Law Commission
Reforming the law

Aviation Autonomy

Summary of the Consultation Paper

Responding to this paper

This is a summary of the full consultation paper, available on our website at https://lawcom.gov.uk/project/aviation-autonomy

We are committed to providing accessible publications. If you require this consultation paper to be made available in a different format please email: aviationautonomy@lawcommission.gov.uk

Comments may be sent:

Using an online form at **https://consult.justice.gov.uk/law-commission/aviation-autonomy**.

However, we are happy to accept comments in other formats. If you would like a response form in word format, do email us to request one. Please send your response:

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OR

By post to Aviation Autonomy Team, Law Commission, 1st Floor, Tower, 52 Queen Anne's Gate, London, SW1H 9AG.

If you send your comments by post, it would be helpful if, whenever possible, you could also send them by email.

Duration of the consultation: We invite responses from 26 February to 27 May 2024.

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Chapter 1: Introduction

The Civil Aviation Authority ("CAA"), and the Department for Transport have asked the Law Commission to review the UK's regulatory framework to prepare the UK for autonomy in aviation. This project forms part of, and is partly funded by, the UK Research and Innovation Future Flight Challenge.

Our focus in this Consultation Paper is on reforms that will enable autonomous and remotely piloted flight to take place safely, lawfully, and with appropriate legal mechanisms for attributing criminal and civil liability when things go wrong.

We are keen to receive a wide range of responses, from all those who may be affected by highly automated and autonomous flight.

We seek responses by 27 May 2024. Details of how to respond are set out on the inside cover. Following consultation, we plan to publish a final report with recommendations for legislation by the end of 2025.

Terms of reference

The operation of modern aircraft already involves many sophisticated automated functions. Our review anticipates further developments in automation which will change or replace functions currently performed by humans. An obvious example is the role of the pilot.

When discussing autonomous flight, our paper uses the existing legal definition: an "autonomous operation" is one during which an uncrewed aircraft operates without a remote pilot being able to intervene.[1]

There is no legal definition of "highly automated" aviation. We use it to refer to the automation of functions beyond what is currently common in aviation, particularly where this affects roles of humans involved in the system. Examples include drone flight beyond the visual line of sight of a remote pilot, or multiple simultaneous operations, where one remote pilot is in charge of many drones flying at the same time.

Greater levels of automation will also enable remote piloting which requires less human input. While drones are already remotely piloted, reform of the law is required to allow remotely piloted aircraft to carry passengers.

We have not been asked whether introducing greater autonomy in aviation is a desirable outcome. That is a policy issue which is not one that the Law Commission can decide. Rather, our focus is on the adequacy of the regulatory framework to deal with greater autonomy when it comes. Our paper therefore reviews the existing law and identifies where there are gaps, uncertainties, or provisions which could prevent the safe deployment of highly automated and autonomous systems. Our aim is consult about the changes to the law which will ensure it is ready to safely accommodate future advances in automation and, ultimately, autonomous flight.

1 UK Regulation (EU) 2019/947 on the rules and procedures for the operation of unmanned aircraft, art 2(17) (the "UK UAS Implementing Regulation").

In particular, we consider:

1. where the law allocates responsibilities to a human person (for example, a pilot or remote pilot) and the issues that arise where functions are performed by autonomous systems; and
2. how to allocate civil and criminal responsibility where functions are performed by a system, or shared between a human and a system.

Given the forward-looking nature of this project, we have been asked to focus on three use cases. These are:

1. drones; and
2. vertical take-off and landing aircraft; and
3. air traffic management and air navigation services.

This paper focuses on the first two use cases. The third will be the subject of a second consultation paper, to be published later this year.

Structure of aviation regulation

There is a lot of aviation law, deriving from multiple different sources. International law is particularly important. The most important treaty is the International Convention on Civil Aviation 1944, more commonly known as the Chicago Convention. The Chicago Convention governs the rights and obligations of States with respect to international civil aviation, and sets down rules and principles that facilitate international air travel. States must keep their own regulations consistent "to the greatest possible extent," with the standards and recommended practices established under the Convention.[2]

Another important international treaty is the Montreal Convention 1999, which deals with the liability of air carriers for death or injury to passengers as well as damages to cargo and baggage.

The Civil Aviation Act 1982 and the Air Navigation Order 2016

The main source of the power to regulate civil aviation at the domestic level comes from the Civil Aviation Act 1982. The Act sets out the functions of the Secretary of State for Transport in relation to aviation and establishes the CAA as the UK's aviation regulator.

The Act enables His Majesty to make regulations by Order in Council "generally for regulating civil aviation".[3] The most important of these orders is the Air Navigation Order 2016 ("ANO"), which contains many of the rules regulating civil aviation in the UK, and is in many cases how the UK achieves compliance with the requirements of the Chicago Convention.[4]

2 Chicago Convention, Ninth Edition (2006), art 12.

3 Civil Aviation Act 1982, s 60(2)(b).

4 SI 2016 No 765.

Domestic law after EU exit

Since the 1990s, aviation has been increasingly regulated at the EU level. As a result, EU law was a key component of UK aviation regulation for many years. Since the UK's exit from the EU, much of this law has remained as "assimilated law".[5] Changes made to EU law by EU institutions no longer have automatic effect in the UK.

