distances for navigation, airspace reservation plotting, and ATC separation are expressed in ***nautical miles (nm)***
- Shorter distances are expressed in ***metres (m)*** and ***kilometres (km)*** when at or over 5000 metres
- Mass is expressed in ***kilogrammes (kg)*** and ***grammes (g)*** *when less than 1kg*
- Speed is expressed in ***knots (kt)***
  - **Note**: *Speeds below 50kt may also be expressed in* ***metres per second (m/s)***

Where appropriate, conversions will be provided within the text with the alternative value shown in brackets e.g., 400 feet (120 metres).

Availability

The primary method of obtaining a copy of the latest version of CAP 722 is via the CAA website[1] under the 'Publications' section.

The CAA also provides a more general aviation update service via the SkyWise system .

1 www.caa.co.uk/CAP722

Point of Contact

For queries relating to the content of CAP 722, or matters concerning operations, authorisations or approvals:

Shared Service Centre (RPAS)
CAA
Aviation House
Beehive Ring Road
Crawley
West Sussex
RH6 0YR

Telephone: 03300 221908

E-mail: uavenquiries@caa.co.uk

Abbreviations and Glossary of Terms

The definitive list of abbreviations and terms/definitions that are relevant to UAS operations within the UK and for the whole CAP 722 ‘series’ of documents are centralised within CAP 722D – Master Glossary and Abbreviations.

CHAPTER 1 | General

1. General

1.1. Introduction

1.1.1. Policy

Civil UAS operating in the UK must meet at least the same safety and operational standards as manned aircraft when conducting the same type of operation in the same airspace.

As a result, when compared to the operations of manned aircraft of an equivalent class or category, UAS operations must not present or create a greater hazard to persons, property, vehicles or vessels, either in the air or on the ground.

However, with unmanned aviation, the primary consideration is the type of operation being conducted, rather than who or what is conducting it, or why it is being done. Because there is 'no one on board' the aircraft, the consequences of an incident or accident are purely dependent on where that incident/accident takes place. The CAA's focus is therefore on the risk that the UAS operation presents to third parties, which means that more effort or proof is required where the risk is greater.

The CAA will supplement CAP 722 with further written guidance when required. For the purpose of UAS operations, the 'See and Avoid' principle employed in manned aircraft is referred to as 'Detect and Avoid'.

1.1.2. Unmanned aircraft – Clarification of terms

Although all definitions are contained within CAP 722D, the following are reproduced here for clarity:

'**unmanned aircraft'** means any aircraft operating or designed to operate autonomously or to be piloted remotely without a pilot on board;

'**aircraft'** means any machine that can derive support in the atmosphere from the reactions of the air other than reactions of the air against the earth's surface;

For clarification, the CAA considers the following as flying 'objects' rather than flying 'machines', and so are not considered to be unmanned aircraft:

- Paper aeroplane.

- Hand launched glider, but only those with no moveable control surfaces or remote-control link.
- Frisbees, darts and other thrown toys.

For the purposes of electrically powered unmanned aircraft, the batteries are considered as part of the aircraft, and the 'charge' is considered as the fuel.

Note:

The term 'Remotely Piloted Aircraft System (RPAS) is used interchangeably with the term UAS. The CAA now considers 'RPAS' as the preferred terminology, rather than UAS, because it is gender inclusive. However, the regulation refers to UAS, and so this is the terminology used within CAP 722, and within AMC/GM.

1.1.3. Scope

The guidance within CAP 722 concerns civilian UAS as they are defined in CAP 722D (UAS Definitions and Glossary of Terms). It primarily focuses on the aspects connected with unmanned aircraft that are piloted remotely, whilst acknowledging the potential for autonomous operations in the future.

UAS operated by the military are regulated by the Military Aviation Authority (MAA).

1.1.4. The role of the CAA

The role of the CAA is set out within the website, here.

The CAA regulates aviation within the legislative framework as set by the government and overseen by the Department for Transport.

Following the UK departure from the EU, the CAA now has responsibility for carrying out rulemaking tasks, which drive regulatory change. The CAA works closely with the Government to carry out these tasks, and ultimately the government will make the resulting legislative change. Further information on this process can be found here.

1.1.5. The role of the GA and RPAS Unit

- Carrying out the tasks of the competent authority as defined in Article 18 of the UAS Implementing regulation (UAS IR).
- The production of policy and guidance.
- Issuing operational authorisations.

- Issuing safety notices and directives.
- Issuing general permissions and exemptions to the Air Navigation Order.
- Oversight activities of organisations and persons holding authorisations and approvals.
- Carrying out enforcement activity in cooperation with the Investigation and Enforcement Team.

It is not the role of the CAA to carry out Research and Development activities; these must be performed by the UAS industry. The research and development process could include consultation with the CAA at appropriate stages so that the CAA can provide guidance on the interpretation of the applicable rules and regulations.

It is strongly recommended that developers of new or novel technology for UAS or support systems set up a programme of discussion and review of their research and development activity with the CAA through the innovation team; early engagement is vital in the process. This will ensure that UAS and system developers will have access to the best advice on the applicable regulations. More information can be found here.

1.2. Legal considerations

1.2.1. The Chicago Convention

As a signatory to the Chicago Convention of 7 December 1944 and a member of ICAO, the United Kingdom undertakes to comply with the provisions of the Convention and Standards contained in Annexes to the Convention, except where it has filed a Difference to any of those standards.

Article 3 of the Convention provides that the Convention applies only to civil aircraft and not to State aircraft. State aircraft are defined as being aircraft used in military, customs and police services. No State aircraft may fly over the territory of another State without authorisation. Contracting States undertake when issuing Regulations for their State aircraft that they will have “due regard for the safety of navigation of civil aircraft”.

Article 8 of the Convention provides that no aircraft capable of being flown without a pilot shall be flown without a pilot over the territory of a Contracting State without special authorisation by that State. Under this Article, ICAO has determined that the term “*without a pilot*” should be taken to mean without a pilot *on-board the aircraft* and hence this has specific relevance to unmanned aircraft operations.

Article 8 of the Convention also requires that “each contracting State undertake to insure *sic* that the flight of such aircraft without a pilot in regions open to civil aircraft shall be so controlled as to obviate danger to civil aircraft”.

1.2.1.1. ICAO Annexes

The 19 Annexes to the Chicago convention contain the International Standards and Recommended Practices (SARPS), upon which every ICAO member State then uses to create its own national regulations, or in some cases a set of ‘regionalised’ regulations (such as within the European Union).

ICAO is currently in the process of developing international SARPS covering Remotely Piloted Aircraft Systems which are conducting international Instrument Flight Rules (IFR) operations within controlled airspace and from aerodromes. These SARPS fit into the Certified category of UAS operations (see 2.2.3 below) and the appropriate UK regulations will be adapted in accordance with these SARPS when they are completed.

1.2.2. UAS Regulation within the UK

UAS are regulated under two separate legislative frameworks:

- Regulations within the framework of UK Regulation (EU) 2018/1139 (*the Basic regulation*).
- The Air Navigation Order 2016, as amended, within the framework of the Civil Aviation Act 1982.

Regulations made under these frameworks can be found on the CAA website, here.

This section describes these two frameworks and how UAS are regulated within them.

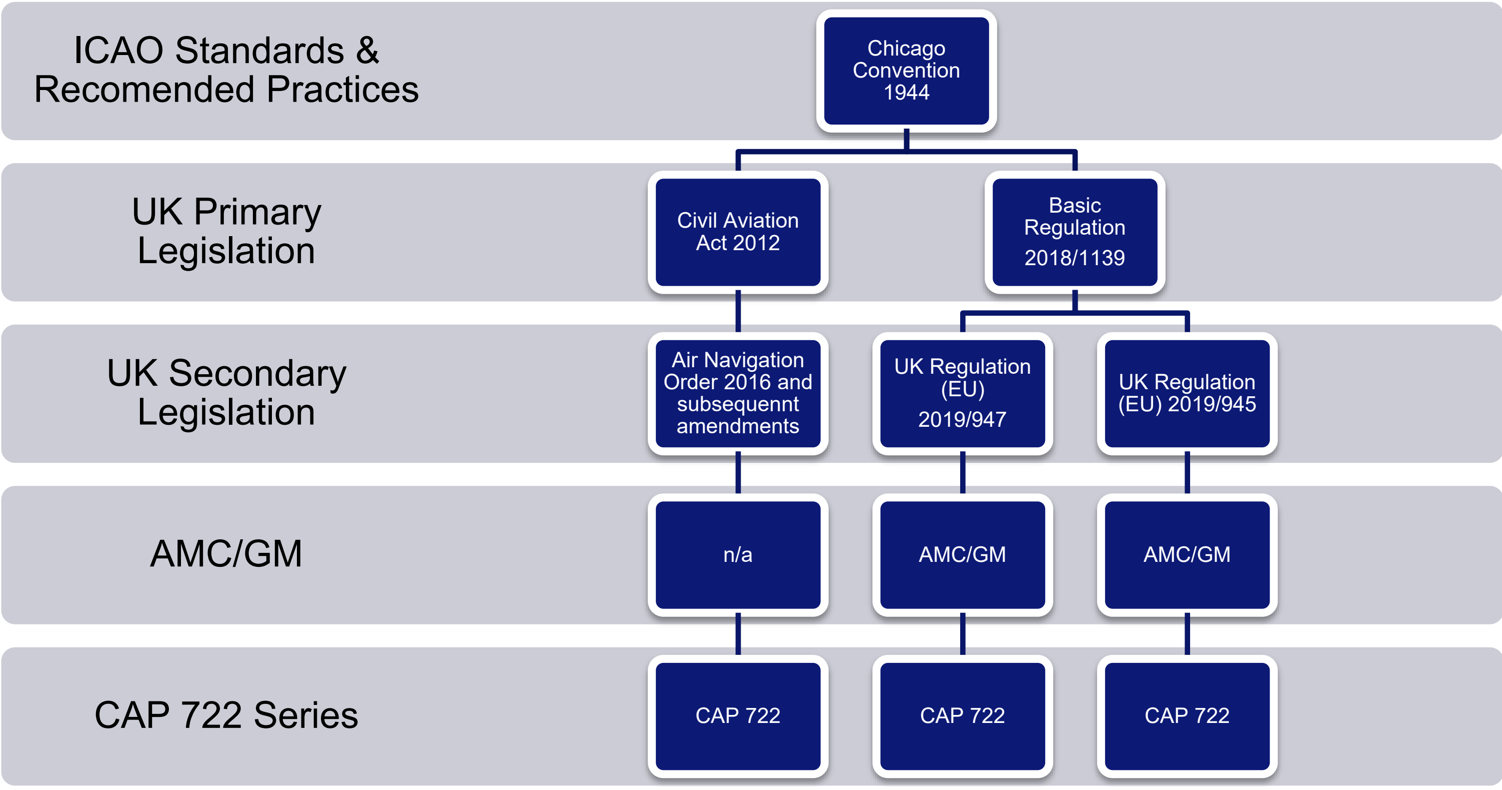


Figure 1- Regulatory framework

The relevant EU regulations were transferred across into UK domestic law, as UK regulations. These regulations are referred to as ‘retained EU law’, and will be amended as necessary. It should be noted that these no longer mirror the equivalent EU versions of the regulation.

It should be noted that the names of the ‘retained’ regulations (E.g., *COMMISSION IMPLEMENTING REGULATION [EU] 2019/947)* have not been substantially changed. However, there are differences, and extreme care must be taken when any reference is made to a regulation to ensure that the regulation made in UK domestic law is being referenced.

The revised naming convention that is used is as follows:

- **Full name of the regulation**:

  “Regulation (EU) No ###/year as retained (and amended in UK domestic law) under the European Union (Withdrawal) Act 2018”

- After first use within a document, **the shortened version** is used:

  "UK Regulation (EU) No ###/year"; or

  "UK Regulation (EU) No year/####"

  the order (year first or number first) is wholly dependent on how the regulation was originally expressed.

Note:

The presumption to be followed is that any reference made in domestic law to EU legislation should be interpreted as a reference to the 'retained EU law' version of the EU legislation that applies in UK domestic law (as opposed to the EU law version).

1.2.3. The Basic Regulation

The Basic Regulation (BR), formally known as *'REGULATION (EU) 2018/1139 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL as retained (and amended in UK domestic law) under the European Union (Withdrawal) Act 2018'* sets out the common rules for civil aviation within the UK. It makes provision for Implementing Regulations or Delegated Regulations dealing with subjects such as airworthiness certification, continuing airworthiness, operations, pilot licensing, air traffic management and aerodromes.

Note:

The link above provides a 'retained version' of the BR which has been applicable since 1 January 2021.

The essential requirements for unmanned aircraft are contained within Annex IX of the BR.

Certain categories of civil aircraft are also exempt from the need to comply with the BR and its Implementing Regulations. These exempt categories are listed in Annex I to the BR (normally referred to as 'Annex I aircraft') and primarily consist of manned aircraft categories. The exempt categories which are of relevance for UAS are detailed in paragraph 2 of Annex I, and copied below:

- tethered aircraft with no propulsion system, where the maximum length of the tether is 50 m, and where:
  - the MTOM of the aircraft, including its payload, is less than 25 kg, or
  - in the case of a lighter-than-air aircraft, the maximum design volume of the aircraft is less than 40 m^3;
- tethered aircraft with a MTOM of no more than 1 kg.

All other UAS are subject to the BR and its implementing and delegated regulations as discussed below.

An aircraft which is not required to comply with the BR remains subject to separate national regulation, to be found within the Air Navigation Order (ANO).

1.2.4. The UAS Regulation Package

Specific regulations covering UAS operations were published on 11 June 2019 and, like the BR, were transferred into UK law at the end of the EU exit transition period. This 'UAS Regulation Package' consists of two separate, but interlinked regulations as follows:

- "Regulation (EU) 2019/947 as retained (and amended in UK domestic law) under the European Union (Withdrawal) Act 2018 on the procedures and rules for the operation of unmanned aircraft".

  Note 1:

  This is sometimes referred to as the 'UAS Implementing Regulation' (UAS IR).

- "Regulation (EU) 2019/945 as retained (and amended in UK domestic law) under the European Union (Withdrawal) Act 2018 on unmanned aircraft and on third country operators of unmanned aircraft systems".

  Note 2:

  This is sometimes referred to as the 'UAS Delegated Regulation' (UAS DR).

Both regulations have been amended separately by the UK, and by the EU since their first publication. A history of the UK changes to UK Regulation (EU) 2019/947 can be found in CAP 1789A.

Further changes made to the European versions of these regulations by EASA, and the European Commission are not automatically adopted in the UK.

Consolidated versions of each are published by the CAA as CAP 1789A and CAP 1789B.

1.2.4.1. Applicability

UK Regulation (EU) 2019/945 became applicable on 1 July 2019.

UK Regulation (EU) 2019/947 became applicable throughout the EU and the UK on 31 December 2020.

1.2.5. The Air Navigation Order 2016

The main civil requirements for UK aviation are set out in the Air Navigation Order (ANO). A consolidated version of the ANO can be found on the CAA website.

The provisions in the ANO concerning equipment requirements, operational rules, personnel licensing, aerodrome regulation and regulation of air traffic services apply to all non-military aircraft, organisations, individuals and facilities.

With regard to UAS operations, the ANO provides additional regulatory content that is either:

- not covered by other regulations– for example, specific national requirements such as carriage of radio equipment, endangerment regulations and legal penalties for breaches of these regulations; or
- in support of a more general requirement stated within other regulations – for example, airspace restrictions around aerodromes and other 'protected' locations.

ANO 2016 article 240 applies to all persons and stipulates that a person must not recklessly or negligently act in a manner likely to endanger an aircraft or a person within an aircraft.

ANO 2016 article 241 applies to all operating categories and stipulates that a person must not recklessly or negligently cause or permit an aircraft (manned or unmanned) to endanger any person or property (which includes other aircraft and their occupants).

If the CAA believes that danger may be caused by the flight of any aircraft (including unmanned aircraft), then the CAA may direct that the aircraft must not be flown (ANO 2016 article 257 - CAA's power to prevent aircraft flying).

1.2.6. UAS related articles within the ANO

Only certain parts of the ANO apply to UAS within the Specific and Open categories of Operation. The ANO in its entirety applies to Certified category operations.

ANO article 23 exempts certain types/classes of aircraft from the majority of the ANO provisions and specifies the articles that still apply.

With regard to unmanned aircraft, the effect of article 23 is that:

- **Open** and **Specific** category operations (see 2.2.1 and 2.2.2) are only directly affected by a specific number of ANO articles, set out in Article 23.
- **Certified** category operations and certified unmanned aircraft (see 2.2.3) are

subject to the whole of the ANO, unless specifically exempted by the CAA.

The relevant requirements of the above articles are reflected within this document.

1.2.7. International Regulations: Bi-lateral Agreements and Working Arrangements

Bilateral agreements and arrangements allow the airworthiness certification of civil aeronautical products to be shared between two countries.

A Bilateral Aviation Safety Agreement (BASA), Memorandum of Understanding (MoU) or Working Arrangement (WA) and their associated implementing procedures provide for technical cooperation between national civil aviation authorities. They help reduce duplication of activity and aim for mutual acceptance of certificates.

In addition to airworthiness certification, BASAs, MoUs and WAs provide for bilateral cooperation across other areas of aviation, including maintenance, flight operations, and environmental certification.

For aircraft certification and maintenance, additional implementation procedures will cover specific issues such as design approval, production acceptance, export airworthiness approval, post-design approval activities, technical cooperation and maintenance.

For further information on Bilateral agreements please refer to the CAA website: Bilateral-agreements

1.2.8. Civil and Military Regulations

In the United Kingdom, there are two regulatory regimes: civil and military. Military requirements are a matter for the Ministry of Defence. A military aircraft for this purpose includes any aircraft which the Secretary of State for Defence has issued a certificate stating that it must be treated as a military aircraft.

1.2.9. Additional Legal Considerations

UAS Operators and Remote Pilots must not break other relevant laws when operating UAS. UAS regulations and CAA authorisations only primarily address the flight safety aspects of UAS operations.

Nothing in these operating principles or any CAA authorisations constitute a permission for UAS operators or flyers to disregard other laws whilst operating and flying a UA. This means the UAS Operator and Remote Pilot must always be mindful of other legitimate legal interests and laws when operating and flying UAS.

Other considerations include any local byelaws, the need to obtain permission from landowners to operate from their land, and any flight within the vicinity of sites of special scientific interest (SSSIs). Where a flight may take place over an SSSI, operators and remote pilots should contact the appropriate public body (e.g., Natural England, Natural Wales, Nature Scotland, National Trust, Historic Scotland, etc.) for further advice.

1.2.10. Privacy and Security – Images and other Data Collection Requirements

The capture of images or other data solely for the use of controlling or monitoring the aircraft is not considered to be applicable to the meaning of '*a sensor able to capture personal data'* in relation to the registration of UAS operators within Article 14 (5)(a) ii of the IR.

UAS operators and remote pilots should be aware that the collection of images of identifiable individuals, even inadvertently, when using surveillance cameras mounted on an unmanned aircraft, may be subject to the General Data Protection Regulation and the Data Protection Act 2018. Further information about these regulations and the circumstances in which they apply can be obtained from the Information Commissioner's Office and website: https://ico.org.uk/for-the-public/drones/.

UAS operators must be aware of their responsibilities regarding operations from private land and any requirements to obtain the appropriate permission before operating from a particular site. They must ensure that they observe the relevant trespass laws and do not unwittingly commit a trespass whilst conducting a flight.

1.3. Insurance

It is the responsibility of every UAS operator to ensure they have appropriate insurance coverage. This is a condition of each operational authorisation that is issued by the CAA.

UK Regulation (EU) 785/2004 as retained (and amended in UK domestic law) under the European Union (Withdrawal) Act 2018 which came into force on 30 April 2005, requires most operators of aircraft, irrespective of the purposes for which they fly, to hold adequate levels of insurance in order to meet their liabilities in the event of an accident. This regulation specifies, amongst other things, the minimum levels of third-party accident and war risk insurance for aircraft operating into, over or within the EU (including UAS) depending on their Maximum Take-Off Mass (MTOM). Details of the insurance requirements can be found on the CAA website.

UK legislation which details insurance requirements is set out in Civil Aviation (Insurance) Regulations 2005[2].

Article 2(b) of UK Regulation (EU) 785/2004 states that the regulation does not apply to 'model aircraft with an MTOM of less than 20kg', but the term 'model aircraft' is not defined within the regulation itself. Therefore, for the purposes of interpretation within the insurance regulation only, its use of the term 'model aircraft' should be taken to mean:

"*Any unmanned aircraft which is being used for sport or recreational purposes only*".

Note:

For all other purposes, the definition of model aircraft is as set out within CAP 722D.

For all other types of unmanned aircraft operation, whether commercial or non-commercial, appropriate cover that meets the requirements of UK Regulation (EU) 785/2004 is required.

[2] http://www.opsi.gov.uk/si/si2005/20051089.htm

1.4. Registration

The registration requirements for civil UAS are contained within UK Regulation (EU) 2019/947, Article 14; they are in line with the requirements of ICAO Annex 7.

The registration requirements for unmanned aircraft depend on the category of operation the UAS is within.

- UAS operated within the **Certified category** (i.e. the design is subject to certification) – each individual UA must be registered.
- UAS operated within the **Open or Specific categories** – the UAS operator must be registered.

Note:

Provision is built in to Article 14 to dis-apply the registration requirement to UAS Operators of 'small control line model aircraft'. These are defined in Article 14(10) as: a fixed-wing unmanned aircraft having a MTOM of not more than 7.5 kg and which is flown within limits imposed by a restraining device of not more than 25 metres in length which attaches the aircraft to the surface or to a person on the surface.

Further information can be found in GM1 Article 14(5A), and AMC1 Article 14(10) of UK Regulation (EU) 2019/947.

Further information on Registration requirements can be found in:

- GM1 Article 14(1)
- GM1 Article 14(5)(a)(ii)
- AMC1 Article 14(8)
- GM1 Article 14(8)

Of UK Regulation (EU) 2019/947

1.5. Enforcement

The CAA takes breaches of aviation legislation seriously and will seek to prosecute in cases where dangerous and illegal flying has taken place.

The CAA's enforcement strategy is designed to reflect the balance of capabilities between the CAA and local Police services.

The Police often have greater resources, response times and powers of investigation than the CAA. To support this, the CAA has agreed with the Police, in a signed Memorandum of Understanding that the Police will take the lead in dealing with UAS misuse incidents, particularly at public events, that may contravene aviation safety legislation or other relevant criminal legislation. Please report any misuse of UAS to your local Police force.

The CAA's remit is limited to safety and also to investigate where someone is operating, or has operated, in a manner that is not in accordance with their operational authorisation. This does not include concerns over privacy or broadcast rights.

Breaches of Aviation Regulation legislation must be reported directly to:

Investigation and Enforcement Team
Civil Aviation Authority
Aviation House
Beehive Ring Road
Crawley
West Sussex
RH6 0YR

E-mail: ietmailbox@caa.co.uk

Privacy issues are covered by the Information Commissioners Office (ICO) and will not be dealt with by the CAA.

If you have any concerns about UAS being used in your area, either from a safety or privacy perspective, contact your local police on 101.

CAA Enforcement guidance can be found here Enforcement-and-prosecutions.

CHAPTER 2 | Operational Guidance

2. Operational Guidance

2.1. Operating Principles

2.1.1. Visual line of sight operations (VLOS)

When operating within VLOS, the remote pilot must be able to see the UA at all times during the flight, sufficiently well to be able to maintain control of it. The maximum distance from the remote pilot at which this can be safely achieved depends on a number of factors and may change from flight to flight.

When operating within the open category, or when set out within the terms of an operational authorisation for the specific category, the UA must be operated within visual line of sight of the remote pilot (VLOS).

A VLOS Operation is defined within UK Regulation (EU) 2019/947 as:

> *'a type of UAS operation in which, the remote pilot is able to maintain continuous unaided visual contact with the unmanned aircraft, allowing the remote pilot to control the flight path of the unmanned aircraft in relation to other aircraft, people and obstacles for the purpose of avoiding collisions.'*

Maintaining VLOS ensures the remote pilot can monitor the aircraft's position, orientation, and the surrounding airspace at all times. This is important in order to ensure the UA can be manoeuvred clear of anything that might pose a collision hazard.

While corrective lenses may be used, the use of binoculars, telescopes, or any other forms of image enhancing devices are not permitted.

Note:

Provision is made within UK Regulation (EU) 2019/947 for the use of FPV equipment within the Open Category, providing an observer is used.

The maximum VLOS distance varies for every operation, and will include such considerations as:

- The size of the aircraft (and its 'visual conspicuity')
- Any lighting onboard the UA to aid in orientation and navigation
- The weather conditions (fog, sun glare etc.)
- The remote pilot's eyesight

- Terrain and obstacles that may obscure the view between the RP and the UA

It is for the RP to satisfy themselves, after careful consideration of the above guidance, the maximum horizontal distance that can be safely achieved whilst still maintaining unaided visual contact with the UA.