One key regulation is Regulation (EU) 2018/1139 (the "Basic Regulation"), which sets out some of the basic principles governing aviation. Aircraft falling within the scope of the Basic Regulation, and assimilated law, are known as "Part 21" aircraft.

Non-Part 21 aircraft fall outside of the Basic Regulation and are instead subject to airworthiness, operational and licensing rules found in the ANO and British Civil Airworthiness Requirements. They include certain historic aircraft, aircraft designed for research, experimental or scientific purposes, some smaller aircraft, and some balloons and airships. This Consultation Paper is primarily concerned with Part 21 aircraft, as we expect our use cases to fall within this category.

Essential requirements in relation to a number of aviation fields are fleshed out in annexes to the Basic Regulation. These essential requirements are then elaborated on in "implementing" and "delegated" regulations made by the European Commission. An explanation of UAS regulation is given in Chapter 3.

5 Retained EU Law (Revocation and Reform Act) 2023, s 5.

Chapter 2: Key concepts and terminology

The aviation field is replete with specialist terminology. Where new use cases for aircraft and new possibilities for autonomous flying are regularly emerging, it can be difficult to agree on the right vocabulary. Chapter 2 explains the terms we choose to use in the rest of our paper.

Frameworks for describing levels of autonomy

There are multiple different frameworks used for describing the levels of "autonomy" of an aircraft. We describe here two of the most influential in the UK: the Joint Authorities for Rulemaking on Unmanned Systems ("JARUS") levels and the European Aviation Safety Agency ("EASA") levels.

JARUS levels of automation

In 2023, JARUS published its methodology for evaluation of automation for unmanned aircraft systems.[6] The levels are set out below.

1. **Level 0 – Manual operation:** the human is fully responsible for function execution, with no machine support.
2. **Level 1 – Assisted operation:** the machine supports the human in executing the function, for example, by the provision of relevant information.
3. **Level 2 – Task reduction:** the machine has a management role in reducing human workload to accomplish the task. For example, the machine could provide a "conflict alert" and "resolution advisory" (advice as to what action to take) based on predicted flight paths.
4. **Level 3 – Supervised automation:** the machine executes the function under the supervision of the human who is expected to monitor and intervene as required.
5. **Level 4 – Manage by exception:** the machine executes the function alerting the human in the event of an issue. The human is not required to monitor the function in real time and is able to intervene at any time after being alerted by the machine to an issue.
6. **Level 5 – Full automation:** the machine is fully responsible for function execution. The human is unable to intervene in real-time either due to practical limitations or deliberate exclusion within the operational design domain (the conditions and limitations under which a system is designed to function).

The methodology draws a distinction between Levels 0 – 2 (where the human is "in control") and 3 – 5 (where the machine is "in control").[7]

The JARUS levels enable a very clear description of exactly what functions on an aircraft are performing at what level. It would be difficult however to translate them directly into legislation. Instead of operating at the level of "functions" of parts of a system, the current legislative framework, and our proposals, ultimately require a view to be taken of the overall capacity of an aircraft and its supporting systems (ie whether it is "remotely piloted" or "autonomous").

6 Joint Authorities for Rulemaking of Unmanned Systems, JARUS methodology for evaluation of automation for UAS operations (April 2023) p 21. http://jarus-rpas.org/wp-content/uploads/2023/06/jar_21_doc_JARUS_Methodology_for_Evaluation_of_Automation_for_UAS_Operations.pdf.

7 Joint Authorities for Rulemaking of Unmanned Systems, JARUS methodology for evaluation of automation for UAS operations (April 2023) p 19. http://jarus-rpas.org/wp-content/uploads/2023/06/jar_21_doc_JARUS_Methodology_for_Evaluation_of_Automation_for_UAS_Operations.pdf.

EASA AI roadmap

EASA's artificial intelligence ("AI") roadmap, now updated in a second version, outlines the Agency's vision for the safe introduction of AI in aviation. As the levels increase, the level of human involvement in the system decreases.[8] They reflect broadly the staged approach that industry is expected to take when deploying AI applications.

Level 1 AI: assistance to human	Level 1A – Human augmentation Level 1B – Human cognitive assistance in decision and action selection
Level 2 AI: advanced automation	Level 2A – Human and AI-based system cooperation Level 2B – Human and AI-based system collaboration
Level 3 AI: human-AI teaming	Level 3A – The AI-based system performs decisions and actions, overridable by the human Level 3B – the AI-based system performs non-overridable decisions and actions (for example, to support safety upon loss of human oversight)

These levels are used by EASA to prioritise its work in this area. In February 2023, EASA published a concept paper with a first set of objectives for applicants hoping to use AI systems at Levels 1 and 2. EASA anticipates that there will have to be a further split within level 3 to accommodate fully autonomous flight.[9]

"Autonomous" aircraft

UK Regulation (EU) 2019/947 on the rules and procedures for the operation of unmanned aircraft systems (the "UAS Implementing Regulation") defines an autonomous operation as one "during which an unmanned aircraft operates without the remote pilot being able to intervene."[10]

The guidance material explains that the implementation of a pre-programmed emergency procedure (for example, an automatic "return to home" function if the command and control link is lost) does not amount to an autonomous operation. It adds that:

> An autonomous operation should not be confused with an automatic or automated operation, which refers to an operation following pre-programmed instructions that the UAS executes while the remote pilot is still able to intervene in the flight.[11]

8 European Union Aviation Safety Agency, *Artificial intelligence roadmap 2.0* (May 2023), p 18 figure 4.

9 European Union Aviation Safety Agency, *Artificial intelligence roadmap 2.0* (May 2023) p 18.

10 UK UAS Implementing Regulation, art 2(17).

11 UK UAS Implementing Regulation, GM1 art 2(17).

For this paper, we have continued to use this definition of an autonomous operation. When we refer to an autonomous aircraft, we mean an aircraft that can carry out an autonomous operation.

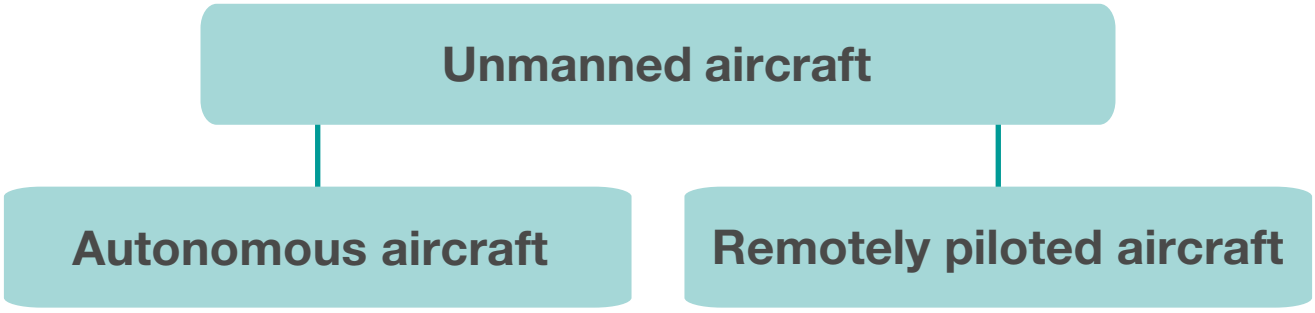
The CAA guidance uses the term "high authority automated systems", meaning systems that "can evaluate data, select a course of action and implement that action without the need for human input" (for example, flight control systems). These high authority automated systems may combine to form an "autonomous UAS".[12]

Terminology used in the law and this paper

Unmanned aircraft (system) ("UAS")

An "unmanned aircraft" is defined by the UK Basic Regulation as "any aircraft operating or designed to operate autonomously or to be piloted remotely without a pilot on board", as illustrated below.[13]

ICAO similarly calls an unmanned aircraft an aircraft "which is intended to operate with no pilot on board".[14] What these definitions tend to agree on is that the general class of "unmanned aircraft" can be divided into two: autonomous aircraft and remotely piloted aircraft. The division is illustrated below.



Remotely piloted aircraft (system) ("RPAS")

The UK UAS Delegated Regulation defines a remote pilot as:

> a … 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 its course at any time.[15]

We use the same definition in this paper. In practice the distinction between a remotely piloted and an autonomous aircraft can be difficult to draw. In order to operate safely, a remotely piloted aircraft must be able to handle loss of connection with the "pilot". The result is that remotely piloted aircraft are likely to operate independently under particular conditions.

12 Civil Aviation Authority, *Unmanned Aircraft System Operations in UK: Airspace – Policy and Guidance* (2022) (CAP 722) para 4.5.1.

13 UK Regulation (EU) 2018/1139 on common rules in the field of civil aviation and establishing a European Union Safety Agency, art 3(3).

14 ICAO, *Unmanned aircraft systems* (UAS) Cir 328 AN/190 (2011) p x.

15 UK Regulation (EU) 2019/945 on unmanned aircraft systems and on third-country operators of unmanned aircraft systems, art 3(27).

What terminology have we adopted?

Our project requires terms for:

1. **Aircraft where there are no people on board at all**. Our choice for this is "unoccupied" aircraft or, in some cases, "drone" (see further below).
2. **Aircraft where there is no pilot on board**. The best suggestion we have found to date in existing literature is "uncrewed aircraft" ("UA" or "UAS", as appropriate): however, it is important to be clear that this term does not, in our view, exclude the possibility of a remote crew. Where it is necessary to specify that such aircraft carry passengers, our choice for this is "passenger only".
    a. **Aircraft where there is a pilot able to intervene during an aircraft's operation, but the pilot is not on board**. The obvious candidate here is "remotely piloted aircraft (system)", or RPAS.
    b. **Aircraft where there is no human pilot (or, if there is, where the pilot is not able to intervene during the normal course of the aircraft's operation)**. We adopt here the term "autonomous". This is in line with the existing definition in UK law outlined above.
    c. **Aircraft with no pilots on board, that are under collective control and in flight simultaneously**. We use the term "multiple simultaneous operation" in this paper.