Note:

It is important to consider additional technical factors which may limit the safe operating distance from the RP and the UA during VLOS operations. For example, the C2 link capability of the UAS.

2.1.1.1. VLOS Operating Heights

Open Category operations are limited to a maximum distance of 400 feet (120 metres) from the closest point of the surface of the earth.

Note:

This is not a 'vertical height', but a distance between the UA and the closest point on the surface of the earth. See figure 1 below.

UK Regulation (EU) 2019/947 UAS.OPEN.010 gives two additional height provisions:

- For UA to be flown up to 15m higher than the height of an 'artificial obstacle', when that obstacle is taller than 105m, and the UA is kept within 50m of it.
- For unmanned sailplanes (with an MTOM less than 10Kg) to be flown at a height greater than 120m above the surface of the earth, provided that it is not flown higher than 120m above the remote pilot.

This height limitation is intended to reduce the risk of collision with a manned aircraft. Although other aircraft may fly below this height, the vast majority fly at higher levels.

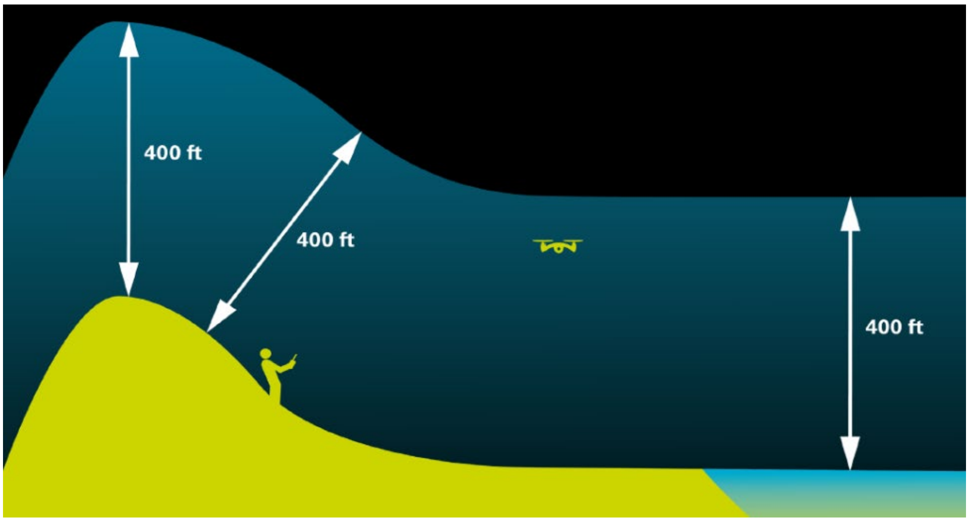


Figure 2- 400ft (120m) separation from surface of the earth

2.1.1.2. VLOS operations at night

There are no specific prohibitions to VLOS operations during night-time. The basic VLOS principles still apply (i.e., you must be able to see the aircraft and the surrounding airspace).

Any applications for operational authorisations which include VLOS flight at night will be expected to include a 'night operations' section within the operations manual which details the operating procedures to be followed and should include items such as:

- daylight reconnaissance and site safety assessment of the surrounding area;
- identification and recording of any hazards, restrictions and obstacles;
- illumination of the launch site;
- aircraft lighting/illumination requirements;
- weather limitations for operation.

2.1.2. Avoidance of other aircraft

There are no right-of-way rules set out in regulation between unmanned aircraft and other airspace users, however it is likely that the unmanned aircraft remote pilot will identify other airspace users before they identify the unmanned aircraft, and therefore the remote pilot will usually be first to manoeuvre away from any conflicting aircraft.

UK Regulation (EU) 2019/947 sets out, in UAS.OPEN.060 (2)(b), that: *the remote pilot shall maintain a thorough visual scan of the airspace surrounding the unmanned aircraft in order to avoid any risk of collision with any manned aircraft. The remote pilot shall discontinue the flight if the operation poses a risk to other aircraft, people, animals, environment or property.*

Note:
A similar requirement is set out within UAS.SPEC.060(3)(b), for the Specific Category.

Although this places a responsibility for collision avoidance on the remote pilot, it does not absolve other airspace users from their own collision avoidance responsibilities. Neither does it imply any 'right of way' over UAS, by other airspace users.

Remote pilots should be aware that their unmanned aircraft are generally difficult, if not impossible, to see from another aircraft until they are extremely close- particularly when flying within urban areas.

Although many aerodromes are protected by FRZs, many unlicensed helicopter landing sites also exist, including hospital helipads. Such aircraft may loiter at low-level or land and take off unexpectedly. All of these types of helicopter operations may therefore be affected by VLOS operations particularly when approaching to land or departing from a site; UAS operators and remote pilots must take active precautionary measures to avoid affecting the safety of other airspace users, either by requiring them to take avoiding action, disrupting a mission or distraction (for example, aborting an air ambulance landing due to a UAS sighting).

A NOTAM is generally not required to be issued for VLOS operations due to the typically small scale, duration and operating limitations of VLOS flights. The potential need for NOTAM action must form part of the operator's risk assessment process, particularly above 400ft (120m), outside of controlled airspace or when several unmanned aircraft will be operating together.

2.1.3. Beyond visual line of sight operations (BVLOS)

Operation of an unmanned aircraft beyond a distance where the remote pilot is able to respond to or avoid other airspace users by direct visual means (i.e. the remote pilot's observation of the unmanned aircraft) is considered to be a BVLOS operation.

Unmanned aircraft intended for BVLOS operations will require either:

- A **technical** capability which has been accepted as being at least equivalent to the ability of a pilot of a manned aircraft to 'see and avoid' potential conflictions. This is referred to as a Detect and Avoid (DAA) capability. Further details regarding DAA can be found at 3.6.

  Note:

  Any DAA capability would be expected to comply with Regulation (EU) 923/2012 as retained (and amended in UK domestic law) under the European Union (Withdrawal) Act 2018: The Standardised European Rules of the Air (SERA) chapter 2 (avoidance of collisions), as adjusted by Rule 8 of the Rules of the Air Regulations 2015 (Rules for avoiding aerial collisions);

  or

- *An **operational** mitigation, which reduces the likelihood of encountering another aircraft to an acceptable level, which may be achieved either using airspace segregation, or another suitable method of ensuring such segregation.*

Note:

The primary means of achieving BVLOS operations without using a technical DAA capability, is using airspace segregation. It is not current CAA policy to accept a *probabilistic safety argument based on historic traffic data as the sole component of a safety argument.*

2.1.3.1. BVLOS Operations utilising visual observation (Extended visual line of sight – EVLOS)

In some cases, the requirement for the remote pilot to maintain direct visual contact with the unmanned aircraft can be addressed via other non-technical ‘visual observation’ methods or procedures while still achieving the key responsibilities of avoiding collisions.

These are still classed as BVLOS operations, however they may also be referred to as ‘Extended Visual Line of Sight’ or EVLOS operations. When operating ‘EVLOS’, collision avoidance is still achieved through the ‘unaided visual observation’ of a human, either through the use of additional observers and/or visually ‘scanning’ a block of airspace for conflicts.

With the exception of two provisions made in the regulation (see GM1 Article 4(1)(d) of UK Regulation (EU) 2019/947), EVLOS operations may only be conducted within the Specific category (see 2.2 below) under the terms of an operational authorisation issued by the CAA and based on a risk assessment. Factors taken into consideration must include:

- the procedures for avoiding collisions;
- the size of the unmanned aircraft being used;
- the colour of and markings on the unmanned aircraft;
- any additional aids to observation;
- meteorological conditions and visibility, including background conditions (cloud / blue sky);
- the use of deployed observers, including suitable communication methods within the team; and
- operating range limits - suitable radio equipment must be fitted in order to be able to effect positive control over the UA at all times.

2.1.4. Protection of Third Parties

While the primary focus of the UAS Regulations is on the protection of persons, UAS operators and remote pilots must also bear in mind their responsibilities towards vehicles, vessels and structures while flying, even if they are unoccupied.

Under ANO 2016 article 241, ‘*no person may recklessly or negligently cause or permit an aircraft to endanger any person or property*’. This article applies to the endangerment of manned aircraft with an unmanned aircraft.

Similarly, ANO 2016 article 240 requires that ‘*a person must not recklessly or negligently act in a manner likely to endanger an aircraft, or any person in an aircraft’.* Although this article does not apply to 'unmanned aircraft that are not subject to certification' (see the exception in article 23 – i.e., the unmanned aircraft itself cannot be 'endangered'), its requirements still apply to UAS operators and remote pilots, in relation to the endangerment of *other* aircraft with a UA.

Key points to note when considering the safety of third parties:

- Fly cautiously and with the expectation that control of the UA could be lost without notice
- Reduce the harmful characteristics of the unmanned aircraft to people
  - Minimise the UA's mass wherever possible or use a smaller/lighter UA
  - Use a UA with design features that reduce harm
  - Do not fly at excessive speeds when close to people
- Check that the UA is in a safe condition to fly
- Consider the environmental factors that may aggravate the potential for loss of control or loss of propulsion
- Consider the use of additional operating personnel to warn uninvolved people immediately following any loss of control or propulsion
- Make use of any available technology or safety features which may reduce the risk of harm if control is lost

2.1.5. Uninvolved persons

The primary focus for UAS operations is the protection of people that are not a part of the operation (i.e., third parties). Within the UAS regulations, they are referred to as 'uninvolved persons'.

The regulation sets out that 'uninvolved persons' means an individual, or group of individuals, who either:

- are not, in any way, participating in the UAS Operation; or
- have not received clear instructions and safety precautions from the RP, the UAS Operator or a person nominated by the UAS Operator, to follow throughout the operation and in the event the UAS exhibits any unplanned behaviour.

A person is considered to be 'participating' in the operation, if they are the UAS Operator, or acting on behalf of the UAS Operator, for example, the remote pilot, or another member of the flight or supporting ground crew.

2.1.5.1. Overflight of uninvolved persons

The overflight of uninvolved people is possible in some circumstances within the Open and Specific category of operation.

The overflight of uninvolved people should always be minimised where possible, to reduce the risk of a collision with them, following a loss of control, to as low as reasonably practicable.

This risk can be reduced by lowering the **likelihood** of such a collision occurring, and the **severity** of the collision.

Factors that a UAS Operator and remote pilot should take to reduce the **likelihood**, include:

- Only flying directly over people when absolutely necessary to achieve the aim of the flight (and when legal to do so) and minimise the time doing so.
- Consider remote pilot experience and fatigue level.
- When flying over uninvolved people remote pilots should, whenever reasonably possible, maintain some horizontal separation between their aircraft and those uninvolved people. The extent of this horizontal distance is for the remote pilot to judge based on any relevant factors such as the prevailing weather conditions and the flight characteristics of the UA and its flight, for example;
    - Wind direction- avoid flying ‘upwind’ of uninvolved people, a strong wind may blow the aircraft towards them as it falls.
    - Think before flying towards people, especially at higher speeds as the aircraft’s trajectory while falling may present a danger to people on the ground.
- Consider the nature and temperament of uninvolved people being overflown and how they may react to the presence of an unmanned aircraft.
- Keep the UA maintained in accordance with the manufacturer’s guidance.
- Maintain an appropriate margin of confidence in the flying time that can be provided by the existing battery power/charge to carry out the intended operation and cope with unexpected issues.
- Consider environmental factors that may increase the chance of a loss of control, including;
    - Flight in precipitation – which may suddenly prevent the UA from operating
    - Sources of interference with the Command and Control link
    - Wind speed and turbulence – which could affect the remote pilot’s ability to control the aircraft precisely and increase its power consumption.

- Colder outside air temperatures - which could reduce battery performance.

Factors that a UAS Operator and remote pilot should take to reduce the **severity**, include:

- Minimise the mass of the aircraft while flying, in order to reduce the kinetic energy that may be transferred in a collision;
    - If possible, use a lighter UA.
    - The UA should only carry loads that are necessary.
- Use UA with design features that reduce harm following collision with a person.
- Do not fly at excessive speeds when close to people.

Note:

This guidance replaces that contained within Safety Notice SN-2020/002, which is now cancelled.

2.1.5.2. Assemblies of people

Assemblies of people are defined as: *gatherings where persons are unable to move away due to the density of the people present*.

There are no strict numbers defined above which a 'group of people' would turn into an 'assembly' of people as different situations would result in different conclusions. An assembly must be evaluated qualitatively, based on the ability of people within that group to 'escape' from any risk posed by the UAS operation.

Examples of assemblies of people may include the following, *(this is not an exhaustive list):*

- sporting, cultural, religious or political events;
- music festivals and concerts;
- marches and rallies;
- parties, carnivals and fêtes.

2.1.6. The 1:1 rule

The '1:1 rule' is a principle which can be used to identify when the minimum separation distance from uninvolved people may need to be increased, and by how much. It is based on the relationship between the UA's height and its distance from the uninvolved person (the 1:1 line).

The horizontal separation between the UA and uninvolved people should not be less than the height of the aircraft. The higher the aircraft, the further it will travel should it suffer a catastrophic failure, and therefore the higher the likelihood of it colliding with uninvolved people, and so the separation distance must be increased (or the height reduced). This is so that, in the event of a propulsion failure, the UA is not likely to fall in an area with uninvolved people present.

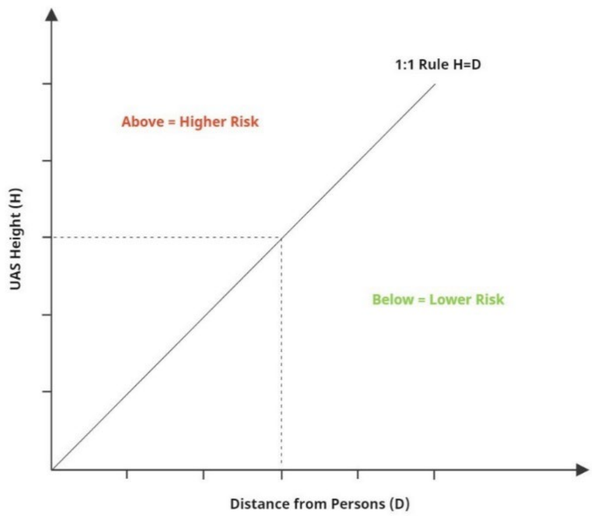


Figure 3- 1:1 Rule

2.1.7. Vehicles, vessels and structures

Although there are no specific separation distances from vessels, vehicles and structures within the regulations, in many cases these will still have persons inside them who need to be protected. For example, the 'endangerment' regulation in the Air Navigation Order (article 241)- it is an offence to 'endanger' such property with an unmanned aircraft.

Additionally, the overall security and privacy situation must also be considered. There may be buildings in the area where it would be inadvisable, from a security or privacy standpoint, to be flying close to without first obtaining permission to do so.

2.1.8. Congested areas

As part of the aim to protect uninvolved persons, flights within areas that are used for residential, commercial, industrial or recreational purposes (i.e. areas that are densely populated or likely to be occupied by large numbers of persons) have additional operational limitations placed on them.

UAS flights within these 'congested' areas may only be undertaken:

- by UA that are deemed to be small enough to not present a hazard;
- by UA that have been built to specific product safety standards;

Note: *in both of the cases above, additional remote pilot competency requirements may also be required.*

or,

- if authorised by the CAA.

2.1.9. Tethered UAS operations

A tethered UAS operation is one where the unmanned aircraft remains securely attached (tethered) via a physical link to a person, the ground or an object at all times while it is flying. The tether normally takes the form of a flexible wire or a cable and may also include the power supply to the aircraft.

Operations with a tethered UAS can be used as an efficient solution in a number of cases, for example where an operating area is restricted, or when the required flight time exceeds the normal endurance of a free flying battery powered aircraft.

Tethered UAS that are powered and have a mass greater than 1kg are subject to the same regulatory framework as all other unmanned aircraft (i.e. the requirements set out within UK Regulation (EU) 2019/947). But the fact that the operation is tethered can be used as a significant mitigation factor when applying for an operating authorisation, thus greatly simplifying the overall process.

2.1.9.1. Tethered small unmanned aircraft

Tethered UAS with a mass of 1kg or less are not subject to the requirements within UK Regulation (EU) 2019/947, but are instead addressed within article 265E of the ANO as 'tethered small unmanned aircraft'.

The overall effect of article 265E is that the requirements for the operation of tethered small unmanned aircraft are matched with the equivalent Open category 'untethered' unmanned aircraft. This is achieved by:

- If the tethered small unmanned aircraft's mass is:
  - Less than 250g – the requirements for flights conducted in subcategory A1 apply.
  - 250g or more (up to 1kg) – the requirements for flights conducted in subcategory A3 apply.
- Permission from the CAA is required to operate outside of these requirements

(*whilst remaining at 1Kg or below. Operations above 1Kg are covered by UK Regulation (EU) 2019/947*).

- When considering the points above, any references to 'unmanned aircraft' or 'UAS' should be read as if they include a tethered system as well.
- No dropping of materials, or carriage of dangerous goods without permission from the CAA.
- Maximum tether length is 25m, unless in accordance with a permission from the CAA.
- An offence is committed if the above are contravened.

2.1.10. Swarming UAS operations

Guidance regarding VLOS rotary wing UAS swarming operations can be found within CAP 722E.

2.2. Categories of operation

UAS operations are regulated in a manner that is proportionate to the level of risk that the individual operation presents. This 'risk and operation centric' approach means that each operation will fall into one of three operating categories as described in 2.2.1, 2.2.2 and 2.2.3 below.

2.2.1. Open Category

The Open category covers operations that present a low risk to third parties. Operations within this category are conducted within a set of basic and pre-defined limitations and do not require any further authorisation by the CAA. The Open category is sub-dived into three further subcategories.

2.2.1.1. Operational boundaries

Open category operations are bounded by a number of factors, all of which must be met:

- the maximum take-off mass/flying weight of the unmanned aircraft must be less than 25kg; and
- the unmanned aircraft must be operated within VLOS (unless operating in accordance with the procedure described in GM1 Article 4(1)(d) of UK Regulation (EU) 2019/947); and
- the unmanned aircraft must not be flown further than 400 feet (120 metres) from the closest point of the surface of the earth (unless operating in accordance with the procedure described in UK Regulation (EU) 2019/947 UAS.OPEN.010 (3); and
- Only one UA may be operated at any one time.
- The UA must not drop any material during the flight. See AMC1 Article 4(1)(f) of UK Regulation (EU) 2019/947 for further information.

2.2.1.2. Open Category subcategories

The Open category is then further divided down into three operational 'subcategories', primarily based on the proximity of the unmanned aircraft to uninvolved persons while in flight, as follows:

- **A1 (fly 'over' people)** – Operations in subcategory A1 can be conducted within 'congested' areas (as defined in section 2.1.8) and may be carried out over uninvolved people (*other than A1 transitional UAS)*, but not assemblies of people. Any overflight of people should be avoided if possible and kept to a minimum. Operations must be conducted with a:

- UAS less than 250g, that is privately built or placed on the market before 1 Jan 2026 (*under the 'Legacy' provisions)*; or
- A1 Transitional UAS with a mass less than 500g, provided the remote pilot holds an A2 CofC certificate as described in section 5.2.3.1, and does not overfly uninvolved people – only until 01 January 2026.

- **A2 (Fly 'close to' people)** *(under the transitional provisions)* – Operations in subcategory A2 can be conducted 'near' people with a minimum horizontal distance of 50 metres from uninvolved persons. The remote pilot must have successfully completed an additional competency examination (the A2 CofC), and the UAS must be a transitional UAS, with a mass less than 2Kg - only until 01 January 2026.
- **A3 (Fly 'far from' people)** – This category covers the more general types of unmanned aircraft operations. The unmanned aircraft may only be flown in areas where no uninvolved person may be endangered by the unmanned aircraft, and may not be flown within 150 metres horizontally of areas that are used for residential, commercial, industrial or recreational purposes.

2.2.1.3. Open Category product Requirements

A set of product requirements has been introduced within UK Regulation (EU) 2019/945. Currently, it is not possible for manufactures to comply with these requirements in the UK, due to the lack of designated standards, or Conformity Assessment Bodies, established under this regulation. As such, there are currently no UAS in the UK which are class marked in accordance with this regulation. For this reason, the CAA has removed class marking guidance from this document, for simplicity and readability.

This is subject to a regulatory review to be conducted by the DfT and the CAA in due course.

UAS which are marked with a class mark, in accordance with the European version of this regulation, are not recognised in the UK as being class marked, and must be flown under the other open category provisions (i.e. transition, legacy or non-class marked).

Legacy UAS

UAS products (which are not privately built) which do not conform to the class markings, but which are placed on the market **before** 01 January 2026 may continue to be used in the Open Category in the A1 and A3 subcategory- providing that the unmanned aircraft has a MTOM less than 250g (for the A1 subcategory) or 25Kg (for the A3 subcategory).

New UAS products (which are not privately built) and which are placed on the market on or **after** 1 January 2026 and which do not conform to the class markings described above, may not be used in the Open category. [3]

Transitional Arrangements

In order to manage the transition to the new product standard rules, UK Regulation (EU) 2019/947 Article 22 sets out transitional provisions that allow certain UAS that don't meet the class marking requirements to continue to be operated in the Open category until 01 Jan 2026. These are:

- A1 sub-category: UA less than 500g, and remote pilot must hold an A2 CofC certificate. No overflight of uninvolved people.
- A2 sub-category: UA less than 2Kg, no close than 50m horizontally from uninvolved persons, remote pilot must hold an A2 CofC certificate.

2.2.1.4. Open Category – Interpretation of mass and weight

The MTOM includes all the elements on board the UA, including the motors, propellers, electronic equipment and antennas, batteries/fuel, oil and all other fluids and the payload, including sensors and their ancillary equipment.

Privately built UA, and some off the shelf UA do not have a MTOM defined. In this case, the mass of the aircraft at the time of take-off should be used instead, when interpreting the term 'MTOM' within the regulation. Although the UAS Regulations refer to 'maximum take-off mass' (MTOM) throughout, this term creates some confusion when referring to home-built or other non-class marked UA where an MTOM has not been defined by the manufacturer.

Take-off Mass (Article 22)

The term 'take-off mass' is also used when referring to non-class marked aircraft, but only within one article (Article 22 –transitional arrangements) and the term is not specifically defined. For these aircraft, any reference to 'take-off mass should be taken to mean the mass of the UA at the point of take-off for that particular flight

2.2.2. Specific Category

The Specific category covers operations that present a greater risk than that of the Open category, or where one or more elements of the operation fall outside the boundaries of

[3] UAS.OPEN.020 (for A1) and UAS.OPEN.040 (for A3) set out that UAS must either be class marked, privately built, or meet the requirements of Article 20, which sets out that 'legacy UAS' , i.e. those placed on the market before 1 Jan 2026 may continue to be used in the A1 and A3 subcategory after this date, providing the conditions of Article 20 are met.

the Open category.

The key element of the Specific category is that the UAS operator is required to hold an operational authorisation, which has been issued by the CAA.

This operational authorisation will be based on the CAA's evaluation of a safety risk assessment that has been produced by the UAS operator or, in some circumstances, has been 'pre-defined' and published by the CAA as a pre-defined risk assessment (PDRA). See CAP 722H for more information on PDRAs, and CAP 722A for further information on the risk assessment process, and development of the OM.

The operational authorisation document sets out the conditions and limitations of the operation.

In order to obtain an operational authorisation, the UAS operator must conduct a risk assessment of the proposed operation and submit this as part of the application. This must

- outline the proposed operation ('what' the operator wants to do);
- describe the operational process that will be used ('how' the operator will do it);
- describe the technical aspects of the UAS ('what' the operator will do it with);
- demonstrate that it can be done safely (provide a risk assessment/safety case).

Details on how to make an application for an operational authorisation can be found on the CAA's UAS webpages www.caa.co.uk/uas .

Operational authorisation holders are subject to regulatory oversight by the CAA; further details are provided at 1.1.4.

Note:

An operational authorisation issued by the CAA only addresses the flight safety aspects of the UAS operation in the UK and does not constitute permission to disregard the legitimate interests of other statutory bodies such as the Police and Emergency Services, Highways England, Data Commission, Ofcom or local authorities.

2.2.2.1. Specific Category – Use of certified UA or certified equipment

Certified UA and/or certified equipment may be used for Specific category operations as a means of risk reduction or as a mitigating measure in the risk assessment.

'Certified equipment' is considered to be any equipment for which the relevant design organisation has demonstrated compliance with the applicable certification specifications and received a form of recognition from the CAA that attests such compliance (e.g., a TSO approval).

The use of certified UA or equipment does not mean that the whole flight operation is then transferred to the Certified category, but if the certification of those products is relied upon within the risk assessment, then all aspects/conditions related to that certification (such as routine maintenance, scheduled servicing and the qualifications of the organisations and personnel carrying out those duties) must also be complied with.

2.2.2.2. Risk assessments

The authorisation process (and thus the authorisation requirements) aims to ensure that the public and other airspace users are not exposed to unacceptable risk introduced by UAS operations.

Each application for an operational authorisation (other than one based on a PDRA) must be accompanied by a risk assessment carried out by the UAS Operator.