None of these terms implies the use of any particular technology (such as machine learning).

For our two aircraft use cases we use:

Drone. "Drone" is not a legal term and there is no universally accepted definition. We use the term as it is generally understood by the public, namely to refer to uncrewed aircraft generally smaller than traditional aircraft, which are unoccupied and can be remotely piloted or are autonomous.

VTOL. We use the term "VTOL" and the definition used by the CAA's recent policy statement on type certification of VTOL: a heavier-than-air aircraft, other than an aeroplane or helicopter, capable of performing vertical procedures by means of more than two lift/thrust units and certified for one or more occupants.[16]

16 Civil Aviation Authority, *Policy statement on type-certification of VTOL aircraft* (October 2023) p 1 https://consultations.caa.co.uk/policy-development/type-certification-of-vtol-aircraft/supporting_documents/Policy%20Statement%20%20VTOL%20Initial%20Airworthiness.pdf

Chapter 3: UAS regulation

The Civil Aviation Act 1982 does not contain a definition of aircraft. Nonetheless, our tentative view is that it, and the ANO, apply to uncrewed aircraft except to the extent specified otherwise in the ANO). Uncrewed aircraft are also within the scope of UK Regulation (EU) 2018/1139 (the "Basic Regulation"), which applies to aircraft registered in, or operated by an operator registered in, the UK and to unregistered unmanned aircraft that are operated within the UK.

A specific regulatory regime for uncrewed aircraft can be found in EU law in Regulations made under the Basic Regulation; these now form part of assimilated law. We give an overview of the regime in this chapter, which helps to understand the specific discussion of drones and VTOLs in later chapters. This regime consists of two complementary regulations:

1. UK Regulation (EU) 2019/945 (the "UAS Delegated Regulation"), which sets out requirements in relation to the design and production of UAS; and
2. UK Regulation (EU) 2019/947 (defined above as the "UAS Implementing Regulation"), which contains rules governing the operation of a UAS.

The overall approach underpinning the UAS regulatory regime is that the applicable rules and procedures should be proportionate to the nature and risk of the operation in question. This means that the characteristics of the intended UAS operation determine the applicable rules at both the design and production stage and the operation stage.

The UAS Regulations establish three categories of operations: open, specific, and certified. The "open" category is subdivided into three further sub-categories which we discuss below.

As currently structured, the open category is of limited practical application to new forms of UAS. Most proposed uses for drones, for example, involve flying beyond the visual line of sight of the pilot (known as "BVLOS") and would therefore fall within the specific or certified categories. Our other use case, VTOLs, involves carrying passengers, and therefore would fall within the certified category. As far as we are aware, there are no certified UAS in the UK at present.

Open category

The open category is intended for low-risk flights. Article 4 of the UAS Implementing Regulation sets key criteria for an operation to fall within the open category. The main requirements are that:

1. aircraft must have a maximum take-off mass of less than 25 kg;
2. the remote pilot must ensure that the craft is kept at a safe distance from people and that it is not flown over assemblies of people;
3. the remote pilot must ensure that the craft is kept in visual line of sight ("VLOS") at all times except when flying in "follow-me" mode or when using an unmanned aircraft observer;
4. during flight, the craft must be maintained within 120 metres of the closest point of the surface of the earth, except when overflying an obstacle; and
5. the craft must not carry dangerous goods and must not drop any material.[17]

17 UK UAS Implementing Regulation, art 4(1).

Autonomous operations are not allowed in the open category: for most aircraft, the remote pilot must also be able to take control of the aircraft at any time, except if the communications link is lost. Additional guidance, in the form of "acceptable means of compliance" ("AMC") makes it clear that the remote pilot should only operate one aircraft at a time.[18]

Open category – operational rules

The Implementing Regulation places some general obligations on the remote pilot and UAS operator for all operations in the open category. It further divides the open category into subcategories A1, A2 and A3 and lays down some rules specific to each.

Amongst other things, the remote pilot must:

1. keep the unmanned aircraft in visual line of sight, and discontinue the flight if the operation poses a risk to other aircraft, people, animals, environment or property; and
2. have the ability to maintain control of the unmanned aircraft.[19]

Specific category

The specific category of operations covers operations which do not fall into either the open or certified categories.[20]

For operations in this category, the operator must apply to the CAA for an operational authorisation. This involves a risk assessment, in which the UAS operator must propose mitigating measures to keep the UAS operation safe. If satisfied, the CAA will then grant an operational authorisation, which will include the required technical capabilities of the UAS.[21]

Applicants may use a template risk assessment, published in advance by the CAA. These are known as pre-defined risk assessments and apply to repeatable and low risk operations in the specific category.[22] The only one currently in use is PDRA 1, which applies to VLOS operations within 150 metres of any residential, commercial, industrial or recreational areas for UAS with a MTOM less than 25kg.

The CAA may decide that the risks of an operation cannot be adequately mitigated without certification of the system and the operator, or licensing of a remote pilot. In these cases, the operation will need to be conducted in the certified category.

18 AMC1 UAS.OPEN.060 (2)(d) CAA ORS9 Decision No.16.

19 See generally UK UAS Implementing Regulation, annex, part A, UAS.OPEN.060, para 2.

20 UK UAS Implementing Regulation, art 5(1) and art 6(2).

21 UK UAS Implementing Regulation, art 12(1); UK Regulation (EU) 2019/945 on unmanned aircraft systems and on third-country operators of unmanned aircraft systems, art 40(3).

22 Civil Aviation Authority, *Specific category operations: pre-defined risk assessment requirements, guidance and policy* (August 2023) (CAP 722H), para 1.1.

Specific category – operational rules

The UAS Implementing Regulation places responsibilities on the operator and remote pilot for operations in the specific category. Many of the responsibilities of the operator the remote pilot overlap with the responsibilities prescribed for operations in the open category.[23] The possibility of autonomous flight is alluded to, with the operator required to designate a remote pilot for each flight or, for autonomous operations, ensure that responsibilities and tasks are properly allocated.[24]

A small number of provisions of the UK Standardised European Rules of the Air ("UK SERA") are applied to operations in the specific category.[25] These include prohibitions on operating an aircraft in a negligent or reckless manner, so as to endanger life or property of others (SERA.3101); and operating an aircraft in such proximity to other aircraft as to create a collision hazard (SERA.3205).

Other requirements are highlighted but their applicability is marked as "as required". These include SERA.3201 (collision avoidance), and SERA.3210 (right of way).

Certified category

Operations in the certified category are the highest risk operations. Generally speaking, they are subject to the same regulatory regime as crewed aviation. Operations are in the certified category if they:

1. involve an uncrewed aircraft with a characteristic dimension of 3m or more being flown over assemblies of people; or
2. involve the transport of people; or
3. involve the carriage of dangerous goods, that may result in high risk for third parties in case of accident.[26]

Certified category – design and production rules

UAS in the certified category must comply with the same requirements imposed on traditional crewed aviation in terms of design and manufacture. This means that UAS in the certified category are subject to the "applicable requirements" of UK Regulation (EU) 748/2012 (the "Initial Airworthiness Regulation"), Regulation 2015/640 (the "Additional Airworthiness Specifications Regulation") and UK Regulation (EU) 1321/2014 (the "Continuing Airworthiness Regulation").[27] The "applicable requirements" have not yet been specified.

Currently, for any UAS requiring certification, the command unit would be assessed as part of the overall system and not as a separate component.

23 UK Regulation (EU) 2019/947 on the rules and procedures for the operation of unmanned aircraft, annex, part B, UAS.SPEC.050.

24 UK Regulation (EU) 2019/947 on the rules and procedures for the operation of unmanned aircraft, annex, part B, UAS.SPEC.050.

25 UK Regulation (EU) 2019/947 on the rules and procedures for the operation of unmanned aircraft, art 7(2).

26 UK Regulation (EU) 2019/947 on unmanned aircraft systems and on third-country operators of unmanned aircraft systems, art 6.

27 UK Regulation (EU) 2019/945 on unmanned aircraft systems and on third-country operators of unmanned aircraft systems, art 40(2).

Certified category – operational rules

The UAS Implementing Regulation provides that UAS operations in the certified category are subject to UK SERA (the rules of the air), UK Regulation (EU) No 965/2012 on technical requirements and administrative procedures related to air operations; and UK Regulation (EU) No 1332/2011 on common airspace usage requirements and operating procedures for airborne collision avoidance.[28]

Unlike operations in the open and specific categories, which are excepted from most of the ANO 2016, UAS in the certified category are subject that order.[29] Therefore, it is an offence to fail to comply with the rules of the air for certified category operations except to the extent that departure is permissible to avoid immediate danger.[30]

28 UK Regulation (EU) 2019/947 on the rules and procedures for the operation of unmanned aircraft, art 7(3).

29 Air Navigation Order 2016 SI No 765, art 23(1)(c).

30 Air Navigation Order 2016 SI No 765, art 249.

Chapter 4: Airworthiness and certification

Safety is at the forefront of aviation. Aircraft and other systems in aviation are subject to strict standards making sure that they are safe both before they are used for the first time, and on an ongoing basis. There is therefore already a robust legal framework in place for ensuring that novel forms of aircraft are only deployed when this is considered safe.

Airworthiness and certification

Airworthiness describes the fitness of an aircraft or other airborne equipment or system to be operated in flight. There are two aspects of airworthiness:

1. Initial airworthiness requires that aircraft or airborne equipment conform to their design specifications.
2. Continuing airworthiness requires that the aircraft or airborne equipment should be maintained such that they can be operated without presenting a hazard to aircrew, ground crew, passengers or third parties.