Further guidance on the preparation and submission of risk assessments is provided in CAP 722A .

2.2.2.3. Pre-defined risk assessments (PDRA)

A PDRA is a shortened set of prescriptive conditions that must be complied with by a UAS operator in order to conduct a pre-determined type of operation.
In these cases, the CAA conducts a risk assessment for the operation, to generate a list of mitigations. These mitigations are then published as a series of requirements and limitations. The Operator must demonstrate compliance with these mitigations within the operations manual, as part of a 'shortened' application for an operational authorisation.

Individual PDRAs that are available for use within the UK are listed in CAP 722H.

Note 1:

The UAS operator must still apply to the CAA for an operational authorisation in order to fly under the terms of a PDRA.

Note 2:

PDRAs that have been published by EASA for use within the EU are not applicable within the UK.

2.2.2.4. Standard Scenarios (STS)

The concept of 'standard scenarios' is omitted in the retained version of UK Regulation (EU) 2019/947 and therefore will not be used in the UK for the foreseeable future.

2.2.2.5. The Light UAS Certificate (LUC)

UK Regulation (EU) 2019/947 Article 5 and Part C of the Annex, makes provision for an optional light UAS operator certificate (LUC) scheme, which allows the CAA to issue privileges to UAS operators, including the possibility of authorising certain elements of their own operations.

Note:

UAS operators considering the LUC should first contact the CAA in order to discuss their options and the next steps before making an application. The CAA is currently reviewing the LUC concept, and will provide further AMC and GM to this article, in due course.

2.2.2.6. Model Aircraft

Further information on the operation of model aircraft can be found in Appendix A AMC/GM to UK Regulation (EU) 2019/947.

2.2.3. Certified Category

The Certified category covers operations that present an equivalent risk to that of manned aviation; because of this they are be subjected to the same regulatory regime (i.e., certification of the unmanned aircraft, certification of the UAS operator, licensing of the remote pilot).

UK regulations relating to the Certified category are still being developed and are not yet published. Until unique UAS regulations are available, the principles set out in the relevant manned aviation regulations for airworthiness, operations and licensing will be used as the basis for regulating the certified category.

2.2.3.1. Boundary with the Specific Category

UAS operations in the 'certified' category include operations with a high risk.
Being dependent on the safety risk assessment process, and the nature and risk of the type of operation concerned, the boundary between 'specific' and 'certified' category cannot be expressed purely in terms of mass of the UA.
The combined effect of Article 6 of UK Regulation (EU) 2019/947 Article 40 of UK Regulation (EU) 2019/945 is that UAS operations must be conducted in the 'certified' category when they:

- Involve a UA with a characteristic dimension of 3m or more being flown over assemblies of people; or,
- involve the transport of people; or,
- involve the carriage of dangerous goods, that may result in high risk for third parties in case of accident.

Additionally, the CAA may determine that an operation, originally proposed for the specific category, must instead be conducted in the certified category. This would be the case when, having considered the risk assessment provided by the UAS operator, the CAA considers that the risk of the operation cannot be adequately mitigated without:

- the design, production and maintenance of the UAS being certified; and
- the UAS operator being certified; and,
- the remote pilot being licensed (unless the UAS is autonomous).

2.3. Airspace

This section outlines the operating principles associated with UAS flights both in segregated and non-segregated airspace within the UK.

2.3.1. Basic principles

UK aviation legislation is designed to enable the safe and efficient operation of all aircraft in all classes of airspace. UAS operators must work within this same regulatory framework.

The table below sets out the basic airspace requirements for UAS.

	Controlled Airspace (Class A-E)	**Danger, Restricted, Prohibited Areas (including FRZs around aerodromes and space sites) (EG D, EG R, EG RU, EG P)**
Open Category Operations	Not Applicable *Accommodated through the operating limitations of the Open category*	Applicable *These are usually applicable to all aircraft, including unmanned aircraft. Full details for restricted and prohibited areas can be found within the SI that sets out the airspace restriction. Some areas are only applicable to unmanned aircraft.*
Specific Category Operations	*Controlled airspace requirements are generally not applied to VLOS UAS operations that take place below 400ft.* *Air Navigation Service Providers (ANSPs) responsible for the management of controlled airspace may request to be notified about UAS operations within their airspace, above 400ft. This will be set out within the AIP (section ENR 2.1). This is not a 'permission' request, but a notification.* *Information provided by the ANSP, following such a notification, must be taken into account by the UAS Operator.* *Operators and remote pilots must be clear within their procedures on **how** and **when** to engage*	Applicable *These are usually applicable to all aircraft, including unmanned aircraft. Full details for restricted and prohibited areas can be found within the SI that sets out the airspace restriction. Some areas are only applicable to unmanned aircraft.*

	with the ANSP, should their flight take place within controlled airspace.	
Certified category Operations	**The same requirements that relate to manned aircraft are applicable**	

Table 1-Basic airspace requirements as applied to individual operating category

Note:

Where a requirement exists, as set out within an Operational Authorisation, or within an operation manual, for the notification of a ***Specific*** *Category flight to an air traffic service (ATS) unit, making such a notification does not imply the provision of any service, or 'clearance'. Neither does it mean any separation service is provided by the ATS unit to the UA against other aircraft, or to other aircraft against the UA. Should the ATS unit pass the remote pilot any information during the notification process, the remote pilot should make use of this information when assessing the risk of the operation. UAS operators are reminded of their obligations under ANO Article 240, to not recklessly or negligently act in a manner likely to endanger an aircraft; as such, use of any such information provided by an ATS unit during the notification of a flight, should be used to inform the UAS Operators when making operational decisions.*

In order to integrate with other airspace users, UAS operators must ensure that their operation does not pose any additional risk to other airspace users. A UA must not be flown if the appropriate safety provisions cannot be made or if such operations would have an unreasonably negative impact on other airspace users.

2.3.2. UAS Operations within Segregated Airspace

The UK uses Danger Areas as the primary method of airspace segregation for UAS operations, where required- for example, BVLOS operations.

For flights within segregated airspace, whilst some restrictions may still apply, an unmanned aircraft will generally be given freedom of operation within the bounds of the allocated airspace, subject to any agreed procedures and safety requirements.

A specific category operational authorisation to operate will take into account the risks associated with any unintended excursion from the allocated airspace and it will also consider the possibility of airspace infringements. In addition, measures that may be put in place to enhance the safety of UAS activities will also be considered in the authorisation process.

While segregated airspace, by its nature, provides exclusive use of that airspace to the UAS activity, other aircraft may still infringe such airspace boundaries. In order to enhance the safety of UAS operations, the following constraints may be imposed:

- Where available, the remote pilot is to make use of an ATS provider to monitor UAS flights and to provide a service to them and to other aircraft operating in the vicinity of the segregated airspace;
- Communications are to be maintained between the ATS provider and the remote pilot.

Procedures are to be put in place for, amongst others, emergency recovery, loss of control link and the avoidance of infringing aircraft.

Until BVLOS UAS can comply with the requirements for flight in non-segregated airspace, one-off or occasional BVLOS UAS flights outside permanently established segregated airspace (i.e. DAs) may be accommodated through the establishment of Temporary Danger Areas (TDAs). see section 2.3.2.1 below.

Note:

An operation within segregated airspace that also falls within the Specific category, must still be authorised by the CAA. An airspace sponsor may not unilaterally authorise an operation that falls within the Specific category.

2.3.2.1. Temporary Danger Areas (TDA)

It is recognised that there may be occasions when UAS flights are planned to take place outside an established DA; in these cases, one or more TDAs could be established to temporarily provide the appropriate segregation. Although the use of TDAs offers a flexible tool for segregating specific portions of airspace on a temporary basis, it is important to emphasise that segregation effectively denies the use of airspace to other airspace users.

TDAs must not be considered to be a convenient 'catch all' for short notice UAS activities that can simply be requested, and implemented, without due consideration for other airspace users.

TDAs will mainly be used for longer term measures, where activities have been properly planned and prepared, and adequate time is available for full consideration by the CAA's Airspace Regulation team along with full promulgation to other airspace users.

Details regarding the application process to establish a TDA can be found within CAP 1616.

Any queries relating to TDAs should also be directed to arops@caa.co.uk .

2.3.2.2. TDA Sponsorship

The requirement for sponsorship of a TDA is identical to that required for any other DA. Details regarding DA sponsorship, including Terms of Reference, are contained in the following document SARG Policy: Policy for Permanently Established Danger Areas and Temporary Danger Areas

2.3.3. Prohibited, Restricted and Danger Areas

Prohibited Areas and Restricted Areas, as notified in the AIP (section ENR 5.1) apply to unmanned aircraft (irrespective of their size) as well as manned aircraft. Where approval is required to enter these areas, permission must be sought in accordance with the entry requirements as set out in the Statutory Instrument that established the specific area. This is usually described within the 'remarks' column of the AIP entry for that piece of airspace, and also within most drone safety apps.

Danger Areas also apply to both unmanned, and manned aircraft and are established to notify airspace users of activities which may pose a risk to them. Although there is usually no specific legal requirement to obtain permission to enter, there *is* a legal requirement to ensure it is safe to enter. Contact details can usually be found within the AIP entry, and on some drone safety apps.

2.3.4. Flight Restriction Zones

As defined in the ANO, FRZs are established around **aerodromes**, and **space sites**.

2.3.4.1. Aerodrome Flight Restriction Zones

Aerodrome Flight Restriction Zones (FRZ) are implemented at the majority of UK aerodromes (a complete list can be found in the AIP, and on the DroneSafe Website). Their purpose is to enhance safety for other airspace users within the vicinity of an aerodrome.

Aerodrome FRZs are always active.

In order to operate within an Aerodrome FRZ, permission must be sought from the appropriate authority, either the Air Traffic Service unit (ATSU) or the Aerodrome Operator. This may be obtained through an online platform, or directly from the aerodrome. The procedure is normally outlined on the aerodrome website, otherwise the ATSU may be contacted directly, contact details can be found within the AIP.

An approval in principle may be issued in advance, which must normally be followed by an 'on the day' approval from the appropriate air traffic service unit, or aerodrome operator. In some cases, a standing agreement may be appropriate, and agreed by both parties, which grants permission on a standing basis for a specific operation.

Aerodrome FRZs are defined in article 94A of the ANO and comprise three sections:

- A cylinder, with the same dimensions as the Aerodrome Traffic Zone (ATZ);
- Runway Protection Zones (RPZs);
- Additional Boundary Zones.

The ATZ is an existing airspace structure, which applies to manned aircraft, and is a 2.0 or 2.5 NM radius cylinder which extends to 2000 ft above aerodrome level, centred around the centre point of the longest runway.

The RPZs are rectangular blocks, starting at the runway threshold and extending out 5 km along the extended runway centreline, which are 1 km wide and extend to 2000 ft above aerodrome level.

The Additional boundary zones exist where a line drawn that is 1km beyond the airfield boundary, extends outside of the ATZ. This additional volume is called the 'additional boundary zone'. This also extends to 2000 ft above aerodrome level.

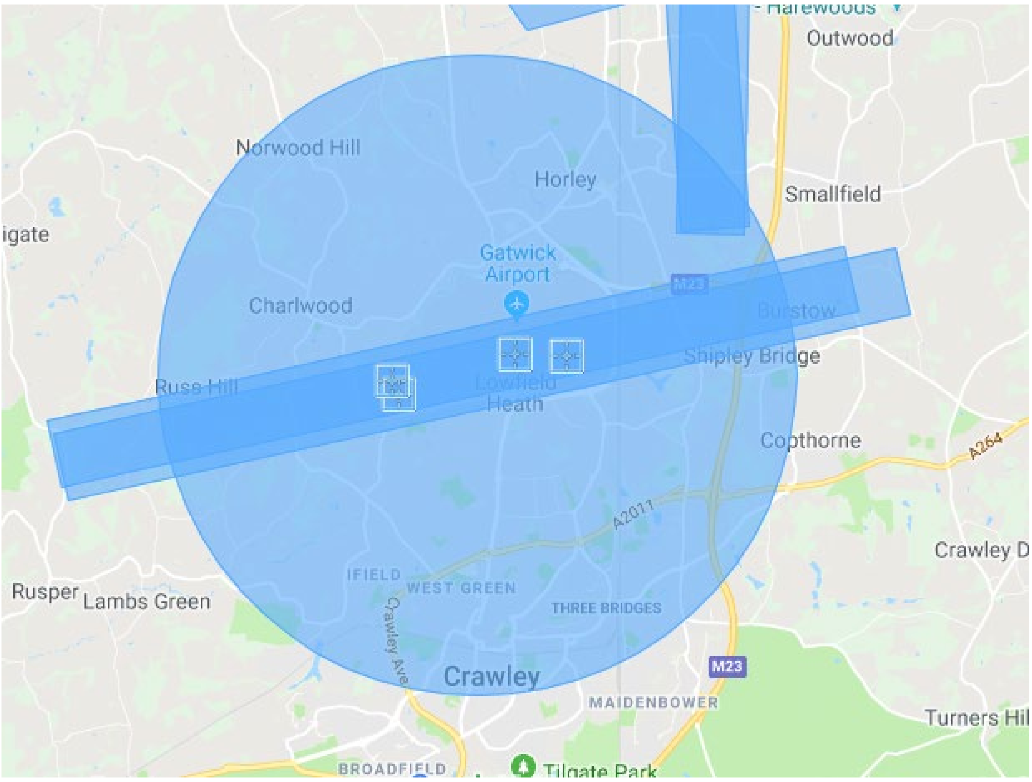


Figure 4- Gatwick airport Flight Restriction Zone (correct at time of publication- presented here for illustrative purposes only).

UAS Operators intending to operate above 400ft (120m) within an FRZ must obtain an operational authorisation from the CAA to do so. The air traffic control unit, flight information service unit or aerodrome operator may issue a permission for *access* to the FRZ (at any level), but may not authorise operations in the Specific category (e.g. above 400ft).

In order to mitigate safety risks associated with UAS operating within an FRZ and interacting with manned aircraft, the following NOTAM action is strongly recommended by the CAA. Any operation within the specific category will include such a requirement within the conditions of the authorisation.

In the case that FRZs overlap with each other, or with other airspace, then permission must be obtained to enter each portion of airspace as required.

	Within Operating Hours of Air Traffic Service Unit (Air Traffic Control, Aerodrome Flight Information Service or Air Ground Radio service)		Outside Operating Hours of Air Traffic Service Unit (Air Traffic Control, Aerodrome Flight Information Service or Air Ground Radio service)	
	Below 400ft	**Above 400ft**	**Below 400ft**	**Above 400ft**
ATZ Portion of FRZ			NOTAM (Requested by aerodrome via NOTAM Office)	NOTAM (Requested by aerodrome via NOTAM Office)
Portion of FRZ outside the ATZ		NOTAM (requested in advance via AROps@caa.co.uk)		NOTAM (requested in advance via AROps@caa.co.uk)

Table 2- NOTAM Requirement Summary

Full details of NOTAM and permission requirements for UAS operations within FRZs can be found in the AIP (ENR 1.1 Section 4.1.8).

2.3.4.2. Space site Flight Restriction Zones

Flight restriction zones are established around 'protected space sites', as defined in Article 94BA of the Air Navigation Order 2016, as amended.

A protected space site is defined as:

- A **spaceport** (as defined in the Space Industry Act 2018), which is:
    - A site from which spacecraft or carrier aircraft are launched or (as the case may be) are to be launched; or
    - or a site at which controlled and planned landings of spacecraft take place or (as the case may be) are to take place; or
- An **installation at sea**, at which controlled and planned landings of spacecraft take place or are to take place, which can be moved from place to place without major dismantling or modification

A site which is coincident with a certified, national licenced or government aerodrome is not a protected space site (and is instead protected by an aerodrome FRZ).

Permission must be sought for access to a Space site FRZ, from the operator of the space site, for any operation within the FRZ taking place within the Open or Specific category. The requirement to obtain permission does not apply to a UAS operated in the Certified category.

The Space site FRZ comprises a cylinder of airspace extending vertically upwards from the surface to a height of 2000ft, and with a radius of 5km centred on the mid-point of the launch pad with the largest area.

2.3.5. Aerodromes without Flight Restriction Zones

A large number of small aerodromes, private strips and other launch sites exist, which are not protected by airspace restrictions, such as FRZs. These can usually be identified from VFR charts or alternative online mapping software. Although there may be no requirement to obtain permission to operate near these sites, caution should be exercised when nearby and a good look-out must be kept at all times.

Remote pilots should remember that a wide variety of other airspace users make use of these sites, including many which are unpowered and therefore extremely quiet- such as hang gliders, gliders and paragliders. These areas are usually denoted, on VFR flight planning charts (and online flight planning software) using the following symbols, which refer to: Glider launch sites, aerodromes, aerodromes with gliding, paraglider sites and parachuting sites, respectively:

Figure 5- VFR Chart Symbols

2.4. International operations

For the purposes of this guidance, international boundaries are considered to be coincident with lateral FIR/UIR boundaries.

UK UAS operators planning to operate beyond an international FIR/UIR boundary must comply with the regulatory and ATM requirements applicable to the territories over which the UAS is flown; these may differ from UK requirements. Guidance on foreign national procedures is to be sought from the appropriate State National Aviation Authority (NAA), and any permissions or authorisations are to be sought directly from that NAA. This requirement stems from Article 8 of the Convention on International Civil Aviation ('Chicago Convention'), which states that:

- "No aircraft capable of being flown without a pilot shall be flown over the territory of a contracting State without special authorisation by that State and in accordance with the terms of such an authorisation. Each contracting State undertakes to insure (*sic*[4]) that the flight of such an aircraft without a pilot in regions open to civil aircraft shall be so controlled as to obviate danger to civil aircraft".

For the purposes of the Convention the territory of a State shall be deemed to be the land areas and territorial waters adjacent thereto under the sovereignty, suzerainty, protection

[4] ICAO’s use of the word ‘insure’ should be read as ‘ensure’

or mandate of such state (Chicago Convention Article 2).

ICAO requirements concerning the authorisation of UAS flight across the territory of another State are published at Appendix 4 to ICAO Annex 2, Rules of the Air.

2.4.1. Non-UK operators operating within the UK (third country operators)

Note 1:

The term 'third country' means any country or territory other than the United Kingdom.

Third country UAS operators (those that have their principal place of business, are established, or reside outside of the UK) must first register as a UAS operator in the UK.

Once registered, they must then comply with the same requirements as set out for an equivalent UK UAS operator.

Note 2:

There is scope for valid national documents relating to remote pilot competency or even national operational authorisations to be accepted by the CAA as part of a risk assessment. This is particularly the case where the regulatory environment in the UAS operator's parent country is similar to that of the UK (e.g. EU Member States).

2.4.2. Article 41 (3) of the UAS DR makes provision for any third country itself (i.e. the State, not individual UAS operators) to ask the CAA for recognition of its own certificates or authorisations for the purpose of operating within the UK. Prior to any recognition of these documents, the CAA will first be required to ensure that those documents provide the same level of safety as their UK equivalents.UK operators operating outside of the UK

UK UAS Operators wishing to operate outside the UK must comply with the requirements that are set out for UAS operations within that State. In the first instance, operators should consult the guidance documentation that has been prepared by the relevant NAA.

Note:

Although the UK operates a very similar regulatory framework to that within the EU, there are regulatory differences, and the UK is considered a third country to the EU. UK Operators must comply with the applicable regulatory requirements of the state they are operating within. An easy access format of the applicable EU regulations can be found here. The National Aviation Authority (NAA) of the EU State where a UK UAS operator first *plans to operate becomes the 'parent NAA' for that operator throughout the EU. The UK operator must register within this Member State and deal with the 'parent NAA' for all certificates, operational authorisations, declarations etc. Access to the websites of individual EU Member States, including a link to their 'drones' webpages, can be obtained via this link EASA Light-MS .*

2.5. Dangerous goods – carriage by unmanned aircraft

Dangerous goods may only be carried in the Specific and Certified categories of operation.

Dangerous goods guidance is linked at the end of this section.

2.5.1. Operating category – applicability to dangerous goods

Open category – dangerous goods must not be carried in the Open category (UK Regulation (EU) 2019/947 Article 4, paragraph 1(f)).

Specific category – dangerous goods may be carried in the Specific category unless assessed as a high risk for third parties in case of accident (UK Regulation (EU) 2019/947 Article 6). A Dangerous goods permit is required, as a condition of the operational authorisation.

Certified category – dangerous goods can be carried in the Certified category (UK Regulation (EU) 2019/947 Article 6).

2.5.2. Application requirements

Applications to carry dangerous goods are processed by a separate Dangerous Goods Team within the CAA and a different process is followed. Therefore, UAS operators must make a separate Dangerous Goods application to their application for an operational authorisation.

These applications can be submitted at the same time.

Application for operational authorisation – apply to the UAS Unit using the established procedure detailed in 2.3.1.

Application for approval to carry dangerous goods – follow the procedure outlined 2.7.2.1 below.

UAS operators must refer to the CAA dangerous goods approvals webpage for the most up-to-date information and to ensure all application requirements are met and then:

- Complete CAA Form SRG 2807
- Submit the appropriate fee using Payment Form SRG 2812 and send to the Dangerous Goods Office
- Details of costs can be found in the CAA Scheme of Charges - Air Operator and Police Air Operator Certificates

2.5.3. Further information about carriage of dangerous goods by RPAS

CAP2248 contains further guidance on the carriage of dangerous goods by RPAS.

2.6. Security considerations

This section offers guidance to industry on how to implement and satisfy the requirements for security through all UAS lifecycle activities (i.e. initial concept, development, operation and maintenance and decommissioning). In this context, security refers to the security of the unmanned aircraft, including both physical and cyber elements.

UAS operating in non-segregated airspace must not increase the risk to existing airspace users and must not deny airspace to them. This policy requires a level of safety and security equivalent to that of manned aviation.

UAS must have adequate security to protect the system from unauthorised modification, interference, corruption or control/command action. These considerations must be taken into account during the risk assessment process, outlined in CAP 722A.

2.6.1. Security factors for consideration

2.6.1.1. Holistic approach

When considering security for the UAS it is important to take a holistic approach, paying equal cognisance to technical, policy and physical security for the UAS as a whole. Utilising this approach will help ensure that issues are not overlooked that may affect security and ultimately safety.

By utilising proven industry approaches to the protection of confidentiality, integrity and availability, the security measures that are applied can benefit the UAS operator by assuring availability of service and the integrity and confidentiality of both data and operations.

2.6.1.2. Aspects to be addressed

Security aspects are required to address potential weaknesses to UAS such as employees, location, accessibility, technology, management structure and governance. Such security aspects include but are not limited to:

- The availability of system assets, e.g. ensuring that system assets and information are accessible to authorised personnel or processes without undue delay;
- Physical security of system elements and assets, e.g. ensuring adequate physical protection is afforded to system assets;
- Procedural security for the secure and safe operation of the system, e.g. ensuring adequate policies such as Security Operating Procedures are drafted,

applied, reviewed and maintained;

- Data exchange between system elements, e.g. ensuring the confidentiality and integrity of critical assets is maintained during exchanges within the system, over communication channels and by other means such as physical media;
- Accuracy and integrity of system assets, e.g. ensuring threats to system assets caused by inaccuracies in data, misrouting of messages and software/hardware corruption are minimised, and actual errors are detected;
- Access control to system elements, e.g. ensuring access to system assets is restricted to persons or processes with the appropriate authority and 'need-to-know';
- Authentication and identification to system assets, e.g. ensuring all individuals and processes requiring access to system assets can be reliably identified and their authorisation established;
- Accounting of system assets, e.g. ensuring that individual accountability for system assets is enforced so as to impede and deter any person or process, having gained access to system assets, from adversely affecting the system availability, integrity and confidentiality;
- Auditing and Accountability of system assets e.g. ensure that attempted breaches of security are impeded, and that actual breaches of security are revealed. All such attempted and actual security incidents must be investigated by dedicated investigation staff and reports produced;
- Object Reuse of system assets, e.g. ensure that any system resources re-usage, such as processes, transitory storage areas and areas of disk archive storage, maintains availability, integrity and confidentiality of assets;
- Asset Retention, e.g. ensuring that system assets are securely retained and stored whilst maintaining availability, integrity and confidentiality.

Any identified and derived requirements would then sit within each identified security aspect and be applied (where necessary) to parts of the UAS, e.g. ground based system (including the communications link) and the UA itself. The requirements must be ultimately traced to the overall policy requirements.

2.6.1.3. Security process

Security design, mitigation, evaluation and operational safety process will be assessed in line with the cybersecurity requirement of the UAS Implementing Regulation. [5]

[5] The Cyber obligation for UAS in the specific category is identified in Regulation UK (EU) 2019/947 UAS.SPEC.050 paragraph (iii): measures to protect against unlawful interference and unauthorised access.

Therefore, an OSC will need to evidence how cybersecurity has been considered in the following:

- Organisational Governance and Culture
- RPAS Maintenance
- C3 Link Characteristics
- Operational Procedures
- Crew Training
- Safe Design and Operation
- External Supporting Services
- Data protection from unintentional and intentional interference
- 3rd party suppliers security verification and management.