Certification requirements for the airworthiness of civil aircraft are derived from Annex 8 of the Chicago Convention. In the UK those aircraft which fall within the scope of the Basic Regulation are, for historical reasons, referred to as "Part 21 aircraft" and are subject to the Basic Regulation's airworthiness requirements. The airworthiness of non-Part 21 aircraft is regulated under the ANO, with airworthiness requirements set out in the British Civil Airworthiness Requirements.[31]

Certification of initial airworthiness

Initial airworthiness regulations include procedures for the approval of the design of aircraft, airborne systems and equipment. If a design is approved by a contracting state to the Chicago Convention then it will issue a "type certification". Type certification describes the approved design and certifies that it meets the appropriate initial airworthiness requirements of the issuing State.[32]

Subject to limited exceptions, to create and/or produce a certified design, organisations must gain design organisation approval ("DOA") and/or production organisation approval ("POA").[33] Only once DOA and POA have been granted, is an organisation eligible to begin the process of applying for certification of its design or products. The certification process itself can be long and complex.

The certification of a type design does not however mean that all aircraft of that design are automatically approved - individual aircraft must also be certified as airworthy.[34] A certificate of airworthiness will be issued to aircraft which conform to the relevant type-certificate.

31 CAA, BCAR (accessed March 2023). https://www.caa.co.uk/commercial-industry/aircraft/airworthiness/organisation-and-maintenance-programme-approvals/bcar/

32 Chicago Convention Annex 8, 1-7.

33 UK Regulation (EU) 2018/1139 on common rules in the field of civil aviation and establishing a European Union Safety Agency, art 15.

34 UK Regulation (EU) 2018/1139 on common rules in the field of civil aviation and establishing a European Union Safety Agency, art 14.

Only UAS falling within the certified category and some UAS in the specific category are subject to the certification process set out above. However, at present there are no specifications with which to certify a UAS for initial airworthiness.

Continuing airworthiness

The term "continuing airworthiness" refers to the processes put in place to ensure that the aircraft continues to be airworthy once in use. The CAA is responsible for ensuring continuing airworthiness. If a safety issue comes to light, the CAA can issue binding airworthiness directives to address the problem.[35]

The CAA is responsible for approving and monitoring organisations involved in the maintenance, and therefore continuing airworthiness, of aircraft.[36]

Future challenges

We see two key challenges to the existing certification framework. The first is simply that there currently are gaps: there are certification specifications for conventional aircraft, but none for UAS in the certified category. The second is that to enable autonomous flight aircraft will have to rely on complex AI technologies which may be difficult to certify.

Certification of UAS

Most operations falling within the 'open' and 'specific' categories are regulated by the UAS Implementing and Delegated Regulations.[37] Only UAS falling within the "certified" category, and some within the "specific" category, are subject to certification.

Certifying UAS in accordance with existing standards can be challenging – existing rules were designed with conventional forms of aircraft in mind. UAS operations are associated with an increased risk of ground damage (both to infrastructure and people), an increased risk of mid-air collisions, and physical and cyber security concerns.

These risks are common to all aircraft but are more of an issue for UAS because many will be specifically designed to operate at lower altitudes and more UAS will mean more aircraft in a smaller volume of airspace. These risks suggest specific measures may be required to ensure the safe introduction of UAS. In Europe, EASA has proposed that manufacturers should be able to modify a manned aircraft to create a hybrid "optionally piloted" or "unmanned" versions. The configuration of such a hybrid aircraft would then be listed on a single type certificate. This would allow a single certificate of airworthiness to be issued for individual craft, rather than multiple certificates.[38]

35 UK Regulation (EU) 2018/1139 on common rules in the field of civil aviation and establishing a European Union Safety Agency, art 77(h).

36 UK Regulation (EU) 1321/2014 on the continuing airworthiness of aircraft and aeronautical products, parts and appliances, and on the approval of organisations and personnel involved in these tasks, art 4(1).

37 UK Regulation (EU) 748/2012 laying down implementing rules for the airworthiness and environmental certification of aircraft and related products, parts and appliances, as well as for the certification of design and production organisations; UK Regulation (EU) 2019/947 on the rules and procedures for the operation of unmanned aircraft.

38 EASA Opinion No 3/2023, *Introduction of a regulatory framework for the operations of drones— Enabling innovative air mobility with manned VTOL-capable aircraft, the initial airworthiness of unmanned aircraft systems subject to certification, and the continuing airworthiness of those unmanned aircraft systems operated in the 'specific' category* (August 2023) p 13.

EASA has also suggested changes in relation to control and monitoring units which are commonly called "command units".[39] Command units describe equipment used to control a UAS remotely and are central to the operation of UASs. EASA has proposed to introduce a dedicated type certificate for command units, meaning they could be assessed either together or separately from the aircraft

We invite views on whether similar amendments should be made in UK law.

Consultation Question 1

We seek views on how current airworthiness and certification regulation might need to be adapted or developed in light of highly automated and autonomous aircraft. In particular, should provisions be adopted which allow for:

1. the certification of optionally piloted and uncrewed or unoccupied versions of conventional aircraft (hybrid versions); and
2. the separate certification of command units?

Certifying autonomy

The use of AI technologies is central to the development of autonomous flight. However, AI technologies are difficult to certify for three main reasons.

1. **Predictability and explainability**. Much of the current focus in terms of AI development is in relation to machine learning ("ML") and deep learning approaches. These types of AI involve algorithms whose performance can change and improve as they are exposed to data. While this can improve performance, it also means these systems can be unpredictable. This makes assuring the safety of the system more difficult.

   Another important concept is that of explainability. EASA has defined explainability as:

   > the capability to provide the human with understandable, reliable, and relevant information with the appropriate level of details and with appropriate timing on how an AI/ML application produces its results.[40]

2. **The importance of data sets**. Data is crucial for training and developing AI models. The behaviours of an AI system will be dependent on the knowledge bases and data sets that are used to develop it. The quality of the knowledge bases and data sets therefore becomes a crucial aspect of AI development. In the context of certification, this raises a new

39 Defined in UK Commission Implementing Regulation (EU) 2019/947, Article 2(26) as "the equipment or system of equipment to control unmanned aircraft remotely … which supports the control or the monitoring of the unmanned aircraft during any phase of flight, with the exception of any infrastructure supporting the command and control (C2) link service". The new terminology of "control and monitoring unit" (CMU) would be defined as "the equipment to control and monitor unmanned aircraft remotely as defined in point (32) of Article 3 of Regulation (EU) 2018/1139".

40 EASA, *Concept paper: guidance for Level 1&2 machine learning applications* (February 2023) p 14. https://www.easa.europa.eu/en/document-library/general-publications/easa-artificial-intelligence-concept-paper-proposed-issue-2

problem: should requirements be put in place for both the AI systems and the knowledge bases and data sets used develop the model?

3. **Adaptability**. At the core of some forms of AI such as ML, is the ability to adapt and produce different outputs. These outputs may be unpredictable. Consequently, the certification of such adaptive systems is difficult, especially in a safety critical context. It is unclear whether the use of adaptive machine learning systems in safety critical aviation contexts will be feasible, even in the long term.

We invite stakeholder views on what type of changes might be necessary to address the issues created by the use of AI in aviation and enable higher automation and autonomy.

Consultation Question 2

We welcome views on what changes to the certification system might be necessary to enable higher automation and autonomy in aviation.

Consultation Question 3

We seek views on whether current regulatory tools to support the development of highly automated and autonomous aviation technologies are adequate.

Chapter 5: Rules of the air

Rules for humans tend to be subject to judgement or interpretation. Humans are often expected to act outside certain rules if circumstances require it. In an emergency, a human pilot might be expected to disregard certain rules, such as those relating to flight speed or cruising height in the interests of safety. Programming an autonomous aircraft to disregard certain rules, at the right time, and in unusual circumstances, may be extraordinarily difficult.

Rules of the air

The rules of the air are the core set of directions that must be followed when conducting aircraft operations. The key elements of the rules of the air are established by the Chicago Convention, and in particular Article 12 and annex 2.

Article 12 requires contracting states to establish rules of the air, which they must keep uniform "to the greatest possible extent" with those made under the Convention. The main treatment of the rules of the air in the Chicago Convention is to be found in annex 2. They are divided into general rules, visual flight rules (VFR) and instrument flight rules (IFR).

The distinction between VFR and IFR is an important one. VFR may be used when the aircraft can be operated safely in visual meteorological conditions (VMC). It is not possible to fly using VFR in cloud, and more difficult to fly VFR at night.[41] IFR on the other hand does not need clear skies. The use of instruments compensates for the pilot's lack of visibility. Such flights are more reliant on air traffic control to make sure that they maintain separation from other aircraft and, ultimately, maintain safe flight.

The main source of the rules of the air in the UK is UK Regulation (EU) 923/2012 establishing the Standardised European Rules of the Air ("UK SERA"). The rules themselves are found in the Annex to the Regulation. UK SERA is supplemented by the Rules of the Air Regulations 2015,[42] and some provisions in the ANO.

The rules have a broad scope. They include rules about: protecting third parties; collision avoidance; regulating unusual use cases (eg aerobatic and formation flights); signalling; flight plans; air space classification; air traffic control systems; emergency procedures; and voice communication procedures. Many of the rules are directed towards coordinating the movement of aircraft: for example, SERA.3210 determines which aircraft has right of way over another.[43]

The rules of the air do not apply to UAS operations in the open category, while UAS in the certified and specific categories are only subject to the "applicable operational requirements" of UK SERA.

Currently, a small number of "applicable operational requirements" of UK SERA are applied to UAS operations in the specific category pursuant to article 7(2) of the UAS Implementing Regulation. These are listed in the accompanying AMC and include provisions related to: collision avoidance; rights of way; and flying in prohibited and

41 See for example UK Regulation (EU) 923/2012 laying down the common rules of the air and operational provisions regarding services and procedures in air navigation, annex I, SERA.5005 and ORS 1496.