The security design, evaluation and accreditation process will be considered as a factor to the operational scenario, including but not limited to:

- Applicable flight rules;
- Aircraft capabilities and performance including kinetic energy and lethal area;
- Operating environment (type of airspace, overflown population density);
- Opportunities for attack and desirability.

The operational scenarios, along with other applicable factors, must be combined with possible weaknesses to the system to determine a measure of perceived risk. A possible security lifecycle for the UAS is shown in Figure 1 and this particular phase is referred to as the risk assessment phase of the process.

Risk management techniques must then be utilised to reduce the perceived risk to an acceptable level of residual risk. As shown in Figure 1 this phase is referred to as the risk mitigation phase of the process.

The risk management techniques implemented are verified and evaluated for effectiveness in a regular cycle of ‘action and review’ ensuring optimum effectiveness is maintained throughout the lifecycle. As shown in Figure 1 this phase is referred to as the validation and verification phase of the process.

Although the approach above is directly applicable to technical security it must be borne in mind that this process must be supported by the application of both good physical security and procedural security and these could be drawn up by interactions between industry, the

CAA and Government agencies.

Further guidance can be found in CAP 722A.

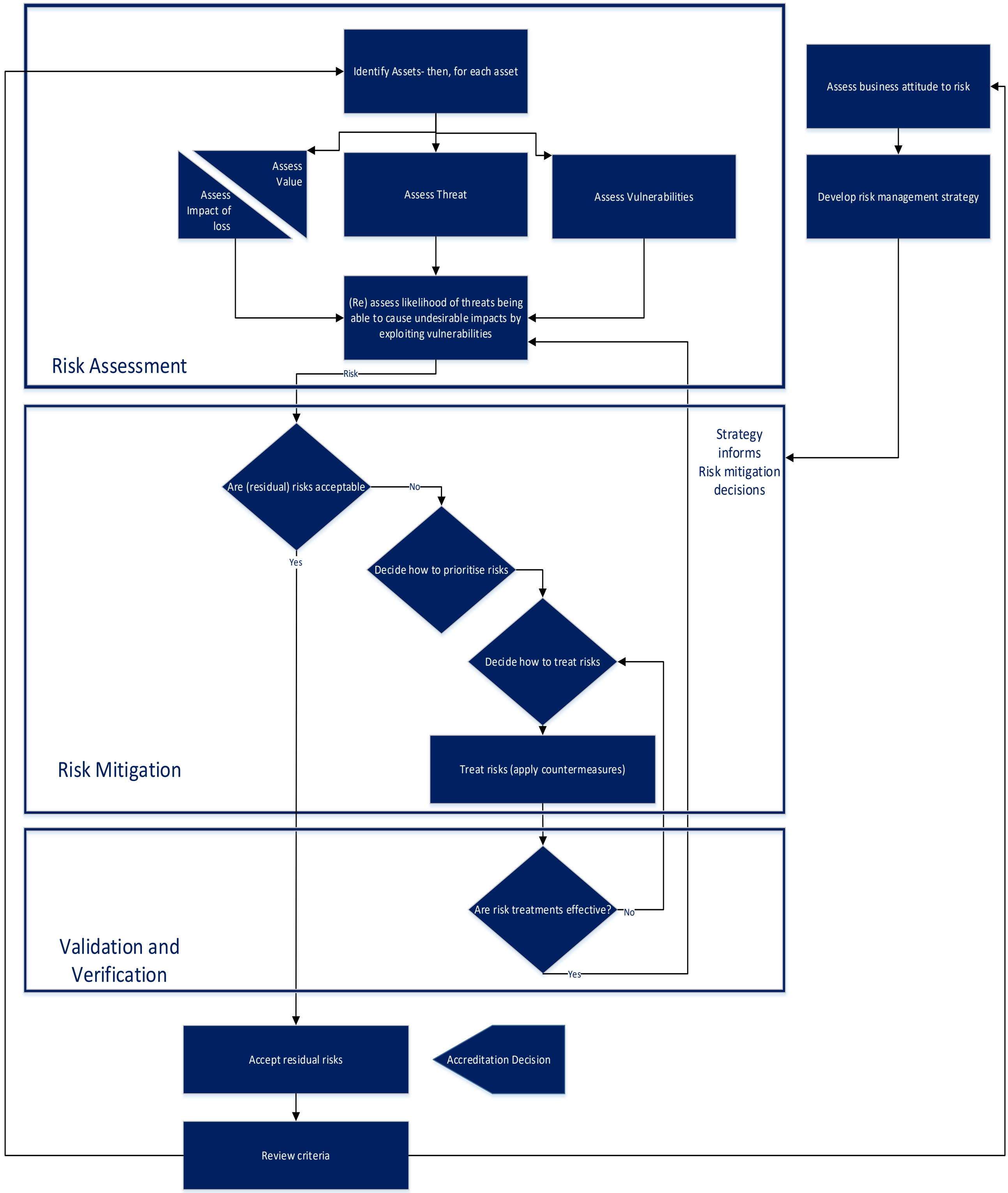


Figure 6-Security assessment process

2.7. UAS occurrence reporting

2.7.1. UAS Occurrences

This section describes the actions to take if there has been an occurrence involving an unmanned aircraft, and describes how to report it, and to whom.

2.7.2. Latest information

UAS occurrence reporting is evolving and the CAA may need to make changes to occurrence reporting policy and guidance before the next issue of CAP 722. Any relevant updates will be published on the RPAS webpages.

2.7.3. The purpose of occurrence reporting

Occurrence reporting systems are not established to attribute blame or liability.

Occurrence reporting systems are established to learn from occurrences, improve aviation safety and prevent recurrence.

The purpose of occurrence reporting is to improve aviation safety by ensuring that relevant safety information is reported, collected, stored, protected, exchanged, disseminated and analysed. Organisations and individuals with a good air safety culture will report effectively and consistently. Every occurrence report is an opportunity to identify root causes and prevent them contributing to accidents where people are harmed.

The safe operation of UAS is as important as that of manned aircraft. Injuries to third parties, or damage to property, can be just as severe. Proper investigation of each accident, serious incident or other occurrence is necessary to identify causal factors and to prevent repetition. Similarly, the sharing of safety related information via good reporting is critical in reducing the number of future occurrences.

2.7.4. Who must occurrences be reported to?

There are two separate reporting requirements, for:

- The Air Accidents Investigation Branch (AAIB); and

The Civil Aviation Authority (CAA). It may be necessary to report to one or both. The regulations that describe these requirements are explained, below.

2.7.5. Occurrence reporting regulations

The applicable regulations (as retained in UK domestic law) are:

a. UK (EU) Regulation 996/2010 on the investigation and prevention of accidents and incidents in civil aviation.

b. UK (EU) Regulation 376/2014 on the reporting, analysis and follow-up of occurrences in civil aviation.

Note: this regulation was amended by UK (EU) Regulation 2018/1139 on common rules in the field of civil aviation (The Basic Regulation).

c. UK (EU) Implementing Regulation 2015/1018 laying down a list of classifying occurrences in civil aviation to be mandatorily reported.

2.7.6. Occurrence reporting flowcharts

The flowcharts below explain:

- **What** occurrences need to be reported;
- **Who** to report to;
- **How** to report

There is a flowchart for the open category and another for the specific category. Each flowchart contains links to sections in this guidance containing key definitions and other information to help understand why and how to report to the AAIB and/or the CAA.

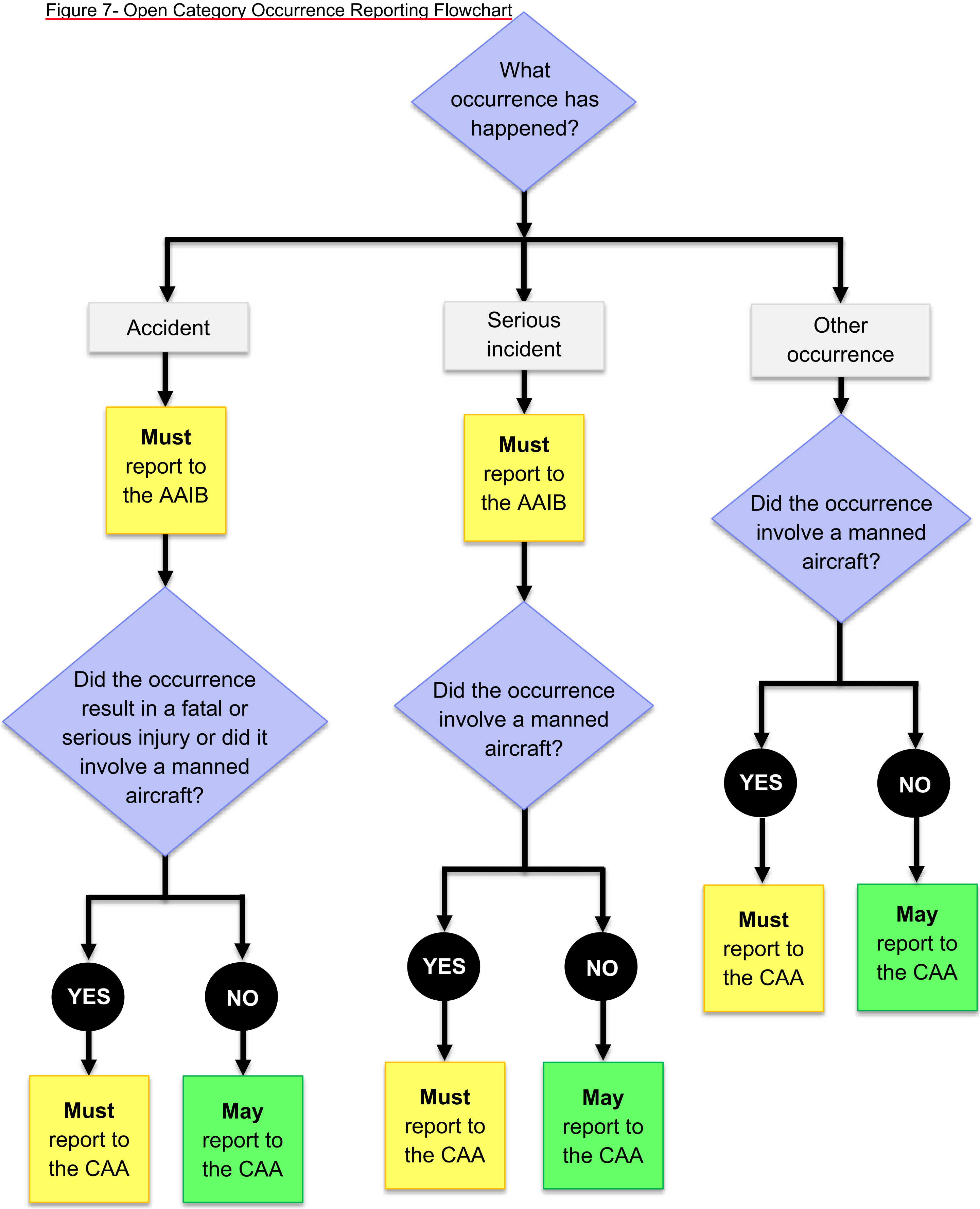
Yellow boxes mean mandatory reporting is required and green boxes mean reporting is voluntary. Voluntary reporting is useful to provide opportunity for safety lessons to be learned more widely from an occurrence.

Note:

It is often considered that a high level of reporting, and voluntary reporting, is a sign of an engaged air safety culture.

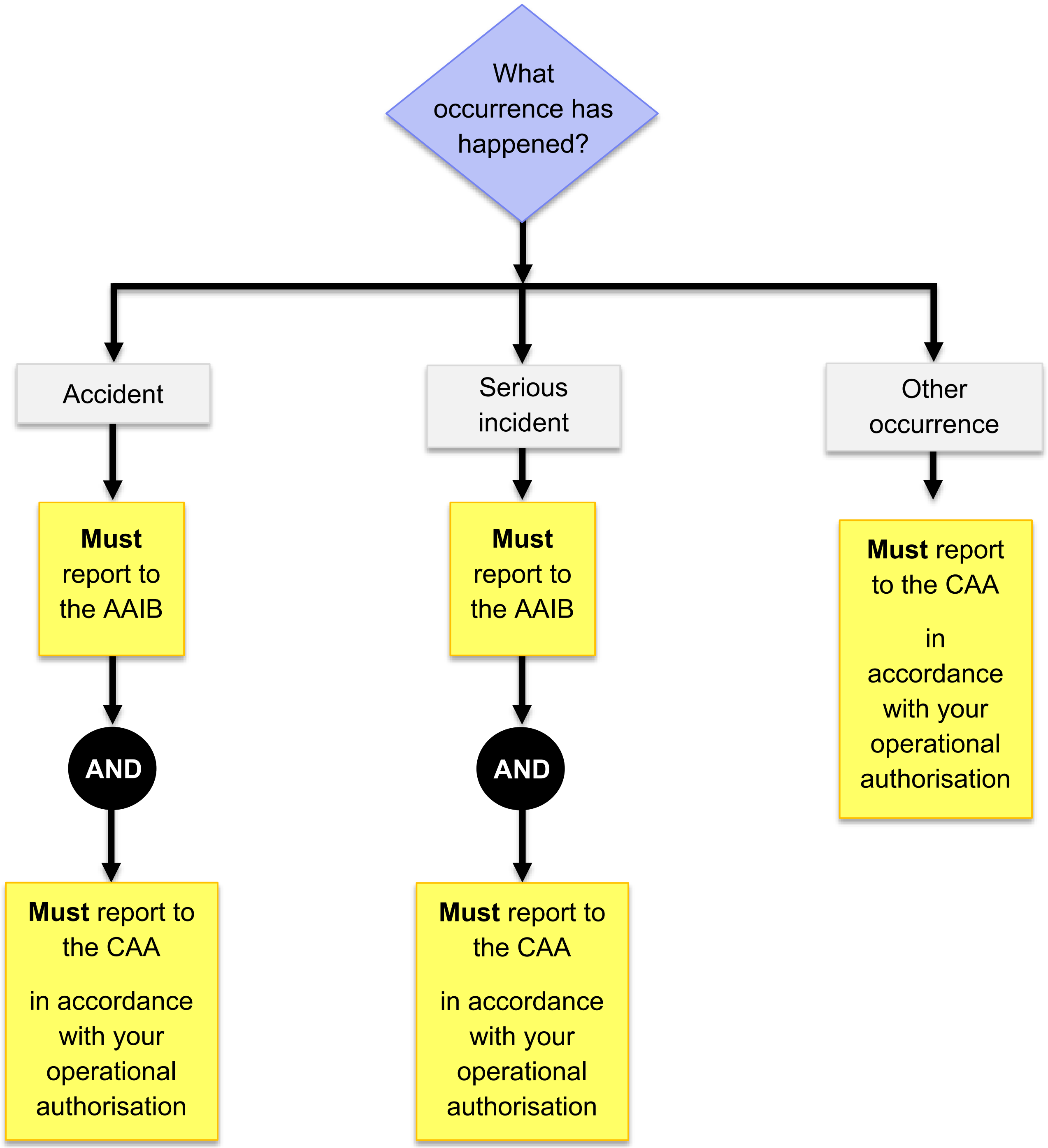
2.7.6.1. Open Category occurrence reporting flowchart

Figure 7- Open Category Occurrence Reporting Flowchart



2.7.6.2. Specific Category occurrence reporting flowchart

Figure 8- Specific Category Reporting Flowchart



2.7.7. Definitions

The definitions in this section are from UK (EU) Regulation 376/2014 and UK (EU) Regulation 996/2010.

2.7.7.1. Occurrence

Any safety-related event which endangers or which, if not corrected or addressed, could endanger an aircraft, its occupants or any other person and includes in particular an **accident** or **serious incident**.

Accidents and serious incidents are classifications of occurrence.

2.7.7.2. Accident

An occurrence associated with the operation of an aircraft which, in the case of a manned aircraft, takes place between the time any person boards the aircraft with the intention of flight until such time as all such persons have disembarked, **or in the case of an unmanned aircraft, takes place between the time the aircraft is ready to move with the purpose of flight until such time it comes to rest at the end of the flight and the primary propulsion system is shut down**, in which:

a. a person is fatally or seriously injured as a result of:

- being in the aircraft, or,
- direct contact with any part of the aircraft, including parts which have become detached from the aircraft, or, — direct exposure to jet blast, except when the injuries are from natural causes, self-inflicted or inflicted by other persons, or when the injuries are to stowaways hiding outside the areas normally available to the passengers and crew; or

b. the aircraft sustains damage or structural failure which adversely affects the structural strength, performance or flight characteristics of the aircraft, and would normally require major repair or replacement of the affected component, except for engine failure or damage, when the damage is limited to a single engine, (including its cowlings or accessories), to propellers, wing tips, antennas, probes, vanes, tires, brakes, wheels, fairings, panels, landing gear doors, windscreens, the aircraft skin (such as small dents or puncture holes) or minor damages to main rotor blades, tail rotor blades, landing gear, and those resulting from hail or bird strike, (including holes in the radome); or

c. the aircraft is missing or is completely inaccessible.

2.7.7.3. Serious incident

An incident involving circumstances indicating that there was a high probability of an accident and is associated with the operation of an aircraft, which in the case of a manned aircraft, takes place between the time any person boards the aircraft with the intention of flight until such time as all such persons have disembarked, or in the case of an unmanned aircraft, takes place between the time the aircraft is ready to move with the purpose of flight until such time it comes to rest at the end of the flight and the primary propulsion system is shut down.

2.7.7.4. Fatal injury

An injury which is sustained by a person in an accident, and which results in his or her death within 30 days of the date of the accident.

2.7.7.5. Serious injury

An injury which is sustained by a person in an accident and which involves one of the following:

a. hospitalisation for more than 48 hours, commencing within 7 days from the date the injury was received;

b. a fracture of any bone (except simple fractures of fingers, toes, or nose);

c. lacerations which cause severe haemorrhage, nerve, muscle or tendon damage;

d. injury to any internal organ;

e. second- or third-degree burns, or any burns affecting more than 5 % of the body surface;

f. verified exposure to infectious substances or harmful radiation.

2.7.7.6. Additional UAS occurrences that must be reported

In addition to Accidents and Serious Incidents other, more UAS specific occurrences must also be reported should they or a similar occurrence be experienced or observed. These occurrences are listed below but the list is not exhaustive.

When considering whether an occurrence is reportable, you should also take into account other situations where the same thing could have happened. For example, the actual occurrence may have been ‘benign’ as it happened in a remote area. However, if the full scope of how the aircraft could be operated is taken into account, for example over people, could the same occurrence in a different situation result in a more serious outcome?

<u>Operation of the aircraft</u>

- Unintentional loss of control
- Loss of control authority over the aircraft
- Aircraft landed outside the designated area
- Aircraft operated beyond the limitations established in the relevant operating

category or operational authorisation

- Aircraft operated without required licencing, registration or operational authorisation
- Aircraft operated in an unairworthy or unflightworthy condition

Technical malfunction/failure of the aircraft or command unit

- Loss of command and control link (C2 link)
- Battery failure/malfunction
- Powerplant failure
- Aircraft structural failure (for example, part of the aircraft detaches during operation)
- Errors in the configuration of the command unit
- Display failures
- Flight programming errors
- Navigation failures

Confusion/liaison errors between flight crew members (human factors)

- Inter crew communication
- Briefing
- Competency oversights

Interaction with other airspace users and the public

- Conflict with another aircraft, such that a risk of collision may have existed
- Infringement of airspace restrictions (Including Flight restriction zones (FRZs) around aerodromes and space sites)
- Inadvertent flight within close proximity of uninvolved persons (i.e. within the prescribed separation distances)

Other emergencies

- Any occurrence where the safety of the aircraft, operator, other airspace users or members of the public is compromised or reduced to a level whereby potential for harm or damage is likely to occur (or only prevented through luck).

2.7.8. Reporting a UAS occurrence to the AAIB

The purpose of the AAIB is to improve aviation safety by determining the circumstances and causes of air accidents and serious incidents and promoting action to prevent recurrence.

2.7.8.1. What UAS occurrences must be reported to the AAIB

All UAS **accidents** and **serious incidents** are required to be reported to the AAIB, regardless of weight or whether they are being used for commercial purposes.

2.7.8.2. Who must report UAS occurrences to the AAIB?

Any person involved who has knowledge of an aircraft accident or serious incident in the UK must report it to the AAIB. 'Any person' includes (but it not limited to) the owner, operator, and remote pilot of a UAS. A more detailed list can be found on the AAIB website.

2.7.8.3. How to report a UAS accident or serious incident to the AAIB

Details of how to report a UAS accident or serious incident can be found on the AAIB website.

When making a report, UAS operators should also include their 'operator ID' (registration) number, and state whether an operational authorisation is held.

2.7.8.4. The AAIB UAS investigation policy

The AAIB policy is to investigate accidents and serious incidents to UA where they are:

1. Operated under a CAA operational authorisation (i.e. in the specific category) **or**
2. the UA is certified, **or**
3. the UA has a take-off weight greater than 20 kg, **or**
4. the UA has caused a serious injury or fatality.

A non-fatal accident involving an uncertified UA without an operational authorisation may be investigated if there was a risk to life, potential for injury, or there are expected to be lessons to be drawn for the improvement of aviation safety.

Contact the AAIB if you have any questions about their investigation policy.

2.7.8.5. Preservation of evidence after an incident

The law requires that you preserve evidence following an accident.
Regulation (EU) 996/2010 Article 13 Para 2 says:

'Pending the arrival of safety investigators, no person shall modify the state of the site of the accident, take any samples therefrom, undertake any movement of or sampling from the aircraft, its contents or its wreckage, move or remove it, except where such action may be required for safety reasons or to bring assistance to injured persons, or under the express permission of the authorities in control of the site and, when possible, in consultation with the safety investigation authority.'

Contact the AAIB if you have any questions about this law.

2.7.8.6. If you have questions about reporting to the AAIB

Contact the AAIB if you have any questions about reporting occurrences to the AAIB or what to do after an accident.

2.7.9. Reporting UAS occurrences to the CAA

2.7.9.1. How to report a UAS occurrence to the CAA

Reports are submitted to the CAA using the European Co-ordination Centre for Accident and Incident Reporting Systems (ECCAIRS2) reporting portal.

The reporting portal can be found here .

Guidance on how to use the portal can be found in CAP 1496. When making a report, UAS operators should also include their 'operator ID' (registration) number, and state whether an operational authorisation is held.

It should be noted that when selecting the UK, within this system, it explains that the user is reporting as an ICAO state, and not under regulation EU 376/2014. This is because the UK has left the EU, and so reports are made under the UK version of that regulation, rather than the EU version.

2.7.9.2. Specific Category operations

The CAA will expect reporting in accordance with the specific category flowchart when an occurrence takes place at a time when the aircraft or its remote pilot is doing something that does require authorisation.

The CAA will expect reporting in accordance with the open category flowchart when an occurrence takes place at a time when the aircraft or its remote pilot is doing something that does not require authorisation.

Operators and remote pilots carrying out flights in the specific category must be familiar with the guidance of this document **and** the reporting requirements in their authorisation.

This approach is intended to minimise the mandatory reporting requirement on operators and remote pilots. It will also keep mandatory reporting requirements aligned and proportionate to the safety risk of the operation.

Further information on mandatory and voluntary occurrence reporting

Further information can be found in CAP 382.

Reporting analysis and software solutions for organisations

Further guidance for organisations can be found in CAP 382.

2.7.9.3. Voluntary occurrence reporting

Confidential Human Factors Incident Reporting Programme "CHIRP"

Although the CAA MOR process is the default method of reporting incidents, there are circumstances when a reporter may not wish to report through the normal process for personal reasons (for example if they fear that their identification will result in retribution) or if they have been unable to achieve a resolution through normal channels.

The UK Confidential Human Factors Incident Reporting Programme (CHIRP) compliments the occurrence reporting system detailed in 2.9.10 above and any other formal reporting systems, by providing a means by which individuals are able to raise safety-related issues of concern without being identified to their peer group, management, or the CAA.

CHIRP is a totally independent programme for the collection of confidential safety data, and when appropriate, acting or advising on information gained through confidential reports. Independent advice is provided on aeromedical and Human Factors aspects of reports, involving such topics as errors, fatigue, poor ergonomics, management pressures, deficiencies in communication or team performance. Reports may include but are not confined to the design and use of aircraft and equipment, rules and procedures, regulations, workplaces, manpower, organisation, management, communication, human skills and training.

A link to file a report with CHIRP can be found here.

Further information is also available on the CAA website here

The fundamental principle underpinning CHIRP is that all reports are treated in absolute confidence in order that reporters' identities are protected. CHIRP offers a confidential alternative for those who wish their identities to be protected. CHIRP does not accept reports submitted anonymously.

CHAPTER 3 | Airworthiness and Certification

3. Airworthiness and Certification

3.1. Categories of UAS Operation

3.1.1. Open Category

See section 2.2.1.3 for guidance on Open Category product standards.

3.1.2. Specific Category

UAS operated in the Specific category are not necessarily subject to specific certification requirements. Technical standards, (including UAS designed for use in the Open category as designated within UK Regulation (EU) 2019/945) are dependent on the proposed type of operation and its associated risk assessment.

'Certified' equipment may be used within the 'specific' category as per UK Regulation (EU) 2019/947, UAS.SPEC.100. A UAS subject to certification shall comply with the applicable requirements set out in UK Regulations (EU) 748/2012, 2015/640 and 1321/2014.

3.1.3. Certified Category

The design, production and maintenance of a UAS must be certified if any of the following conditions as defined in UK Regulation (EU) 2019/947 Article 6 and UK Regulation (EU) 2019/945 Article 40 are met:

- it has a characteristic dimension of 3 m or more, and is designed to be operated over assemblies of people;
- it is designed for transporting people;
- it is designed for the purpose of transporting dangerous goods and requires a high level of robustness to mitigate the risks for third parties in case of an accident.

In addition, a UAS may also need to be certified if the CAA determines that an application to operate in the specific category presents too high a safety risk and cannot be sufficiently mitigated. In these circumstances the operation must be carried out in the certified category to obtain the appropriate level of assurance that the operation is safe enough.

UK Regulation (EU) 2019/947 Article 12 requires the CAA to evaluate the risk assessment and the robustness of the mitigating measures that the UAS operator proposes to keep the

UAS operation safe in all phases of flight. Following this evaluation, the CAA may refuse to authorise the operation in the specific category and inform the applicant of the reason why.

3.2. Airworthiness and Certification Principles

This chapter offers basic high-level guidance on what aircraft certification is and what activities are associated with aircraft certification. These are more generally referred to as 'initial airworthiness' and interrelate with the activities associated with 'continuing' and 'continued' airworthiness. The text provides an overview of the objectives of the airworthiness and the certification principles and processes. This is intended to give a general understanding of the various aspects of civil aircraft certification and the related organisational oversight activities.

This is a general outline only; reference should still be made to other airworthiness documentation, refer to the CAA website for further information. The principles outlined in this section apply only to certified UAS platforms in the context of this document.

Detailed principles for the certification of autonomous systems have not been developed yet. Once the regulatory framework has been published and adopted then this document will be updated.

3.2.1. What level of certification is required?

This section offers guidance on the level of certification required for an aircraft or UAS and is based upon its intended use. Where no formal airworthiness certification is required guidance is given on the approach to take.

Some aircraft are not required to hold any airworthiness approvals. These can be operated under an operational authorisation or permit to fly, provided they are suitably separated from third parties and property, as well as other airspace users. A lack of 'demonstrable airworthiness' can still be accommodated, albeit with limitations or restrictions placed on the operation, where appropriate. This approach is intended to provide a reasonable and proportionate level of regulation.

At the highest level, aircraft have a Certificate of Airworthiness which is underpinned by Type Certification, continued airworthiness processes, and design and production organisation approvals. These aircraft are flown by licensed and rated pilots, as well as maintained by licenced engineers under the procedures of an approved organisation, and thus are capable of international operations under the mutual recognition arrangements.

3.2.1.1. Aircraft classification

The current certification framework established and used by the UK CAA, EASA and other NAAs, classifies aircraft based on the type (e.g., balloon, fixed or rotary wing) and mass. This reflects the historic developments in manned aviation but is not necessarily fully appropriate for the certification of UAS and may need to be adapted. However, until such time as alternative classification protocols are agreed, this system is in place.

Work is being developed at the UK national level and internationally to categorise new and innovative classes of aircraft such as Hybrid and e-VTOL aircraft.

UAS fall within the remit of Annex IX of the Basic Regulation, unless they are State aircraft or fall within the exceptions defined in paragraph 2 of Annex I.

Certification is the legal recognition by the certification authority that a product, service or organisation complies with the applicable requirements.

Certification comprises the activity of technically checking the product, service, organisation or person, and the formal recognition of compliance with the applicable requirements by issue of a certificate, licence, approval, or other documents as required by applicable regulations.

The rationale behind certification for UAS is that the same target levels of safety that apply to manned aircraft should also apply to UAS being used for higher risk operations. This should ensure the safety of third parties on the ground and in the air.

Therefore, certification is the process to define and establish a set of operational and technical parameters that the aircraft must be operated within. This does not mean that because the product is certified that it may be suitable for all envisaged types of operations. Therefore, operational restrictions may also be applied in addition to the airworthiness requirements.

Generally, it is the manufacturer (i.e., the organisation responsible for designing and constructing the aircraft) that will apply to its respective National Aviation Authority (NAA) for certification. NAAs do not generally certify platforms for individuals acting as operators, unless they are also the designer and manufacturer of the platform.

3.2.2. Certification objectives

Annex 8 of the Chicago Convention contains the SARPS for Airworthiness. These are a system of internationally agreed standards and recommended practices by which each ICAO contracting State can establish a means to ensure that a minimum level of safety is established and achieved. This process enables States to mutually recognise the airworthiness of individual aircraft operating within each other's airspace.

As not all types of aviation require routine international operating capability, each State can define and establish its own standards and practices for these ‘national activities’.

Therefore, it is important to recognise that the headline title of airworthiness/certification is a means by which the competent authority of a State can establish and attest to compliance with an agreed set of standards. These standards cover the necessary range of aircraft types and the activities to be undertaken; typically, the standards applied can be, and usually are, different for varying classes of aircraft and their intended use.

For example:

> To comply with the ICAO international requirements aircraft must be operated under cover of an Operational Approval; each aircraft must have a valid Certificate of Airworthiness (which is underpinned by an approved Type Design) and be flown by appropriately qualified and licensed flight crew.

At the other end of manned aviation, light weight non-complex personal use (recreational) aircraft may only need to have a Permit to Fly, which is a national approval, i.e., Non-ICAO compliant. This limits use to that country only and could include limitations and conditions on where and when it can be flown (e.g., class of airspace, weather conditions, etc). It must also be noted that a national approval precludes automatic rights of use/operation in another country. However, this does not prevent use or operation in another country, but it does mean each NAA will need to determine how and what it will allow by a separate process.

3.2.2.1. Initial, continuing and continued airworthiness

Within the certification and airworthiness system there are three basic processes to set and maintain required standards. These processes determine and maintain the intended level of safety:

- Initial airworthiness

  The initial airworthiness processes are those used to determine the applicable requirements and establish that an aircraft design is demonstrated to be able to meet these requirements. This includes the safety targets and the development of instructions for use and ongoing care/maintenance. It would also cover the elements of production, i.e., those aspects of taking the approved design and manufacturing the end product to the point of a useable aircraft. This phase must be completed prior to an aircraft entering into service.

- Continuing airworthiness

  The continuing airworthiness process refers to the system of management of the aircraft and the scheduling and actioning of ongoing preventative and corrective maintenance to confirm correct functioning and to achieve safe, reliable and cost-effective operation.

- Continued airworthiness

  Continued airworthiness refers to the monitoring, reporting and corrective action processes used for in-service aircraft to assure they maintain the appropriate safety standard defined during the initial airworthiness processes throughout their operational life.

In parallel with each of these processes, there are schemes that require or provide for organisation approvals, e.g., design, production, maintenance. These approvals enable the NAAs to recognise capability within a company system; this limits the level of investigation and oversight that may be necessary to establish compliance against the regulatory standards applicable to individual products.

3.2.2.2. Initial airworthiness processes

The initial airworthiness process establishes a required level of airworthiness integrity for an aircraft and to demonstrate that this level of integrity can be achieved. Integrity must be taken to include all aspects of the design (structurally and systemically) to cover safety, reliability, availability, capability, etc.
When the required level of airworthiness integrity is met and consistently shown to be achieved, the aircraft can be considered to provide an acceptable level of safety; this covers both the vehicle (and any person(s) on board, if applicable) and, by inference from continued safe flight, to persons and property on the ground.

The initial airworthiness processes have the following basic elements for design and production:

- Establishment of the design/certification requirements (certification specifications) which define the high-level design criteria and showing that these are met.
- The design organisation aspects which cover the capability and competence of the company for the design of the complete aircraft, systems or individual parts.
- The production organisation aspects which cover the capability and competence for the manufacture and assembly of the complete aircraft, systems or individual parts in accordance with the approved design and testing of the aircraft prior to delivery.

The design organisation must demonstrate to the certification authority that the proposed design is compliant with the established and agreed certification specifications or other requirements. The production organisation is responsible for showing that the end product is in conformance to the design.

For current categories of manned aircraft, there are already established design/certification requirements, such as the Certification Specifications (e.g., Large Aeroplanes (CS-25), Large Rotorcraft (CS-29), Very Light Aircraft (CS-VLA), and Very Light Rotorcraft (CS-VLR) etc.). These provide acceptable means of compliance and guidance material on the intent of the requirement that are acceptable to the competent authority. It is recognised that these may not fully address the range of aircraft potentially possible, nor how the technology elements relevant to UAS may cross the boundaries between the categories of the requirements.

Except for certain aircraft, where the safety aspect is controlled by separation and operational management, each class of aircraft will have some level of safety requirement. Where a formal certification approval is necessary, the safety assessment requirement for "Equipment, Systems and Installations" and the associated guidance material is already defined in the Certification Specifications under paragraph CSXX.1309 (in some more recent design requirement sets, the paragraph number is XX.2510). However, this may not be wholly appropriate for all categories of aircraft.

3.2.2.3. Continuing airworthiness processes

The continuing airworthiness processes assure that in–service aircraft are managed and maintained correctly. To be performed correctly, this must be done by appropriately competent and authorised persons, and in accordance with the instructions developed by the design organisation. This ensures that assumptions and considerations made during the design, particularly in respect of safety, remain valid. As a result, these processes also need effective communication between the operator, maintenance organisations and the design organisations to ensure that necessary information is shared and if necessary, corrective actions are taken by the relevant parties.

The continuing airworthiness process will support any modifications, repair or component replacement once an aircraft has entered service. This is achieved by undertaking the incorporation of the changes, but also in the management of configuration records, updating of maintenance instructions, etc. This process will last for the entire life span of the aircraft remaining in service.

3.2.2.4. Continued airworthiness processes

The continued airworthiness processes are intended to provide a closed loop monitor and corrective action cycle for in-service aircraft to assure that the intended level of safety is maintained. The process starts with activity within the certification work (for example the development of the maintenance schedules and instructions on how to perform this activity). Thereafter, it includes the monitoring of in-service aircraft and the promulgation of corrective action instructions where necessary.
The development of maintenance schedules typically considers and uses information from the aircraft design and safety assessment processes to determine what maintenance activities are required, and how frequently they will be performed to maintain the appropriate level of aircraft integrity (for example replacing parts before they would typically wear out or fail will prevent the consequence of this and hence aid both safety and commercial costs).

The monitoring and reporting processes support the collection and analysis of in-service information and enable the design organisation to be satisfied that the overall level of safety is being maintained, or if necessary, to determine and promulgate corrective actions to address problem areas.

If these programmes are run correctly, they have the potential to save organisations money as it is usually cheaper in terms of both money and time to fix a minor problem before it becomes a major problem.

3.2.3. Stages of airworthiness

3.2.3.1. Initial and continued airworthiness

This process consists of design and production activities. This is primarily covered under Part 21 - ‘’Certification of Aircraft and Related Products, Parts and Appliances, and of Design and Production Organisation”.

During the initial certification of an aircraft, the initial and continued airworthiness processes may be considered to run concurrently because the information developed within the initial airworthiness processes feeds into the continued airworthiness processes to develop the “instructions for continued airworthiness”, i.e., the maintenance schedules and tasks which need to reflect the assumptions and considerations of use of the aircraft. In principle, once it has been demonstrated both the initial airworthiness and continued airworthiness requirements have been met, an aircraft type will be issued with a Type Certificate (TC).

Type Certificates are currently only issued to the following products:

- Aircraft
- Engines
- Auxiliary Power Unit (APU)
- Propellers

The development of all other types of aircraft system is required to be overseen by the Type Certificate applicant.

Once an aircraft, engine, APU or propeller holds a Type Certificate any changes will fall into the following categories:

- Major Change – This is a significant change to the design of an aircraft, engine, propeller or related system that is designed and implemented by the holder of the Type Certificate.
- Supplemental Type Certificate (STC) – This is a significant change to the design of an aircraft, engine or propeller that is not designed and implemented by the holder of the relevant Type Certificate.
- Minor Change – This is a non-significant change to the design of an aircraft, engine, propeller or related system which is not permitted to affect the extant aircraft, engine or propeller level safety assumptions.
- Change in Operational Use – This is a change to the operational use of an aircraft, engine or propeller that falls outside the agreed scope of use defined

during the initial and continued airworthiness processes. In principle this must be discussed and agreed with the relevant TC holder, but this is not actually mandated.

Clearly any change to a certificated system that does not involve the TC holder has potential implications for aviation safety.

Note 1:

In UAS the Command Unit is an integral component to the UAS. Therefore, it is envisaged that this may require its own TC or appropriate documentation that evidences that the equipment meets the minimum performance requirements.

Note 2:

The DAA capability will not receive its own standalone TC. This will form part of the overall TC issued to the UAS by the Competent Authority.

3.2.3.2. Continuing airworthiness

The continuing airworthiness process begins with an evaluation of an organisation to determine whether or not it meets the basic requirements to be allowed to perform initial and/or continued airworthiness functions.

This process seeks to determine compliance against one or more of a number of organisational approval requirements documents:

- Part 21 – "Certification of Aircraft and Related Products, Parts and Appliances, and of Design and Production Organisation". In simple terms, this document applies to organisations involved in initial airworthiness.
- Part M – "Continuing Airworthiness Requirements". This relates to organisations that are responsible for managing and overseeing maintenance tasks and maintenance scheduling.
- Part 145 – "Approved Maintenance Organisations". This applies to organisations that perform continued airworthiness related tasks under the management of an organisation approved to Part M.
- Part 147 – "Maintenance Training Organisational Approvals". This applies to organisations that are responsible for the provision of aviation maintenance related training and examinations.
- Part 66 – "Certifying Staff". This documents the competency requirements for maintenance personnel that are responsible for signing off aircraft or aircraft systems as serviceable. This is commonly referred to a licenced engineer.

Further information on these regulations and requirements may be found on the CAA website: UK CAA Airworthiness

No organisation is permitted to work within the aviation industry unless they either have the relevant approvals, as dictated by the continuing airworthiness processes or they are overseen by an organisation that holds the relevant approval. This is intended to ensure that any aviation work is performed with a degree of integrity commensurate to the risk associated with that activity. Once an approval has been granted, the continuing airworthiness process runs concurrently with the initial and continued airworthiness processes to ensure that an appropriate level of organisational integrity is maintained to support the individual project/aircraft level tasks overseen by the initial and continued airworthiness processes.

If the initial and/or continued airworthiness processes identify organisational risks, this information is passed back into the continuing airworthiness processes to ensure that these risks are managed appropriately.

3.2.4. General certification requirements

The approach taken by the UK CAA for certification is, in principle, the same as that followed by EASA. Within this process, the actual requirements that make up the certification basis, must be shown to be met and complied with. These requirements may well be different for other NAAs due to the views, experience and concerns of each country.

3.2.4.1. Basic principles

The initial airworthiness or “Type Certification” process can be considered to follow a simple process, however there may be parallel paths in obtaining Design Organisation Approval (DOA) and Production Organisation Approval (POA), where these are necessary, which must come together at key cross-contact points.

All certification tasks, irrespective whether they are performed internally or allocated to an NAA shall be executed following the provisions of this procedure.

The certification project process can generally be divided in the following phases:

- Phase 0: Definition and agreement of the working methods with the applicant.

  The objective of this phase is to check applicant's eligibility and establish the Team of experts.

- Phase I: Technical Familiarisation and establishment of the Initial Certification Basis.

  The objective of this phase is to provide technical information about the project to the Team of experts to enable the definition of an agreement on the initial Competent Authority Certification Basis.

- Phase II: Agreement of the Certification Programme and Level of Involvement.

  The objective of this phase is the definition of, and the agreement on, the proposed means of compliance for each requirement of the Certification Basis and the identification of the Certification Team's Level of Involvement.

- Phase III: Compliance determination.

  The objective of this phase is to demonstrate compliance with the applicable Certification Basis and environmental protection requirements and provide the Competent Authority with the means by which such compliance has been demonstrated and declare that compliance has been demonstrated.

- Phase IV: Technical closure and issue of the Approval.

  The objective of this phase is to technically close the investigation and issue the Certificate.

  Certification Review Items (CRI) and Certification Action Items (CAI) are raised whenever it is foreseen in the procedure. However, CRI and CAI may also be raised in the course of a certification project whenever it is deemed necessary.

Procedure users are advised to consult the UG.CERT.00002 AW of Type Design for additional guidance where necessary.

From the above processes the derivation of the applicable requirements is clearly a key aspect. However, the current manned requirements set does not align with the types/size/mass of aircraft that are being developed as UAS.

Unfortunately, the timeline for developing requirements is likely always to be behind the rate of technological advancement. The current approach is therefore to identify the category that fits as best as possible to the type/classification of the aircraft – and subtract what is not necessary and add to fill the gaps where required. The gaps can be filled by parts of other requirement sets, where practicable, and/or by developing new material where necessary.

- For example: a simple fixed wing aeroplane design may align well with the VLA (Very Light Aeroplanes) category with respect to structure and control surface actuation etc. However, because of the UAS aspects, the design may have a sophisticated command and flight control system, which is not addressed in CS-VLA. Use of the relevant sections of CS-23 or even CS-25 may be applicable.

The following list defines the different certification categories for aircraft:

CS – 23 Normal, Utility, Aerobatic and Commuter Aeroplanes. cs-23

CS – 25 Large Aeroplanes. cs-25

CS – 27 Small Rotorcraft. cs-27

CS – 29 Large Rotorcraft. cs-29

CS – VLA Very Light Aircraft. cs-vla

CS – VLR Very Light Rotorcraft. cs-vlr

The main difficulty with this approach, apart from the commercial risk prior to agreement with the competent authority for design, is the potential lack of cohesion between the safety target levels from the different standards.

Work is being undertaken through various international bodies, such as JARUS, to establish Certification Specifications (CS) for Unmanned Aircraft Systems: JARUS_CS-UAS and JARUS_CS-LURS and CS-LUAS.

These certification specifications may be adopted by competent authorities to assist in the certification process. These need to be agreed between the applicant and the competent authority beforehand.

At present, the UK has not formally adopted any CS publications for UAS. When any certification specification is adopted this will be communicated.

3.2.4.2. Additional certification specifications

There are additional CS used in aviation for engines, propellers, airborne CNS and aircraft noise. These need to be considered by the equipment designer when designing equipment seeking approval from the relevant competent authority.

Examples of this include:

AMC 20 General Acceptable Means of Compliance for Airworthiness of Products, Parts and Appliances.

CS – APU Auxiliary Power Units.

CS – E Engines.

CS – ETSO European Technical Standard Orders.

CS – P Propellers.

CS – 36 Aircraft Noise.

This list is not exhaustive; readers should refer to the UK CAA website for further guidance.

3.2.4.3. Special conditions

Special detailed technical specifications, named special conditions (SC), may be established for a specific product if the related airworthiness code does not contain adequate or appropriate safety standards. These are usually required because:

- The product has novel or unusual design features relative to the design practices on which the applicable airworthiness code is based; or

- The intended use of the product is unconventional; or
- Experience from other similar products in service or products having similar design features has shown that unsafe conditions may develop.

Some of the existing SC that have been issued have a “generic” characteristic, i.e., they are applicable to all products, or all products incorporating a certain technology, or all aircraft performing certain specific operations. Some of these SC have been used for many years on several certification projects.

One recent example, published by EASA, is SC – VTOL EASA_SC-VTOL

3.2.4.4. Restricted Type Certificate (RTC)

A restricted type certificate may be applied for when a type certificate is inappropriate, and the aircraft is designed for a special purpose for which the Competent Authority agrees deviations from the full requirements that provide a sufficient level of safety for the intended use.

3.2.4.5. Supplemental Type Certificate (STC)

A supplemental type certificate (STC) is a type certificate (TC) issued when an applicant has received Competent Authority approval to modify an aeronautical product from its original design. The STC, which incorporates by reference the related TC, approves not only the modification but also how that modification affects the original design.

3.2.4.6. Permit to Fly

An aircraft that does not meet the International Civil Aviation Organisation (ICAO) certification standards required for the issue of a Certificate of Airworthiness (C of A) may be issued a permit to fly, subject to satisfying certain requirements and only operated within certain limitations.

A permit to fly will not be issued to an aircraft that is eligible for the issue of a C of A but may be issued in the event of a C of A becoming temporarily invalid.

3.2.5. General Safety assessment points

This section offers guidance on some general safety assessment points for UAS Certification and Safety Assessment of aircraft systems.

The intent of a Safety Assessment is to demonstrate that the aircraft is safe enough for the manner and type of operation it is intended to perform. It is not intended here to describe any of the many different types of assessment or analyses that can be undertaken, but to outline the general system safety assessment points to be considered.

It is important to recognise that Safety Assessments, if conducted as a fundamental and iterative design process, can provide benefits in terms of the level of safety achievable. This may also achieve a degree of reliability and potentially minimise the cost of ownership through effective maintenance schedules.

If the Safety Assessment is considered retrospectively, the potential findings of an assessment may prove difficult and costly to rectify. Issues identified in the Safety Assessment may require redesign or the implementation of limitations and restrictions. The earlier in the design process these issues are identified, the less impact they are likely to have on the development schedule and budget.

3.2.5.1. Assessment steps

A Safety Assessment may be considered in the following steps:

- Determination of the set of aircraft level threats/hazards related to functional failures are identified;
- The severity of the consequence for each of these failure conditions is determined/classified;
- This classification could be different for differing scenarios, e.g., during different phases of flight;
- The target level of safety (TLOS) is assigned for each failure condition;
- The systems and component failures that could contribute to each of these failure conditions is assessed or analysed to establish if the individual TLOS is met;
- Compliance with each individual failure condition and the overall aircraft level target is shown.

Within the airworthiness requirements set, the aircraft certification specifications contain specific requirements and levels of safety defined in terms of probability. For smaller/ specific classes of aircraft, the airworthiness requirements may not define levels of safety in terms of probability – hence the method of demonstrating compliance is open for discussion. Potential options for demonstrating compliance include the use of sound engineering judgement, justification through assessment and evidence rather than probabilistic analysis. This is important as probability analysis rely on robust component reliability data which may not be possible with new or developing technologies and components.

3.2.5.2. Safety assessment considerations

Each of the UAS design requirement sets will include system safety requirements. These are often referred to as paragraph number 1309 of the applicable CS (e.g. CS-XX.1309). In some more recent design requirement sets, the paragraph number is XX.2510. This requires that the probability of a failure is inversely proportional to the severity of its effect at aircraft level. Therefore, high criticality systems are required to have an extremely low probability of failure.

These certification requirements were established many years ago based on in-service experience (accident data etc) and a desire to set a standard that would drive improvements in what was then being achieved. For each class of passenger transport aircraft (large and small fixed wing aircraft, rotorcraft, etc.), an acceptable fatal accident rate was defined, e.g., 1 accident in 10 million flight hours (10-7 per flight hour), for a large, fixed wing aircraft. Then based on simple assumptions regarding the number of aircraft systems and potentially critical failures in each of these, a target level of safety was defined for each critical failure. This is described in detail within the advisory material that goes with the requirement. The tables below detail the hazard classification and likelihood of occurrence.

Hazard Classification	
Definition	**Meaning**
Catastrophic	Results in accident, death or equipment destroyed
Hazardous	Serious injury or major equipment damage
Major	Serious incident or injury
Minor	Results in minor incident
No Safety Effect	Nuisance of little consequence

Table 3- Summary of Hazard Classification

Likelihood of Occurrence		
Definition	**Meaning**	**Quantitative Numerical Definition of likelihood per hour**
Frequent	Likely to occur many times	1 to 10^{-3} per hour
Occasional	Likely to occur sometimes	10^{-3} to 10^{-5} per hour
Remote	Unlikely to occur but possible	10^{-5} to 10^{-7} per hour
Improbable	Very unlikely to occur	10^{-7} to 10^{-9} per hour
Extremely Improbable	Almost inconceivable that the event will occur	$< 10^{-9}$ per hour

Table 4- Summary of Likelihood Classification

The validity of using these probability targets for UAS is currently a debated subject. Clearly, they relate to passenger transport aircraft and the safety of passengers carried.

However, it must be noted that by protecting persons on board an aircraft, it is implied that third parties on the ground will also be protected.

There is also some discussion that the types of operation undertaken by passenger aircraft are quite different to the range of operations undertaken by UAS and so once again, the probability targets may not be appropriate. However, the safety assessment process already accounts for this to some extent because, due to these differences, the consequence or severity of effect could be quite different, and so result in a different target level of safety.

For UAS, the safety assessment and any analysis or justification to demonstrate compliance with the level of safety target is primarily based on the aircraft system and its associated failure mechanisms. The aircraft system is the total system required for safe flight and landing, e.g., the aircraft, command unit, command and control datalinks and any launch or landing/recovery systems.

In principle, it does not place any reliance on external factors that may mitigate the failure; these are the safety nets that could prevent the worst-case scenario.

It must also be noted that where the simple assumptions made in the certification safety assessment requirements are not valid (e.g., ‘independent’ vs ‘integrated’ systems, ‘simple’ vs ‘complex’ systems, and the number of critical failure conditions), it may be necessary to impose more stringent targets to individual failure conditions in order to meet the aircraft target level of safety.

For UAS operating in the Specific category, the proportionate approach that is taken does not necessarily require a safety assessment to the level described above. However, the safety case and risk assessment approach does still require consideration of the hazards (including those that could be due to aircraft system failures), their severity, and justification of how these will be mitigated and managed. It is therefore required that some level of assessment and justification of how and why hazards are suitably managed will be necessary, albeit not necessarily to the level that uses detail probability-based analyses. This will be assessed by the CAA prior to any operational authorisation being issued to the applicant.

Risk assessment methodology and guidance material for applicants is contained in CAP 722A for operations within the specific category.

3.2.5.3. Additional airworthiness and technical information

The text below describes other airworthiness related terms that relate to product certification and continuing airworthiness. These are high level descriptions. Further information can be found on the related websites and other published documents.

- C of C – Certificate of Conformance: This is a certificate issued to a product which declares that the product meets the required standard for use on an aircraft. It is generally issued against a very generic standard and is mainly used for consumable type products in aviation, e.g., fasteners and other miscellaneous type items.

- ETSO – European Technical Standard Order: This is a detailed airworthiness specification issued by the European Aviation Safety Agency (EASA). An ETSO ensures that a part or appliance complies with a minimum performance standard. In all cases, the installer must apply for an installation approval on-board the aircraft; EASA_ETSO
- TSO – Technical Standard Order: This is issued by the Federal Aviation Administration (FAA). A TSO is a minimum performance standard for specified materials, parts, and appliances used on civil aircraft. When authorised to manufacture a material, part, or appliances to a TSO standard, this is referred to as 'TSO authorization'. Receiving a TSO authorization is both design and production approval. Receiving a TSO authorization is not an approval to install and use the article in the aircraft. It means that the article meets the specific TSO and the applicant is authorised to manufacture it; FAA_TSO
- SB – Service Bulletin: A Service Bulletin is the document used by manufacturers of aircraft, engines or components to communicate details of modifications which can be embodied in aircraft. If an available modification is judged by the manufacturer to be a matter of safety rather than simply product improvement, then these would be issued as an Alert SB in which case a corresponding Airworthiness Directive (AD) would usually then be issued by the appropriate NAA.
- SIL – Service Information Letter: This is a document is used by manufacturers of aircraft, engines or components to communicate details of advisory action or other 'useful information' about their products which may enhance safety, reliability or reduce repetitive costs.
- AD – Airworthiness Directive: An Airworthiness Directive is a notification to owners and operators of certified aircraft that a known safety issue with a particular model of aircraft, engine, avionics or system exists and must be corrected. Therefore, it is mandatory for an aircraft operator to comply with the instructions within an AD. AD's are only published by competent authorities.

3.2.5.4. Additional considerations

The value of the safety assessment process in the development of maintenance programmes (e.g., the type and frequency of maintenance actions), must also be recognised. The outputs of this process provide useful data to determine what maintenance scheduling is required. These maintenance actions can prevent critical failures (e.g., by replacing items before they are likely to fail, or by detecting problems before operation of the aircraft). Not only does this support safety but it has the potential to save money – it is usually cheaper in terms of both money and time to fix a minor problem before it becomes a serious problem.

3.2.5.5. Standards bodies

There are multiple standards bodies that are engaged with the development of standards for aeronautical products such as UAS. Such bodies include EUROCAE, ASTM, RTCA etc. Readers should refer to the respective bodies' websites for further information.
The CAA may choose to accept suitable standards from these bodies as deemed appropriate for application in the certification of UAS. These may be published by the CAA when adopted.

CHAPTER 4 | Aircraft Systems

4. Aircraft Systems

4.1. Communications, Navigation and Surveillance

It is the responsibility of the UAS operator to ensure that the radio spectrum used for the C2 Link and for any payload communications complies with the relevant Ofcom requirements and that any licenses required for its operation have been obtained.

It is also the responsibility of the operator to ensure that the appropriate aircraft radio licence has been obtained for any transmitting radio equipment that is installed or carried on the aircraft, or that is used in connection with the conduct of the flight and that operates in an aeronautical band.

4.1.1. C2 Link Communications

This section provides:

- Information regarding the use of frequencies to support UAS operations.
- Frequency bands that are potentially available to support UAS C2 and DAA systems, their limitations and the required authorisation of their use.

It also sets out the CAA's position in respect to:

- the spectrum currently available and its limitations.
- the application process for the use of spectrum by the UAS industry.
- the process for seeking access to alternative spectrum.

4.1.1.1. Introduction

The provision of a reliable C2 Link is essential to the safe and expeditious operation of UAS. Although many existing aeronautical systems that support safety critical applications operate in suitably allocated and protected spectrum, these are often not suitable for UAS operations.

The CAA's overall aims are:

- to ensure that frequencies used to support safety critical UAS functionality meet both international and national regulations/legislation.
- to ensure that all frequencies used to support safety critical UAS functionality have been co-ordinated and licensed in accordance with the appropriate

licensing regime.

- to ensure that any such licence obtained provides suitable protection to the use of that frequency appropriate to the functionality and safety criticality of the systems being supported and the area of operation.
- to assist in the identification of suitable dedicated spectrum to support UAS safety-critical functionality.

4.1.1.2. UK Radio Regulatory Framework

Within the UK, management of spectrum is the responsibility of Ofcom. The availability of spectrum and the licencing regime under which it operates will vary dependant on the operational requirement (e.g., within or beyond visual line of sight etc), environment (e.g., urban/rural etc,) and the safety criticality (e.g., separation, kinetic energy etc) of the function being supported.

4.1.1.3. Spectrum Availability

Frequency bands are allocated by Ofcom, details can be found on the Ofcom website and include IR 2030 – UK Interface Requirements 2030 which covers licence exempt short range devices. Applications for the assignment of frequencies within the bands must be addressed to Ofcom.

Note:
Any proposed use that does not conform to the regulatory limits applicable within a frequency band will need to be shown to be compatible with incumbent systems and approved/ licenced by Ofcom.

4.1.1.4. Allocation of Spectrum

The CAA supports Ofcom by providing the UK lead on issues related to aeronautical spectrum, including UAS. For information on how to participate in the process for the identification and allocation of spectrum that can be used to support UAS operations contact the CAA.

Licencing of frequency allocations is the responsibility of Ofcom and hence, where required, all applications for a frequency assignment should be directed in the first instance to Ofcom. In frequency bands where the CAA is the assigning authority, then the application will be passed to the CAA by Ofcom so that the CAA can conduct the technical work, but Ofcom still remains the licencing authority.

Where a frequency licence is required (e.g., in protected frequency bands or where powers exceed the current regulatory limits) the CAA will not be able to issue a permission or exemption.

4.1.1.5. Common Frequencies

There are no specific frequencies allocated for use by UAS in the UK. However, the most used frequencies are 35 MHz, 2.4 GHz and 5.8 GHz.

35 MHz is a frequency designated for model aircraft use only, with the assumption that clubs and individuals will be operating in a known environment to strict channel allocation rules. It is therefore not considered to be a suitable frequency for more general UAS operations (i.e., not in a club environment) where the whereabouts of other users is usually difficult to assess.

2.4 GHz is a licence free band used for car wireless keys, household internet and a wide range of other applications. Although this is considered to be far more robust to interference than 35 MHz, operators must act with appropriate caution in areas where it is expected that there will be a high degree of 2.4 GHz activity.

5.8 GHz is a licenced band which requires a minimum payment and registration with Ofcom. This band is in use with other services including amateur-satellite, weather and military radars. Details can be found on the Ofcom website.

For further guidance on whether a licence is required for your UAS, more information can be found on the Ofcom website.

4.1.1.6. Frequency Interference

Operations close to any facility that could cause interference (such as a radar station) could potentially disrupt communications with the UAS, whatever the frequency in use. GNSS jamming activities may also disrupt communications as well as command and control signals. Information on scheduled GNSS jamming exercises can be found on the Ofcom website.

This document does not include information on the UK Counter-Unmanned Aircraft Strategy. Details on this strategy can be found on the *gov.uk website*.

4.1.2. Electronic Conspicuity

The UK's airspace is a finite resource. The rapid growth in UAS operations is driving changes to the way air traffic is managed and aircraft are segregated. UAS are expected to co-exist with manned aircraft and there must be means for each aircraft to be able to identify and respond to the other aircraft. While most UAS operations are expected to operate at lower altitudes, some UAS are also expected to operate at higher altitudes. To integrate new and existing airspace users into the finite volume of airspace safely and efficiently, all conventional aircraft must be able to 'see, be seen and avoid', and UAS must be able to 'detect and be detected' by means of available and recognised Electronic Conspicuity (EC) technology if operating BVLOS in non-segregated airspace. This section offers guidance to industry on the use of available and recommended EC solutions. The UK is considering a number of options including a mandate on the use of Electronic Conspicuity in the UK airspace.

For further guidance and information on EC refer to the CAA Website: Electronic-Conspicuity-devices

4.1.2.1. EC Terminology

EC is an umbrella term for technologies that can help airspace users and ATS to be more aware of aircraft operating in the same airspace with the ability to 'see and be seen', or 'detect and be detected'.

The term 'EC solutions' refers to the devices, systems, and infrastructure that bring these technologies to market and ensure that they are interoperable.

'Full adoption' of EC solutions means that all users operating in a designated block of airspace can be detected electronically.

4.1.2.2. EC as a Concept

EC could help to reduce the risk of mid-air collisions through increasing both the quantity and quality of information for remote pilots, increasing their situational awareness. The CAA recognises that the development of EC solutions for UAS will be an evolutionary process and may take number of years for individual EC technologies to reach maturity.

Although a range of technologies, devices, services and infrastructure could achieve a degree of EC, this does not mean that any technology, infrastructure, service or device which involves a form of conspicuity will automatically be classified as EC compatible or authorised. In order to be authorised as 'EC compatible' a piece of equipment, device or service will first have to satisfy certain minimum performance, reliability, safety, interoperability and efficiency standards.

UAS operators should be aware of the certain obligations before buying and using an EC device. Full details on these aspects can be found in CAP 1391 Electronic conspicuity devices .

Note 1:

A Mode S transponder does not fall under the scope of CAP1391 and the requirement for light weight low power Mode S does not meet the performance requirements for general transponder certification. However, there is scope for the use of some transponders if they meet ETSO or FAA TSO certification standard. For more information on certification standards, please refer to 3.2.

Note 2:

Any aircraft system transmitting on 1030 MHz, as may typically be used in collision warning or Detect and Avoid systems, must not be operated without an approval from the National IFF and SSR Committee (NISC) (see CAP 761).

4.2. Radar and Surveillance Technologies

The following requirements are applicable to all civil UAS operating BVLOS within non-segregated UK airspace.

4.2.1. Introduction

UAS must be able to interact with all other airspace users, regardless of the airspace or aircraft’s flight profile, in a manner that is transparent to all other airspace users and Air Navigation Service Providers (ANSPs), when compared to manned aircraft. Unmanned Aircraft, which are integrated with the wider aviation system, must be interoperable with all surveillance systems, without any disproportionate additional workload for ATCOs, manned aircraft pilots or other remote pilots. UAS must include suitable equipment to satisfy any applicable equipage requirements of the airspace in which they are operating, such as Transponder Mandatory Zones (TMZs) or Radio Mandatory Zones (RMZs) to be interoperable with other airspace users and ATC. Where a UAS employs a collision avoidance system with reactive logic, any manoeuvre resulting from a perceived threat from another aircraft must not reduce the effectiveness of a traffic collision avoidance system resolution advisory manoeuvre from that aircraft.

4.2.2. Surveillance Technologies

This section is complementary to the Detect and Avoid (DAA) guidance in this document.

There are various ways in which aircraft communicate and broadcast information about their position and can otherwise be made conspicuous. Air traffic management is achieved through a combination of surveillance technologies such as ground-based radar, ADS-B and Wide Area Multilateration (WAM). All these technologies offer some degree of Electronic Conspicuity. This section sets out the most prominent surveillance technologies, their basic characteristics and functionally.

The primary means of cooperative surveillance within the UK is SSR Mode Select Elementary Surveillance (Mode S ELS). However, within certain areas of UK airspace, the carriage of an SSR transponder is not mandatory (see UK AIP Gen 1.5). In such airspace, where an Air Traffic Radar service is not mandatory, 'see and avoid' is often the primary means of separation of aircraft. Until it is possible to equip UAS with DAA capabilities that comply with appropriate future requirements and the SSR carriage policy, any UA intended to be operated in an area where it requires surveillance services must be equipped with a functioning SSR Mode S transponder, unless operating within the terms of an exemption from this requirement.

Electronic Conspicuity (EC) devices offer an alternative, low-cost option for cooperative airborne surveillance that can effectively signal an aircraft's presence to other similarly equipped airspace users, thereby enhancing situational awareness for those users. EC may assist remote pilots in remaining clear of other aircraft when operating beyond visual line of sight.

4.2.3. ADS-B

Automatic Dependent Surveillance- Broadcast (ADS-B) based Electronic Conspicuity is the modern version of surveillance via which the aircraft determines its own position using GNSS and periodically broadcasts its four-dimensional position (latitude, longitude, altitude, and time), velocity, airspeed, identity, and other additional relevant data as appropriate to the potential ground systems or to nearby aircraft. ADS-B data can be used to facilitate airborne traffic situational awareness, spacing and separation. A major difference between ADS-B and ground-based radar surveillance system is that there is no interrogation or two-way contract.

ADS-B OUT refers to the transmission of data from one UAS to another UAS or UAS to manned aircraft or UAS to the remote pilot or system on the ground.

ADS-B IN refers to the on-board receipt of ADS-B OUT data by another UAS or manned aircraft and allows for the display of nearby aircraft to the remote pilot.

4.2.3.1. ADS-B Frequencies

Under existing arrangements, ADS-B devices exchange information at 1090 MHz. ICAO is looking into the challenges of accommodating UAS within the existing aeronautical surveillance and collision avoidance systems. UAS operating in controlled airspace may be able to use current surveillance facilities. However, given the sizeable, forecasted increase of the UAS sector, the use of 1090 MHz by UAS in the lower airspace could lead to spectrum congestion. ICAO has issued a letter to States to ensure proper utilisation of 1090 MHz below 500 feet. The UK is currently exploring alternative surveillance technology such as 978 MHz for UAS to mitigate the risk of spectrum overloading at 1090 MHz.

4.2.4. Radar Surveillance

There are two types of ground-based radar systems that can be used for surveillance and aircraft traffic management:

- Primary Surveillance Radar (PSR) is a conventional radar that illuminates a large portion of space with an electromagnetic wave that is reflected by the target aircraft. A PSR system is used to detect the position and movement of a non-cooperative target (with no equipment such as transponder or EC device on board). However, the Radar Cross Section (RCS) and size of certain categories of aircraft will make detection by PSR systems challenging, especially at low-level.

- Secondary Surveillance Radar (SSR) is a Cooperative surveillance system which requires aircraft to be suitably equipped to be able to interact with surveillance sensors. Aircraft respond to ground interrogations via their on-board transponder. The global standard frequency for SSR to interrogate aircraft is 1030 MHz and aircraft replies on 1090 MHz via on-board transponder.

4.2.4.1. ICAO 24-bit Aircraft Address

The provision of Air Traffic Services (ATS) in a Mode S environment relies on a unique ICAO 24-bit Aircraft Address (AA) for selective interrogation of individual aircraft. In the SSR environment, the 24-bit AA is used as technical means of identification for use by the surveillance system, for example a Mode S SSR. ADS-B based EC devices also use 24-Bit AA as a means of system identification.

4.2.4.2. 24-bit AA for EC Devices

EC devices including light weight low power Mode-S transponders are designed to be portable, and potentially move from one UA to another. Different rules will need to apply to them. This section explains the licensing obligation and responsibilities of both manufacturers and UAS operators.

- The EC device should not be pre-loaded with an ICAO 24-bit address.
- The device should allow for the ICAO 24-bit address to be programmable or reprogrammable by the user. Manufacturers should put in place a means of mitigating incorrect 24-bit entry, such as a requirement to enter the 24-bit address twice. A function should also exist to clear the programmed 24-bit ICAO address, and to alert the user should no ICAO 24-bit address be entered. Full instructions on how to complete these tasks should be contained within the device operating manual.
- Attention of manufactures is also drawn to more detailed instructions and guidance contained in CAP1391.
- If an EC device is bought to use on an UAS, the owner is required to contact the CAA Infrastructure Section (email: NISC@caa.co.uk) shortly after buying the device. The operator must confirm their contact details and the make, model and serial number of the EC device. The CAA will then allocate the EC device a unique ICAO 24-bit address. The address can then be used on multiple Unmanned aircraft without re-programming.

- If the EC device is re-sold, the vendor should clear any registered aircraft 24-bit code from the device before sale. The new purchaser should contact the CAA at the above email address to allow records to be updated and a unique code allocated if necessary.

4.2.4.3. Special Purpose Transponder Codes

If a UAS is equipped with a transponder and operating in an area where use of the transponder is necessary, the capability to change SSR code whilst in flight must be included. SSR code 7400 is used in order to notify ATC of a lost C2 Link. The UAS must be able to select this in such circumstances.

4.3. Detect and Avoid (DAA) Capabilities

4.3.1. Introduction

Detect and Avoid is a generic expression which is used to describe a technical capability that is at least equivalent to the ‘see and avoid’ principle used in manned aviation to avoid collision with other aircraft and obstacles. When operating VLOS, the rules apply to UAS in the same way that VFR apply to manned aircraft. However, BVLOS UAS operations in a non-segregated airspace will not normally be permitted without an acceptable DAA capability. To maintain the appropriate levels of safety, a suitable method of aerial collision avoidance is required for all UAS operations.

Note:

The use of 'First Person View' equipment is not considered to be acceptable for use as a DAA solution.

To be able to gain access to all classes of airspace without segregation, UAS will have to be able to display a capability that is equivalent to the existing safety standards applicable to manned aircraft types. These capabilities will need to be appropriate to the class (or classes) of airspace within which they are intended to be operated.

This section outlines the position of the CAA in respect of its role in assisting the UAS industry to find solutions to achieving a capability and level of safety which is equivalent to the existing 'see and avoid' concept. A Detect and Avoid (DAA) capability is only one of a number of requirements that will need to be addressed for safe operation of UAS, particularly for operations in non-segregated airspace.

4.3.2. General

The overriding principle when assessing if proposed UAS DAA functions are acceptable is that they must not introduce a greater hazard than currently exists for manned aviation. The UAS must be operated in a way that enables it to comply with the rules and obligations that apply to manned aircraft within the same class of airspace, particularly those applicable to separation and collision avoidance.

An EC based solution could, if the airspace within which it is used was suitably mandated to be fully ‘cooperative’, enable DAA capabilities to be achieved by UAS in a shorter timeframe.

4.3.3. Separation Assurance and Collision Avoidance Elements

Separation and collision avoidance are two distinct and potentially independent elements to a DAA capability, as described below. DAA replaces the capability that is provided in a manned aircraft by the pilot looking out of window which should include minimum of following functions:

- Detect and avoid traffic (aircraft in the air and on the ground) in accordance with the Rules of the Air.
- Detect and avoid all airborne objects, including gliders, hang-gliders, paragliders, microlights, balloons, parachutists etc.
- Enable the remote pilot to determine the in-flight meteorological conditions.
- Avoid hazardous weather.
- Detect and avoid terrain and other obstacles.

4.3.3.1. Detect Function

The detect function is intended to identify potential hazards (other aircraft, terrain, weather etc.) and notify the appropriate mission management and navigation systems.

4.3.3.2. Avoid Function

The avoid function may be split down into two parts:

Separation Assurance & Traffic Avoidance

This term is used to describe the routine procedures and actions that are applied to prevent aircraft getting into close proximity with each other. Any resolution manoeuvring conducted at this stage must be conducted in accordance with the Rules of the Air. When flying in airspace where the provision of separation is the responsibility of ATC, however, the remote pilot must manoeuvre the aircraft in accordance with ATC instructions, in the same fashion as is done for a manned aircraft

Collision Avoidance

This is the final layer of conflict management and is the term used to describe any emergency manoeuvre considered necessary to avoid a collision. While the remote pilot would normally be responsible for initiating a collision avoidance manoeuvre, an automatic function may be required in order to cater for collision avoidance scenarios where the remote pilot is unable to initiate the manoeuvre in sufficient time (e.g. due to C2 Link latency issues or lost C2 Link scenarios.

4.3.4. Minimum DAA Requirements for Routine Operations

For routine BVLOS operations in non-segregated airspace a DAA capability will always be required unless the UAS operator is able to provide the CAA with clear evidence that the operation that is being proposed will pose no hazard to other aviation users.

The minimum level of DAA capability that is required may be adjusted in accordance with the flight rules under which the UA flight is being conducted and class of airspace that the UA is being flown in as follows

4.3.5. IFR Flights within Controlled Airspace (Classes A to E)

A Collision Avoidance capability will be required where the following conditions occur:

- ATC separates from other traffic (although in Class D and E, the pilot of a conflicting VFR flight holds the separation responsibility).
- As for manned aviation, a collision avoidance capability is required in case the 'normal' separation provision fails.
- If the flight is conducted wholly within controlled airspace where the operation of a transponder is mandatory, then a collision avoidance capability that is cooperative (e.g., ACAS) would be acceptable.

If there is any possibility that the UAS may leave controlled airspace and enter non-segregated Class G airspace during the flight (including in an emergency), then the collision avoidance capability must be 'non-cooperative', unless there are other airspace measures in place that would still allow a cooperative system to be used; this includes airspace such as a Transponder Mandatory Zone, airspace above FL100 (where the operation of a transponder is required) etc.

4.3.6. VFR Flights within Controlled Airspace, or any Flight within Class G Airspace

A Separation Assurance/Traffic Avoidance capability **and** a Collision Avoidance capability will be required. The remote pilot is the separator for all conflicts, with the same responsibilities as the pilot of a manned aircraft.

4.3.7. Factors for Consideration when Developing a DAA Capability

To ensure that a DAA capability can provide the required level of safety, it must address a number of component functions including:

- Detect – threat detection.
- Decide – assessment of the collision threat
- Command – selection of an appropriate avoidance manoeuvre
- Execute – perform a manoeuvre that is compatible with the aircraft's performance capabilities and airspace environment
- Feedback loop – communication back to remote pilot

Guidance for those engaged in the development of DAA systems should consider the factors that are listed below:

- Ability to comply with the Rules of the Air;
- Airworthiness, i.e., system reliability and integrity;
- Control method, controllability and manoeuvrability;
- Flight performance;
- Communications procedures and associated links;
- Security (physical and cyber);
- Emergency actions, reversionary or failure modes in the event of degradation of any part of the UAS and its associated Command Unit and/or Relay Stations;
- Actions in the event of lost communications and/or failure of on-board DAA equipment;
- Ability to determine real-time meteorological conditions and type of terrain being overflown;
- Nature of task and/or payload;
- System authority of operation and control;
- Method of sensing other airborne objects;
- Remote pilot level of competence;
- Communications with ATS providers, procedures and links with control station;
- Means of launch/take-off and recovery/landing;
- Reaction logic to other airspace objects;
- Flight termination;
- Description of the operation and classification of the airspace in which it is planned to be flown;
- Transaction times (e.g. including delays introduced by satellite links);

- Address both cooperative and non-cooperative air traffic.

4.4. Remote Identification (Remote ID)

Remote ID is the ability of a UAS to provide identification information that can be received by other parties. The purpose of Remote ID is to assist CAA, Law enforcement and Security agencies to identify a rogue UA or remote pilot or operator who appears to be operating in an unsafe manner or in an area where the UA is not permitted to fly. Remote ID builds on the CAA Drone and model aircraft registration and education service (DMARES) framework.

'Direct remote identification' refers to a system that ensures the local broadcast of information about a UA in operation, including the marking of the UA, so that this information can be obtained without physical access to the UA itself.

'Network remote identification' is a system that transmits information through a connection with a network. In this case, the receiver does not receive the information directly, but through the network.

4.4.1. Remote ID Requirements

4.4.1.1. Open Category

See section 2.2.1.3 for guidance on Open Category product standards.

4.4.1.2. Specific Category

At present, there is no regulatory requirement for the activation of remote ID within the Specific category in the UK.

Note:

Point (1)(l)ii of UAS.SPEC.050 (which refers to remote ID installation and activation) was not applicable when the EU exit transition period ended on 31 December 2020 and so does not form part of the retained EU law. Although paragraph 2 of Article 23 of UK Regulation (EUO 2019/947 still refers to an applicability date of 2 December 2021), this will not apply in the UK without further legislative change. This decision will be made by the UK government.

4.4.1.3. Transmission Options

If equipped with a **Direct Remote Identification** System it shall allow, in real time during the whole duration of the flight the periodic transmission of selected data as determined by the applicable product standard in a way that it can be received by existing mobile devices.

If equipped with a **Network Remote Identification** System it shall allow, in real time during the whole duration of the flight, the transmission from the UA using an open and documented transmission protocol, in a way that it can be received through a network, of selected data as determined by the applicable product standard.

The minimum mandatory data transmitted on either Remote Identification System is listed in UK Regulation (EU) 2019/945. The future standard for Remote Identification shall state any additional mandatory or optional data as required.

4.5. Autonomy and Automation

4.5.1. Introduction

This guidance relates to the regulatory interpretation of the term “autonomous” and provides clarification on the use of high authority automated systems in civil UAS.

The dictionary definition of autonomy is “freedom from external control or influence”. The need to meet the safety requirements, defined in the various Certification Specifications under CS XX.1309/ CS XX.2510, for "Equipment, Systems and Installations" means that at this point in time all UAS systems are required to perform deterministically. This means that their response to any set of inputs must be the result of a pre-designed data evaluation output activation process. As a result, there are currently no UAS related systems that meet the definition of autonomous.

In general, automated UAS systems fall in to two categories:

- Highly automated – those systems that still require inputs from a human operator (e.g., confirmation of a proposed action) but which can implement the action without further human interaction once the initial input has been provided.
- High authority automated systems – those systems that can evaluate data, select a course of action and implement that action without the need for human input. Good examples of these systems are flight control systems and engine control systems that are designed to control certain aspects of aircraft behaviour without input from the flight crew.

The concept of an “autonomous” UAS is a system that will do everything for itself using high authority automated systems. It will be able to follow the planned route, communicate with Aircraft Controllers and other airspace users, detect, diagnose and recover from faults and operate at least as safely as a system with continuous human involvement. In essence, an autonomous UAS will be equipped with high authority control systems that can act without input from a human.

4.5.2. What is the Difference between Automation and Authority?

Automation is the capability of a system to act using a set of pre-designed functions without human interaction (e.g., robotic manufacturing).

The level of authority a system has is defined by the results that the system can achieve. For example, a flight control computer may only be able to command a shallow roll angle, whereas the human flight crew will be able to demand a much higher angle of roll. A full authority system will be able to achieve the same results as a human operator.

4.5.3. Use of High Authority Systems

High authority automatic systems have the capability to take actions based on an evaluation of a given dataset that represents the current situation including the status of all the relevant systems, geographical data and environmental data.

Although these systems will take actions based on an evaluation of a given dataset, they are required to be deterministic in that the system must always respond in the same way to the same set of data. This means that the designs of the associated monitoring and control systems need to be carefully considered such that the actions related to any given dataset are appropriate and will not hazard either the aircraft or any third parties in the same area.

High authority automatic systems are usually composed of a number of sub-systems used to gather data, evaluate data, select an appropriate set of actions and issue commands to related control systems. These systems can include flight management systems, detect and avoid systems, power management systems, etc.

In a UAS a system can have authority over two types of function: general control system functions (e.g., flight control computers) and navigational commands.

4.5.4. Delegation to a High Authority Automatic System

The concept of high authority automatic systems covers a range of varying degrees of system authority ranging from full authority where the systems are capable of operating without human control or oversight to lesser levels of authority where the system is dependent upon some degree of human input (e.g., confirmation of proposed actions).

The level of authority a system can have with respect to navigational commands may vary during any flight, dependent upon the hazards the aircraft is faced with (e.g., terrain or potential airborne conflict with other aircraft) and the time available for the human operator to effectively intervene. If the aircraft is flying in clear airspace with no nearby terrain the system may be designed such that any flight instructions (e.g., amendment to a flight plan) are instigated by a human operator. However, if the aircraft is faced with an immediate hazard (terrain/other aircraft) and there is insufficient time for a human operator to intervene (based on signal latency etc.) the UAS will need to be able to mitigate that risk. These mitigations may include the use of full authority automatic systems.

Although it is anticipated that most systems will be operated using a lesser level of authority, the design of the overall system (command unit, the aircraft itself and related operational procedures) will need to take account of the failure conditions associated with loss of the command-and-control communications link between the control station and the aircraft and this may drive a need for the use of full authority systems.

4.5.4.1. Learning/Self-Modifying Systems

A learning, or self-modifying system is one that uses data related to previous actions to modify its outputs such that their results are closer to a previously defined desired outcome. Although learning systems do have the potential to be used in UAS, the overall safety requirements (for example the need to comply with CS XX.1309) still apply. This means that it may not be possible to use these systems to their full potential.

It is also important to note that these systems have the potential to be more susceptible to the effects of emergent behaviour and, as such, the evaluation of such systems would out of necessity need to be very detailed.

4.5.4.2. Other Potential Developments

It is possible that, at some point in the future, the aviation industry may consider the use of non-deterministic systems to improve overall system flexibility and performance.

Whilst there are no regulations that specifically prohibit this, the use of non-deterministic systems will drive a number of system and operational safety assessment issues that will need to be addressed before the use of this type of technology could be accepted for use in aviation.

4.5.4.3. Human Authority over Automated and Autonomous UAS

The general principle to be observed is that all UAS must be under the command of a remote pilot. Dependent upon the level of autonomy, a remote pilot may simultaneously assume responsibility for more than one aircraft, particularly when this can be accomplished safely whilst directing the activities of one or more other remote pilots. However, if this option is to be facilitated the applicant will need to demonstrate that the associated human factors issues (displayed information, communication protocols, etc) have been fully considered and mitigated.

The following breakdown of automation levels provide a view to the progress of automation within the command-and-control structure of a UAS operation. The levels of human and machine interaction, control and responsibilities are detailed in the table below.

Level 0 – No Automation

No automation, the remote pilot is responsible for all functions.

Level 1 – Assisted Automation

Lowest level of automation, systems which have been automated up to this level are used to support the remote pilot in performing the specified function.

Level 2 – Partial Automation

The level of automation increases to the point where a system may take over a particular function to relieve remote pilot workload and allow focus on other tasks. Control and monitoring are shared between the remote pilot and the system, the interactions must be well understood by the human managing the operational tasks.

Level 3 – Supervised Automation

The capability of the automated system is expanded to handle the monitoring and responding to changes in the environment. The key difference between this level of automation and lower levels is that the human is supervising the outcomes and intervening when required to manage the safety of the operation.

Level 4 – High Automation

At high automation level, controlling the aircraft and monitoring the external/internal environment is entirely automated with no human oversight. The remote pilot does not receive flight information, instead the remote pilot receives operational information of interest to ensure the system is meeting operational objectives.

Level 5 – Full Automation

At full automation there is no human involvement in the operation and human interaction is limited to providing high-level operational directives and observing resulting outcomes. No human intervention is possible as the operation outcomes are entirely within the scope of the machine.

The functions listed in the table below are described as per the following:

Human-Machine Teaming: Describes the relationship between humans and machines performing tasks as automation increases.

Sustained Aircraft Manoeuvre Control: Describes how the aircraft is controlled (e.g., crew inputs), systems are monitored (e.g., fuel level monitoring), and communication with airspace users (e.g., ATC) is achieved as tasks are automated.

Object and Event Detection and Response (OEDR): Describes how the aircraft interacts with the environment in which itis present and how it may respond (e.g., detect and avoid failure monitoring). Events may occur on-board the aircraft or may be external and communicated to the mechanism responsible for sustaining aircraft manoeuvre control.

Fallback (Integrity Thresholds Exceeded): Describes how the UAS responds to a failure and where control of the operations is expected to reside. Fallback is triggered when specific metrics associated with the operation of the system exceed the defined thresholds for safety.

Communication with External Systems (Ground and Airspace systems): Describe how the UAS interacts with the external systems in which it is operating (e.g., ground crew, ATC).

UAS Automation Levels in Flight Operations							
Level / Functions	Level 0 No Automation	Level 1 Assisted Automation	Level 2 Partial Automation	Level 3 Supervised Automation	Level 4 High Automation	Level 5 Full Automation	Components of Trusted Autonomy
Human-Machine Teaming	Human led	Human-In-the-loop	Human-In-the-loop	Human-In/On-the-loop	Human-On-the-loop	Human-Off-the-loop	Human-Machine Symbiosis
Sustained Aircraft Manoeuvre Control	Human	Human AND Machine	Machine (Managed by Human)	Machine (Supervised by Human)	Machine	Machine	Machine
Object and Event Detection and Response (OEDR)	Human	Human	Machine (Managed by Human)	Machine (Supervised by Human)	Machine	Machine	Machine
Fallback (Integrity Thresholds Exceeded)	Human	Human	Human	Human	Fall back Ready Human	Machine (Limited or Segregated Operations)	Optimized Human AND/OR Machine
Communication with External Systems (Ground and Airspace systems)	Human	Human	Human OR Machine (Managed by Human)	Machine (Supervised by Human	Machine	Machine	Machine

Table 5 - Summary of Automation Levels

4.5.5. Safe Operation with Other Airspace Users

Autonomous UAS must demonstrate an equivalent level of compliance with the rules and procedures that apply to manned aircraft. Therefore, this will require the inclusion of an approved Detect and Avoid capability when UAS are operating in non-segregated airspace.

4.5.6. Compliance with Air Traffic Management Requirements

Any autonomous UAS operation is expected to work seamlessly with[6] ATM providers and other airspace users. The autonomous UAS will be required to comply with any valid ATC instruction or a request for information made by an ATM unit in the same way and within the same timeframe that the pilot of a manned aircraft would. These instructions may take a variety of forms and, for example, may be to follow another aircraft or to confirm that another aircraft has been detected in an equivalent manner to being "*in visual sight*".

4.5.7. Emergencies

The decision-making function(s) of any autonomous UAS must be capable of handling the same range of exceptional and emergency conditions as manned aircraft, as well as ensuring that malfunction or loss of the decision-making function(s) itself does not cause a reduction in safety.

4.5.8. Data Integrity

Autonomous systems select particular actions based on the data they receive from sensors related to the aircraft environment (airspeed, altitude, met data etc), system status indicators (fault flags, etc), navigational data (programmed flight plans, GPS, etc.) and command and control data received from control stations. As such, UAS developers will need to ensure that any data related to autonomous control has a sufficient level of integrity such that the ability to comply with basic safety requirements is maintained. This will require the development of appropriately robust communication and data validation systems.

4.5.9. Security

An autonomous system must be demonstrated to be protected from accepting unauthorised commands, or from being "spoofed" by false or misleading data. Consequently, UAS will have a high degree of dependence upon secure communications, even if they are designed to be capable of detecting and rejecting false or misleading

[6] This means that air traffic controllers should not have to do anything different using radiotelephony or landlines than they would for other aircraft under their control, nor should the controller have to apply different rules or work to different criteria.

commands. Security issues are covered in more detail at 2.8.

CHAPTER 5 | Personnel

5. Personnel

5.1. The UAS Operator

As with any other form of aviation, the *operator*, is viewed as being the central and essential element of a successful aircraft operation. Aviation regulation principles largely concentrate on the conduct and oversight of the operator; in simple terms, *"if the operator is organised and efficient, then the operation should be safe and effective".*

The "*UAS operator"* is defined as *'any legal or natural person operating or intending to operate one or more UAS'.*

Note:

'natural person' is the term used when legally referring to a human being and 'legal person' is the term used when legally referring to an organisation/company or similar.

5.1.1. Minimum Age

The minimum age for an individual to become a UAS operator in the UK is 18 years of age, within any category of operation.

This requirement is set out within article 265D of the ANO.

5.1.2. Responsibilities of the UAS Operator

The UAS operator is responsible for the overall operation of the UAS, and most specifically the safety of that operation. This includes the conduct of any safety risk analysis of the intended operations.

The UAS operator's responsibilities that are particular to each operating category are listed within the Annex to UK Regulation (EU) 2019/947. A more general set of responsibilities is listed below.

5.1.3. Operational Procedures Development/Operations Manual

The UAS operator is responsible for developing procedures that are adapted to the type of operations and to the risks involved, and for ensuring that those procedures are complied with.

The extent of the detail that needs to be provided within those procedures will clearly vary depending on the relative complexity of the operation and/or the organisation involved.

- Open category - written procedures may not always be necessary, especially if the UAS operator is also the only remote pilot. The limitations of the Open category and the operating instructions provided by the UAS manufacturer may be considered sufficient. If more than one remote pilot is employed, the UAS operator should:
  - develop and produce procedures for in order to coordinate the activities between its employees; and
  - establish and maintain a list of their personnel and their assigned duties.
- Specific category – an operations manual, detailing the scope of the organisation and the procedures to be followed would be required as a minimum. This should be expanded as necessary to cover any increased complexity in the types of UAS being flown, or of the types of operation being conducted.
- Certified category – the full suite of documentation, as expected for an equivalent manned aircraft operation, will be required.

5.1.3.1. Remote Pilots and Other Operations and Maintenance Personnel

The UAS operator is responsible for:

- nominating a remote pilot and any associated personnel for each flight;
- ensuring that all nominated personnel are sufficiently competent to conduct the flight;
- ensuring that all nominated personnel are sufficiently briefed on the tasks that they are required to perform;
- ensuring that all remote pilots are fully familiar with the UAS operator's operating procedures and the operating instructions provided by the manufacturer of the UAS.
- The UAS Operator, in the Specific category, should maintain an aircraft technical log book, in order to log the flying time of each aircraft. This should be stored electronically, for audit and oversight purposes. More information can be found in AMC1 UAS.SPEC.050(1)(g) of UK Regulation (EU) 2019/947.

5.1.3.2. Use of Contracted Remote pilots

When authorised by the CAA to do so, UAS operators are permitted to utilise remote pilots on an individual contract basis. In so doing, the UAS operator maintains responsibility for the safety of the operation and for ensuring that the competence and obligations of the remote pilot are met in the same way as would be if the contracted remote pilot was an employee of the UAS operator. UAS operators that do not discharge their responsibilities for contracted remote pilots risk having their authorisations suspended or revoked.

5.1.3.3. Unmanned Aircraft and Associated Supporting Systems

The UAS operator is responsible for ensuring that the UAS provided for the operation:

- is suitable for the intended operation;
- is properly maintained and in a safe condition to be flown;
- supports the efficient use of radio spectrum in order to avoid harmful interference and that the relevant C2 Link frequencies being used are appropriately licensed.

5.1.4. Operating Licence

UK Regulation (EU) 1008/2008 as retained (and amended in UK domestic law) under the European Union (Withdrawal) Act 2018, does not apply to UAS Operators within the Open or Specific Category, and therefore the requirement to obtain an Operating Licence under this regulation does not apply to these operations.

5.2. The Remote Pilot

The "remote pilot" is defined as '*a natural person responsible for safely conducting the flight of an unmanned aircraft by operating its flight controls, either manually or, when the unmanned aircraft flies automatically, by monitoring its course and remaining able to intervene and change the course at any time*.'

The remote pilot is therefore a key component in ensuring that UA are flown safely and legitimately.

5.2.1. Minimum Age

5.2.1.1. Open Category

No minimum age.

5.2.1.2. Specific Category

No minimum age is set out in law, however the UAS Operator is expected to include this consideration within the OM.

5.2.1.3. Certified Category

The minimum age for flight within the Certified category is determined by the minimum age requirements of the licence that is used.

5.2.2. Responsibilities

The remote pilot is nominated for each flight by the UAS operator and is responsible for the overall conduct of that flight, with safety obviously being the primary consideration. Where other personnel are also involved in the operation, the remote pilot would normally also be expected to be 'in command' of those personnel.

The remote pilot's responsibilities that are particular to each operating category are listed in the Annex of UK Regulation (EU) 2019/947. A more general set of responsibilities is listed below.

5.2.2.1. General Requirements

Remote pilots must:

- Have the appropriate remote pilot competency, dependent on the operating category to be able to conduct the flight within the designated operating category.

- Be fully familiar with the UAS operator’s operating procedures.
- Be fully familiar with the operating instructions provided by the manufacturer of the UAS.

Remote pilots must not:

- Perform their duties while under the influence of psychoactive substances or alcohol or when they are unfit to perform their tasks due to injury, fatigue, medication, sickness or other causes (see 4.2.6 and 4.2.7 below for further details).

5.2.2.2. Pre-flight Responsibilities

Before the flight is commenced, remote pilots must:

- Ensure that all information regarding the airspace within which the flight will take place has been checked and updated, and any relevant clearances or authorisations have been obtained.
- Ensure that the operating environment is compatible with the intended flight (weather conditions, electromagnetic energy conditions, survey of obstacles, uninvolved persons, critical infrastructure etc).
- Ensure that the UAS is in a serviceable condition to complete the intended flight as planned. This includes:
    - updating any relevant geo-awareness data;
    - the completion of any specified pre-flight checks;
    - ensuring that the UA has sufficient fuel to complete the planned operation with any suitable reserve needed to cater for contingencies;
        - **Note**: *the term “fuel” is intended to include all sources of energy for UA, to include (but not limited to) petroleum based, solar, battery or any future source that provides energy to the UA.*
    - The checking and, if necessary, programming of any lost C2 Link, return to home, or other emergency recovery function to confirm its serviceability;
    - the security of any payloads fitted to the UA;
    - the operation of any lighting and/or remote identification systems (if applicable).

5.2.2.3. In-flight Responsibilities

While the UA is in flight, remote pilots must:

- Comply with the operational limitations that are applicable to the operating category that the UA is being flown in;
- Avoid any risk of collision with other aircraft and discontinue the flight if it may pose a risk to other aircraft, persons, environment or property;
- Comply with the operational limitations regarding to any airspace reservations, Flight Restriction Zones or other UAS related geographical zones that are within or close to the area that the UA is being flown in;
- Comply with the operating procedures that are set out by the UAS operator;
- Ensure that the UA is not flown close to or inside any areas where an emergency response effort is ongoing, unless they have permission to do so from the responsible emergency response personnel.

Note:

The term 'emergency response effort' covers any activities by police, fire, ambulance, coastguard or other similar services where action is ongoing in order to preserve life, protect the public or respond to a crime in progress. This includes activities such as road traffic collisions, fires, rescue operations and firearms incidents, although this list is not exhaustive.

5.2.3. Competency Requirements

Remote pilots must be competent to perform their duties.

The competency of the personnel involved in the operation of an unmanned aircraft is a major factor in ensuring that unmanned aircraft operations remain tolerably safe. Within any UAS operation, the primary focus is obviously placed on the competency of the remote pilot.

Following on with the principle of taking a risk-based approach, the regulations use the competency of the remote pilot as a way of complementing the other risk mitigations and so the precise level of competency that is required is dependent on the category of operation.

5.2.3.1. Open Category

Apart from subcategory A1 operations involving unmanned aircraft that have a mass of less than 250g, all remote pilots operating in the Open category are required to complete an online training course and successfully complete an online theory test before they can fly; Upon completion, a remote pilot will be issued with a 'flyer ID'. This is valid for 5 years, at which point it must be renewed.

This test is the 'foundation' upon which all other levels of remote pilot competency are built; it is a multiple-choice examination and there is no requirement to undertake any practical flight test. The testing package also includes an educational module known as 'The Drone and Model aircraft Code' (the principle being similar to the Highway Code as used for car driving).

The theory test is accessed via the CAA's operator registration webpages and is at this link Register and take the test to fly.

The individual competency requirements for each subcategory are listed below.

A1 subcategory

The remote pilot competency requirements for the A1 subcategory are dependent on the flying weight or class of UA being flown as follows:

UA mass/class	Competency requirements
Less than 250g (including 'legacy')	Read the user manual
A1 Transitional (<500g)	Obtain a 'flyer ID' and an A2 CofC (see 4.2.3.1.2 below)

Table 6- Summary of A1 pilot competence requirements

A2 subcategory

Flights within the A2 subcategory involve the operation of larger UA (less than 4kg flying weight) within residential, commercial, industrial or recreational areas (which may also be known as 'congested areas') and in closer proximity to uninvolved persons.

Because of the additional risks involved, remote pilots must successfully pass an additional theoretical examination to obtain an A2 Certificate of Competency (A2 CofC).

The A2 CofC is a remote pilot competency certificate primarily intended to assure safe operations of unmanned aircraft close to uninvolved persons. The certificate assures an appropriate knowledge of the technical and operational mitigations for ground risk (the risk of a person being struck by the unmanned aircraft).

The examination is conducted at an RAE test facility (see 4.2.4 below). Further details are contained within CAP 722B .

A3 subcategory

Remote pilots flying within the A3 subcategory must be in possession of a 'flyer ID'.

5.2.3.2. Specific Category

In general, a VLOS remote pilot is expected to hold a General VLOS Certificate (GVC) as a minimum.

Due to the wide-ranging scope of the Specific category, the remote pilot competency requirements also will vary widely, dependent on the type of operation being conducted.

Remote pilot competency requirements will be set out in each individual operational authorisation document. UAS operators will be expected to propose the levels of remote pilot competency through the risk assessment associated with the particular operation.

For operations using a PDRA, the remote pilot competency requirements will be specified within the text of the relevant PDRA scenario (see GVC below).

UAS Operators conducting more complex operations, who's RPs may hold other qualifications, must ensure that their RPs have a full understanding of the applicable UAS regulations. This may be achieved by either ensuring they hold a valid GVC, or by carrying out internal training. UAS Operators who chose to carry out internal training, must ensure the theoretical knowledge syllabus described in AMC1 Article 8 to UK Regulation (EU) 2019/947, is followed.

'*NQE full recommendations'* are a previous version of the GVC course, and although no longer issued, some RPs may still hold these qualifications. These qualifications have been superseded by the GVC, and as such the CAA will no longer recognise them after 01 January 2024; until this date, the CAA will recognise their use for operations under an existing OA. Any UAS Operator applying for a new OA, will need to select an alternative pilot competence qualification, such as the GVC.

Note:

Other qualifications with the same name (i.e. GVC) issued outside the UK, are not automatically recognised by the CAA. Any such qualifications that are recognised as equivalent to the UK GVC, will be promulgated separately to this document

Remote Pilot Log Book

Remote pilots in the Specific category are expected to keep a flying log book in order to meet the regulatory requirements of UAS.SPEC.050, as a record of their flying hours, to help evidence currency and to act as a record should it be required in a subsequent investigation. This should be kept on an electronic system, for oversight and audit purposes.

Further information can be found in *AMC1 UAS.SPEC.050(1)(d)(i),(ii) and (iii).*

The General VLOS Certificate (GVC)

The General VLOS Certificate (GVC), is a remote pilot competency certificate which has been introduced as a simple qualification that satisfies the remote pilot competency requirements for VLOS operations within the Specific category.

The GVC satisfies the competency requirements of any published PDRA that involves VLOS flight.

The GVC is comprised of a theoretical examination and a practical flight test, which are both conducted at an RAE facility.

Further details of the GVC can be found in AMC1 Article 8, to UK Regulation (EU) 2019/947.

5.2.3.3. Certified Category

For the certified category, the requirements are as follows, the remote pilot will be expected to hold either:

- an appropriate manned aviation pilot’s licence associated with the type of operation being conducted (with appropriate mitigation related to the operation of the particular unmanned aircraft); or,
- an RPL (when the RPL requirements are published and applicable).

Note:

The requirements for the licensing and training of United Kingdom civil remote pilots have not yet been fully developed. United Kingdom requirements will ultimately be determined by ICAO Standards and Recommended Practices (SARPs). ICAO has developed initial standards for a Remote Pilot's Licence (RPL), but these are part of a larger SARPS package that will not become applicable until 2024 at the earliest. Until formal licensing requirements are in place the CAA will determine the relevant requirements on a case-by-case basis, taking into account additional factors such as the type of operation being conducted, and the system being operated.

5.2.3.4. Remote Pilot Currency Requirements

Remote pilot currency requirements are set out in AMC1 UAS.SPEC.050(1)(d), to UK Regulation (EU) 2019/947.

5.2.3.5. Recognised Assessment Entities (RAE)

The Recognised Assessment Entity (RAE) Scheme has been developed to assist the CAA in assuring the competence of remote pilots for many of the ‘large volume’ VLOS operations that require an operational authorisation. The CAA approves RAEs to assess the competence of remote pilots against a specific set of requirements and to issue the appropriate certificate on the CAA’s behalf. The names of all approved RAE organisations are published on the CAA’s website.

Further information regarding RAEs can be found in CAP 722B .

5.2.4. Medical Requirements

Remote pilots must not fly when they are unfit to perform their tasks due to injury, fatigue, medication, sickness or ‘other causes’.

5.2.4.1. Open Category

While there are no specific requirements or medical standards set out for operations in the Open category, as an outline guide remote pilots should apply the same considerations that they would before driving a motor vehicle or riding a pedal cycle on the road.

5.2.4.2. Specific Category

The medical requirements for operations within the Specific category will be set out in the operational authorisation. Normally, this will be achieved by reference to the medical requirements that have been set out by the UAS operator in its operations manual, although in some cases, additional requirements may be expressed more precisely.

UAS operators will be expected to propose details of their required medical standards through the risk assessment associated with the particular operation.

5.2.4.3. Certified Category

Remote pilots in the Certified category must comply with the medical standards of the licence that they hold.

5.2.5. Alcohol and Psychoactive Substances – Limitations

UK Regulation (EU) 2019/947 sets out some basic requirements regarding the remote

pilot's responsibilities in regard to alcohol and psychoactive substances (drugs) while conducting flying duties.
These limitations are applied in conjunction with the operating category as follows:

5.2.5.1. Alcohol

This section sets out the alcohol requirements for the Open, Specific and Certified Categories of operation.

Open Category

The regulatory requirement is that remote pilots must not perform their duties under the influence of alcohol. [UAS.OPEN.060(2)(a)]

- It is the responsibility of the remote pilot to ensure that they are fit to fly and are not under the influence of alcohol. While the overall message is 'don't drink and fly', additional information is provided below for reference and guidance.
- While no actual limits are specified, the alcohol consumption limitations that are prescribed for driving a car may be considered as an appropriate limit when flying in the Open category. (i.e. if you are fit to drive a car, then you should be considered fit to fly in the Open category).
- These limits are:

Level of alcohol	England, Wales & Northern Ireland	Scotland
Micrograms per 100 millilitres of breath	35	22
Micrograms per 100 millilitres of blood	80	50
Micrograms per 100 millilitres of urine	107	67

Table 7 - Summary of alchol limits for driving

- Personnel carrying out support functions that are directly related to the safe operation of the UA while in flight, such as unmanned aircraft observers, or airspace observers, should comply with the same limitations. Remote pilots are directly responsible for ensuring that such personnel are fit to undertake their duties.

Specific category

The regulatory requirement is that remote pilots must not perform their duties under the influence of alcohol. [UAS.SPEC.060(1)(a)].

UAS operators will be expected to propose details of proposed alcohol limits for operational personnel within the OM procedures and risk assessment associated with their particular operation, and will be reflected within the operational authorisation.

- While no actual limits are specified, because of the more advanced nature of flying in the Specific category, and in particular the requirement to comply with the precise conditions of the operational authorisation, the limits prescribed for manned aviation in Railways and Transport Safety Act 2003 (RTSA 2003) Section 93 should be complied with.
- These limits are:

Level of alcohol	All UK nations
Micrograms per 100 millilitres of breath	9
Micrograms per 100 millilitres of blood	20
Micrograms per 100 millilitres of urine	27

Table 8- Summary of alcohol limits set out within the RTSA 2003

- Personnel carrying out support functions that are directly related to the safe operation of the UA while in flight, such as unmanned aircraft observers, or airspace observers, should comply with the same limitations.

Certified category

Alcohol limits within the Certified category will be set out within future regulatory updates.

5.2.5.2. Psychoactive Substances

This section sets out the psychoactive substance requirements for the Open, Specific and Certified Categories of operation.

Open category

Remote pilots must not perform their duties under the influence of psychoactive substances.

Specific category

Remote pilots must not perform their duties under the influence of psychoactive substances.

Certified category

Remote pilots must not carry out any aviation function if their ability to perform the function is impaired because of drugs. *[RTSA 2003 Section 92]*

Note: *For the purposes of RTSA 2003, the term 'drug' includes any intoxicant other than alcohol.*

5.2.6. Radio Licensing

5.2.6.1. Use of Radio Telephony

There are some circumstances in which the use of VHF radiotelephony (RT) voice communications may be necessary and may form part of a mitigation within a risk assessment, for a specific category UAS operation. These are primarily situations where quick communication is needed with the air traffic service unit, and/or enhanced situational awareness for both the remote pilot, and other pilots, is necessary.

VHF radio communication should not be required in the Open category.

The use of VHF RT is strictly controlled for several reasons and will only be considered as a mitigation within a safety case for those operations which absolutely require it.

Such circumstances *may* include:

- Operations within the close vicinity of an aerodrome, where permission for entry into an FRZ/ATZ has been arranged and the use of VFH RT has been requested by the ATS unit.

- Beyond Visual Line of Sight operations outside segregated airspace
- Operations in close vicinity to other airspace users- such as air shows and flying displays.

It is not possible to give an exhaustive list of such circumstances when the use of VHF RT is appropriate, and it is the responsibility of the operator to apply such a mitigation appropriately. Acceptance of such a mitigation within the safety case does not authorise its use. A number of requirements must also be met in order to legally make use of VHF RT, which are detailed below.

If the operation is approved with such a mitigation, then the following requirements must be met and detailed within the operations manual, and may also be set out within the conditions of the operational authorisation:

- Suitable VHF radio must be installed on the unmanned aircraft, and a relay to the ground station provided to enable remote pilot communication. The equipment and installation must be approved by EASA or the CAA. A ground-based VHF radio must not be used. This is due to regulatory requirements set out by Ofcom. Any queries on this requirement should be directed to Ofcom.
- Appropriate licence held by the remote pilot; this will normally be an FRTOL, which must be issued by the CAA following recommendation from an examiner. Further information can be found here.
- Appropriate radio licence: the radio must either be licenced, or have an exemption from the wireless telegraphy act, to operate. Ofcom issue these licences. Further information can be found on the Ofcom aeronautical licencing web pages here.

Further information on radio requirements can be found in AIP GEN 1.5 section 5.

In some cases, an innovation and trial licence may be suitable. Further information on the Ofcom Innovation and trial licence can be found here.

The use of radiotelephony on aeronautical band radios within the Specific category for contact with air traffic control should be limited to exceptional circumstances and be carried out as directed by the air traffic service unit with which the remote pilot needs to communicate. In the vast majority of circumstances VHF RT is not required, and other methods of communication and/or procedural mitigations are sufficient.

CHAPTER 6 | Human Factors and Safety Management

6. Human Factors and Safety Management

6.1. Introduction

This Chapter offers guidance to industry on how to address the Human Factors issues associated with the design, operation and maintenance of UAS and the proper development, implementation and assurance of a Safety Management System (SMS) as defined in ICAO Annex 19 (Safety Management System).

It is recognised by the CAA that is important to include effective Human Factors considerations in the design, operation and maintenance of UAS.

The fundamental concepts of Human Factors in aviation are covered by CAP 719. Additional guidance on human factors issues associated with aircraft maintenance is provided in CAP 716.

It is important to recognise that the human is an integral element of any UAS operation and, therefore, in addition to the existing Human Factors issues that relate to aviation development, operation and maintenance, several unique Human Factors issues associated with remote operation will also need to be addressed.

This guidance outlines several Human Factors recommendations related to the design, production operation and maintenance of UAS flown routinely in UK airspace.

Of equal importance is the principle of an effective Safety Management System (SMS) as detailed in ICAO Annex 19 which defines the steps to follow the identification of hazards, safety reporting, risk management, performance measurement and safety assurance. A Safety Management System program important for both manned and unmanned aviation. Correct application of the Safety Management System in all categories of operations is important and will ensure the operation is managed in line with appropriate safety parameters.

6.2. Human Factors

6.2.1. General Human Factors

A systems approach must be adopted in the analysis, design and development of the UAS. This approach deals with all the systems as a combined entity and addresses the interactions between those systems. Such an approach must involve a detailed analysis of the human requirements and encompass the Human Factors Integration domains:

- Manpower;
- Personnel;
- Training;
- Human Engineering;
- System Safety;
- Health Hazards.

6.2.2. Design Human Factors

There are two groups of Human Factors issues that need to be addressed for design:

- Human factors issues affecting design teams;
- Design induced remote pilot or maintenance human factors issues.

6.2.2.1. Human Factors that Affect Design Teams

There are two levels of Human Factors issues that need to be addressed for design:

- Human factors that affect design teams;
- Design induced remote pilot or maintenance human factors issues.

Each of these issues can result in a design team making an error and failing to detect it before the aircraft or aircraft system enters service. These errors can result in operational or maintenance problems (system failures, inappropriate maintenance etc) and can even drive additional human factors issues in other aviation domains such as the flight deck or maintenance because of a lack of quality assurance or control to avoid human error.

Organisations developing UAS must ensure that the programme management aspects of their projects address potential Human Factors issues (e.g. provision of appropriate work spaces and instructions, effective control of the number of simultaneous demands made on individuals, effective control of the rate of requirement change, management of fatigue etc). The process to achieve this must be described to the authority for any proposed certification project.

6.2.2.2. Design Induced Remote Pilot Human Factors

The set of design induced remote pilot Human Factors issues includes but is not limited to:

- Non-optimal workspace layout which increases the likelihood of errors;
- Failure to provide on a timely manner relevant information for planning or corrective actions to the remote pilot;

- Incorrect amount of information or documentation provided to the Remote Pilot so that effective assimilation is not possible. Incorrect prioritisation of alerts;
- Insufficient notice of the need to perform a task (possibly related to data latency or poor planning);
- Inadequate, incomplete or ambiguous procedures, work instructions;
- Lack of clarity regarding where to find the relevant control instructions (Standard Operating Procedures, Aircraft Flight Manuals etc);
- Non-obvious system mode changes or mode confusion.

Each of these issues may result in a remote pilot either making an error or failing to detect an aircraft safety issue.

Organisations developing UAS must ensure that any identified potential Human Factors issues (e.g. management of information to the pilot so that they can integrate this effectively, effective control of the number of simultaneous demands made on remote pilots etc) are addressed and mitigated as part of the UAS development processes. How this will be achieved must be described to the authority for any proposed certification project.

6.2.2.3. Design Induced Maintenance Human Factors

The set of design induced maintenance Human Factors issues includes but is not limited to:

- Incomplete situation awareness (because of missing/inadequate information and/or data latency);
- Information overload/underload;
- Incorrect prioritisation of alerts;
- Insufficient notice of the need to perform a task (possibly related to data latency or poor planning);
- Inadequate, incomplete or ambiguous procedures, work instructions;
- Lack of clarity regarding where to find the relevant control instructions (Standard Operating Procedures, Aircraft Flight Manuals etc);
- Non-obvious system mode changes.

Each of these issues can result in a maintenance error which could result in an aircraft safety issue.

Organisations that are developing UAS must ensure that any identified potential maintenance Human Factors issues (e.g. provision of clear and unambiguous task instructions etc) are addressed and mitigated as part of the UAS development processes. How this will be achieved must be described to the authority for any proposed certification project.

6.2.3. Operational Human Factors

In addition to operational Human Factors issues, experienced in other parts of the aviation system, the physical separation of the remote pilot introduces several issues that must be considered. These include but are not limited to:

- Degradation of information due to remote operation and associated lack of multi-sensory feedback, which does not allow the remote pilot to correctly understand how the UAS is operating or provides misleading information;
- Temporal degradation resulting from data latency, pilot recognition, pilot response and pilot command latency over the data link requires consideration in the design of controls and displays;
- The remote pilot's risk perception and behaviour may be affected by the absence of sensory/perceptual cues and the sense of a shared fate with the vehicle;
- Bandwidth limitations and reliability of the data link compromising the amount and quality of information available to the remote pilot and thereby limiting his/her awareness of the UAS status and position;
- If the remote pilot swaps with another remote pilot during a long flight, issues around effective hand-over procedures and communication must be mitigated (further details are provided later in this document).

It is therefore important to:

- Avoid presenting misleading cues and to consider alternative methods of representing the UAS data;
- Prioritise relevant data sent over the C2 Link to satisfy the needs for all phases of the operation;

Ensure that data link characteristics and performance (such as latency and bandwidth) are taken account of within the relevant information and status displays in the Command Unit.

6.2.4. Authority Control

The remote pilot is ultimately responsible for the safe conduct of the aircraft. They will, therefore, be required to sanction all actions undertaken by the aircraft whether that is during the planning stage (by acceptance of the flight plan) or during the execution of the mission via authorisation, re-plans or direct command. Though fully autonomous operation of a UAS is not currently envisaged, certain elements of a mission may be carried out without human intervention (but with prior authorisation). A good example of this is the Collision Avoidance System where, due to possible latency within the C2 Link, the remote pilot may not have enough time to react and therefore the on-board systems may need to be given the authority to take control of the aircraft.

This level of independent capability, that must operate predictably and safely when required, can also be harnessed as a deliberative function throughout the flight. This supports a change in the piloting role from a low-level manual type of control to an effective high-level decision maker. Due to the nature of remote operation, the command unit need no longer be constrained to follow a traditional flight deck design philosophy and must be designed to fit the new operator role. Account may be taken of enhanced system functionality allowing the pilot to control the systems as required via delegation of authority.

A clear understanding of the scope of any autonomous operation and its automated sub-systems is key to safe operations. Specific areas that must be addressed include:

- User's understanding of the system's operation;
- User's understanding of what mode of operating the aircraft is in, and what level of control authority the system has
- Recovery of control after failure of an automated system;
- User's expertise in manual reversion (they will not necessarily be pilots);
- Boredom, habituation and fatigue of the pilot;

Design of the controls, including the design 'model', allowing the user to understand how the different levels of automation operate.

6.2.5. Ergonomics

The command unit will be the major interface between the remote pilot and the aircraft. The advice contained herein relates to the type of information and the nature of the tasks that would be undertaken at an command unit, it does not set the airworthiness, technical or security requirements. The ergonomic standards must ensure that the remote pilot works in an environment that is fit for purpose. That is;

- The environment does not create distractions;
- It provides a suitable and comfortable environment for a range of human crewmembers (for example different heights and other anthropometrical measurements);
- It will allow the remote pilot to maintain alertness throughout a shift period;
- The ergonomics of the wider environment in which the command unit is located

will be considered, including issues such as temperature and lighting.

The ergonomic requirements of ‘handheld’ (VLOS) remote pilot stations must also be considered. Careful consideration must be given to the environmental conditions that will be encountered when operating outdoors (excesses in temperature, wet or windy conditions etc.). The potential for distraction to the pilot is also much greater in this environment.

6.2.6. Remote Flight Crew Awareness

Several sub-systems associated with the operation of a UAS are likely to be complex in their operation and therefore may be automated. The system must provide the operator with appropriate information to monitor and control its operation. Provision must be made for the operator to be able to intervene and override the system (e.g. abort take-off, landing, go around).

6.2.7. Handover to Another Command Unit/Transfer of Control Between Remote Pilots

UAS operations may require the transfer of control to another remote pilot. This operation needs to be carefully designed to ensure that the handover is accomplished in a safe and consistent manner and would be expected to include the following elements:

- Offer of control;
- Exchange of relevant information;
- Acceptance of control;
- Confirmation of successful handover.

The exchange of information between remote pilots (co-located or remotely located) will require procedures that ensure that the receiving pilot has complete knowledge of the following:

- Flight Mode;
- UAS flight parameters and aircraft status;
- UAS sub-system status (fuel system, engine, communications, autopilot etc);
- Aircraft position, flight plan and other airspace related information (relevant NOTAMs etc.);
- Weather;
- The current ATC clearance and frequency in use;

- Positions of any relevant command unit control settings to ensure that those of the accepting command unit are correctly aligned with the transferring command unit.

The transferring pilot will remain in control of the unmanned aircraft until the handover is complete and the accepting pilot has confirmed that they are ready to assume control. In addition:

- Procedures to cater for the recovery of control in the event of a failure during the transfer process will be required;
- Special attention will be required when designing handover procedures involving a significant change in the control interface, for example between a VLOS 'Launch and Recovery Element' command unit and a BVLOS 'En-Route' command unit.

The effective Transfer of Controls between remote pilots is important. Procedures should be established on the Standard Operating Procedures (SOP) if required for the type of operation intended.

6.2.8. Crew Resource Management

Crew Resource Management principles play an equally important role in the command unit as they do on a manned flight deck. The allocation and delineation of roles must ensure a balanced workload and shared or complementary understanding of the UAS status and proximity to other aircraft and flight paths to ensure that:

- The display design provides clear and rapid information retrieval matched to the human needs;
- The CU design promotes a clear and effective team co-ordination.

6.2.9. Fatigue and Stress

Fatigue and stress are contributory factors which are likely to increase the propensity for human error. Therefore, to ensure that vigilance is maintained at a satisfactory level in terms of safety, consideration must be given to the following:

- Crew duty times;
- Regular breaks;
- Rest periods and opportunity for napping during circadian low periods;
- Health and Safety requirements;

- Handover/Take Over procedures;
- The crew responsibility and task/cognitive workload (including the potential for ‘boredom’);
- Ability to mitigate the effects from non-work areas (e.g. financial pressure causing anxiety).

The work regime across the crew must take this into account. Where required, an effective Fatigue Reporting System should be implemented within the organisation to increase awareness of fatigue or stress risks and mitigate them accordingly.

Further information to support Fatigue Management approaches for safety relevant workers can be found in the ICAO Fatigue Management guidance material (Doc. 9966).

6.2.10. Degradation and Failure

Degradation of performance and failures will require a philosophy for dealing with situations to ensure consistent and appropriate application of warnings, both visual and auditory. The philosophy must ensure that:

The design provides good error detection and recovery;

The design is fail-safe and protects against inadvertent operator actions that could instigate a catastrophic failure;

In the event of degraded or total breakdown in the communication link the status of the lost link will be displayed to the operator. Ideally the expected planned reactions of the UA to the situation will also be displayed to the operator;

Operating procedures are designed to be intuitive, not ambiguous and reinforced by training as required.

6.2.11. Maintenance Human Factors

The set of problems that can initiate Human Factors issues for maintenance teams is not dissimilar to other environments. These include but are not limited to:

- Insufficient time to perform a task;
- Insufficient training and experience to perform a task;
- Inadequate, incomplete or ambiguous procedures, work instructions;
- Inappropriate working environments that can lead to distraction (e.g. noisy offices, multiple demands on individual’s time);

- Fatigue;
- Poor or non-existent working relationships with management and/or other teams.

Each of these issues can result in a maintenance team making an error and failing to detect it before the aircraft or aircraft system enters service. These errors can result in operational or maintenance problems (system failures, inappropriate maintenance etc.) and can even drive additional Human Factors issues in other aviation domains such as the flight deck or maintenance.

Organisations that are developing UASs must ensure that any maintenance Human Factors issues (e.g. provision of clear and unambiguous instructions) are addressed. How this will be achieved must be described to the authority for any proposed certification project.

6.2.12. Future Trends

Future developments in UAS Industry are moving towards reducing remote pilot workload through advanced decision support systems and enhanced automation. Human Factors expertise will be central to such developments to produce a system that is not only safe but also ensures the correct level of crew workload for all mission tasks and phases of flight.

6.3. Safety Management

Further guidance on Safety Management systems can be found in CAP 795.

Annex A - CAP 722 Revision History

Ninth Edition Amendment 1 December 2022

Update in Section 2.2.1.2 to the A1 section to clarify that 'transitional' A1 UA must not overfly uninvolved people, and that privately built UA may make use of the A1 provisions. Simplification of the A2 section, to remove reference to class mark requirements.

Reflection of maximum height provisions for unmanned sailplanes in section 2.1.1.1.

Updates to URLs following a website re-structure since publication.

Ninth Edition December 2022

This revision applies the effect of additional regulations and other updates that have been made within the UK since the Eighth edition was published, enhances some guidance points and corrects a number of minor typography errors. Annex A, B, C and D have been deleted as a result of the publication of a separate AMC/GM document. Chapter 3 has been split into chapter 3 (Airworthiness and Certification) and chapter 4 (Aircraft Systems).

Eighth Edition November 2020

This revision implements the new UAS Regulatory Package, which becomes applicable in its entirety in the UK from 31 December 2020. The document has been completely restructured in order to accommodate the necessary changes and present them in a clearer and more comprehensible manner.

Seventh Edition September 2019

A number of small amendments have been made to CAP 722 Seventh edition since it was published in July.

Seventh Edition July 2019

This amendment updates references and text in accordance with ANO 2016 and its subsequent amendments, changes to European regulations brought about by the publication of the New Basic Regulation in Autumn 2018, incorporates Guidance material that has been published in the interim, and brings terms, definitions and procedures/processes up to date as they have evolved, and a change to the structure of the document.

In addition, the opportunity has been taken to transfer the Appendices into two separate, but related, documents with CAP 722A covering the development of Operating Safety Cases, and CAP 722B covering the requirements for National Qualified Entities.

Some minor editorial amendments have been made to this edition, since original publication in July. A list of these changes can be found on the CAP 722 publication web page.

Sixth Edition March 2015

CAP 722 has been completely refreshed and restructured under this revision. Key changes to the document are:

- Complete restructure of the document.
- Updates to all Chapters (including Abbreviations and Glossary of Terms).
- Introduction of a Concept of Operations Approach (ConOps)
- Introduction of the UAS OSC - Unmanned Aircraft System Operating Safety Case (formerly titled Congested Areas Operating Safety Case).
- Introduction of an Approval Requirements Map.
- Removal of Military Operations Chapters.
- Addition of Alternative Means of Compliance to demonstrate Operator Competency.
- Introduction of Restricted Category Qualified Entities.

Fifth Edition 10 August 2012

The changes at this edition primarily concentrate on updating areas where terms, definitions or procedures have evolved significantly and where details of chapter sponsors have also been changed. The specific areas to note are:

- Revised Abbreviations and Glossary (also reflected throughout the document), which reflect worldwide developments in UAS terminology.
- Introduction of a Human Factors chapter.
- A complete rewrite of the 'Civil Operations, Approval to Operate' chapter.
- Amendments to civilian Incident/Accident Procedures.
- A complete revision to Section 4 (Military Operations), which reflects the formation of the Military Aviation Authority (MAA) and the revised Military Aviation Regulatory Publications.

Fourth Edition 6 April 2010

This edition incorporates the changes to legislation introduced in Air Navigation Order 2009 (ANO 2009) regarding the requirement for operators of small unmanned aircraft to obtain a CAA permission when their aircraft are being used for aerial work, and also in some cases for surveillance or data acquisition purposes (now termed small unmanned surveillance aircraft).

Unmanned aircraft having a mass of less than 7 kg are now covered by this new legislation, which is intended to ensure public safety by applying appropriate operational constraints, dependent on the flying operation being conducted and the potential risks to third parties. In line with this change, some guidance on the additional details to be provided within an application for permission to operate small unmanned aircraft have also been included (Annex 1 to Section 3, Chapter 1).

Expanded guidance regarding the reporting of incidents/occurrences involving the operation of unmanned aircraft has also been included; such reporting is viewed as being a vital element in the successful development of the 'fledgling' civilian UAS industry.

Finally, in line with continued developments in UAS terminology, and the principle that unmanned aircraft are still to be treated as aircraft rather than as a separate entity. In line with this, the term 'pilot' (i.e. the person who operates the controls for the aircraft) is used more frequently. The term 'Remotely Piloted Aircraft' (RPA) is also emerging in some areas, although it has not yet been wholeheartedly accepted for use in the UK.

Third Edition 28 April 2008

Introduction

Following discussions at the CAA Unmanned Aircraft Systems (UAS) Working Group, held on 12 October 2006, it was considered that sufficient progress had been made in many areas of UAS work to warrant a substantial review of CAP 722. In particular, as an upsurge in UAS activity is envisaged over the coming years it is essential that both industry and the CAA, as the regulatory body, clearly recognize the way ahead in terms of policy and regulations and, more importantly, in safety standards.

With an ever-increasing number of manufacturers and operators, it is vital that the regulations keep pace with UAS developments, without losing sight of the safety issues involved in the simultaneous operation of manned and unmanned aircraft. As a living document, it is intended that CAP 722 will be under constant review and that it will be revised, where necessary, to take account of advances in technology, feedback from industry, recognised best practice and changes in regulations, which are developed to meet these demands. However, it is recognised that with continual rapid developments there will inevitably be times when Chapter sponsors will have to be approached directly for further guidance.

Revisions in this Edition

The layout of the document has been amended to more clearly separate Civil and Military guidance and as such the Chapters have changed in many areas. In addition, while there are many minor textual changes to the document, a significant revision has been made in many areas and as such it is recommended that those involved in UAS operations review the entire content of the document to ensure that they are fully cognisant with the update.

Impending Changes to Regulation

The CAA is in the process of a consultation with industry over a proposal to amend the Air Navigation Order which will require operators of UAS with a UAV component of less than 7 kg mass to obtain a CAA permission, as is currently the case for UAVs with a mass of 7-20 kg. This proposal intends to ensure public safety by applying operational constraints to UAVs of less than 7 kg mass, as deemed appropriate to the type of operation envisaged and the potential risk to members of the public.

If the consultation exercise approves the proposal, it is likely that the ANO Amendment will pass into law in December 2008. Potential operators of UAS with a UAV component of less than 7 kg must ascertain, before commencing operations, whether or not they are required to obtain a CAA permission.

Third Edition incorporating amendment 2009/01 14 April 2009

This amendment is published in order to update contact details and references throughout the document and make some editorial corrections.

Second Edition 12 November 2004

The major changes in this document are on legal, certification, spectrum and security issues.

Details of the CAA Policy on Model Aircraft/Light UAV have also been included.

First Edition 29 May 2002

First edition.