42 SI 2015 No 840.

43 UK Regulation (EU) 923/2012 on the Standardised European Rules of the Air, Annex I, SERA.3210.

restricted airspace.[44] The CAA may also apply any additional applicable requirements of the rules of the air as a condition of an operational authorisation. At present there are no AMCs or guidance on which of the operational requirements within UK SERA are applicable to the UAS in the certified category.[45]

Applying the rules of the air to remote piloting and autonomous operations

The rules currently operate on the strong presumption that there will be a human in the aircraft. For example, UK SERA.14026 indicates that it is expected that communications should be "spoken". Discretion is given to the human pilot, with the pilot-in-command having the power to depart from the rules "in circumstances that render such departure absolutely necessary in the interests of safety".[46]

Some requirements in the rule of the air (for example, regarding minimum heights) may be simple to apply to remotely piloted and autonomous systems. Others may prove more difficult.

Emergency situations

In emergencies, the pilot-in-command is responsible for ensuring that the aircraft lands safely, and some discretion is given to them. For example, in the event of a sudden decompression or malfunction requiring emergency descent, a pilot should, if able:

> remain on the assigned route or track whilst carrying out the emergency descent unless doing so would endanger the aircraft, in which case navigate as deemed appropriate by the pilot.[47]

Other emergency scenarios may lead a pilot to choose to disregard rules such as height restrictions or airspace prohibitions if it means they can achieve a safer outcome.

Should a similar freedom to disregard rules of the air in emergencies be available to highly automated and autonomous aircraft? Or should they be required to follow detailed predetermined rules, in all cases? We seek views from consultees.

Consultation Question 4

We seek views on how highly automated and autonomous aircraft should act in emergency scenarios. In particular:

1. should highly automated and autonomous aircraft be given the freedom to operate outside the rules of the air in emergency circumstances; or
2. should a comprehensive set of rules be developed for highly automated and autonomous aircraft in emergency situations.

44 UK Regulation (EU) 2019/947 on the rules and procedures for the operation of unmanned aircraft, AMC1 article 7(2).

45 UK Regulation (EU) 2019/947 on the rules and procedures for the operation of unmanned aircraft, art 7(3).

46 UK Regulation (EU) 923/2012 on the Standardised European Rules of the Air, annex I, SERA.2010(a).

47 UK Regulation (EU) 923/2012 on the Standardised European Rules of the Air, GM1 SERA.11001.

Consultation Question 5

We seek consultee views about what challenges remotely piloting an aircraft in an emergency scenario presents and how these might be addressed.

Communications

Throughout UK SERA, there are requirements for aircraft to maintain air-ground voice communications, which is defined as "two-way communication between aircraft and stations or locations on the surface of the earth".[48] This is premised on there being a pilot on board the aircraft who can communicate by voice to those on the ground. The pilot is under particular obligations to inform others, through voice communication, when they observe potentially dangerous meteorological conditions (such as moderate or severe turbulence or thunderstorms).[49] There are also provisions in the rules of the air which prescribe the hand signals that a pilot should use with signalpersons and emergency services.[50] The "signals" rules are designed with conventional aircraft in mind, and several require some level of human judgement.

The rules of the air also create numerous duties of ATS to provide information to pilots. For example, pilots are to be informed by ATS when a controlled flight is on a conflicting path with another unknown aircraft.[51]

Finally, in some critical circumstances, such as when an aircraft has entered prohibited aircraft, aircraft may need to be intercepted by relevant authorities (eg, the RAF). The current rules of the air require the pilot-in-command to follow instructions by looking for and responding to visual signals during an interception. For example, an intercepting aircraft conveys the message "you have been intercepted. Follow me" by rocking and flashing navigational lights at irregular intervals from a position slightly above, ahead of, and normally to the left of, the intercepted aircraft. If the intercepted aircraft wishes to convey the message "understood, will comply", the pilot must rock the aircraft, flashing navigational lights at irregular intervals and then following.[52]

The rules also envisage the intercepting pilot will make radio contact with the intercepted aircraft, and require ATS to attempt to establish two-way communication with all of the aircraft involved. ATS may be required to relay messages between the intercepting and intercepted aircraft. For these scenarios, communication with a highly automated or autonomous aircraft could prove difficult.

Given the paramount importance of communications during aviation operations, we seek consultees' views on how the rules of the air relating to communication should be adapted for remotely piloted and autonomous aircraft.

48 UK Regulation (EU) 923/2012 on the Standardised European Rules of the Air art 2(22)}. Also see SERA.6001, Annex I section 14, and Appendix IV.

49 UK Regulation (EU) 923/2012 on the Standardised European Rules of the Air, annex I, SERA.12015.

50 A signalperson is responsible for marshalling the aircraft on the ground, providing nonverbal signal which indicate to the pilot of an aircraft a range of information such as when to slow down, where to stop the plane, and when to shut down engines.

51 UK Regulation (EU) 923/2012 on the Standardised European Rules of the Air, annex I, SERA.7002.

52 UK Regulation (EU) 923/2012 on the Standardised European Rules of the Air, annex I, SERA.11015.

Consultation Question 6

We seek consultees' views on whether the rules of the air relating to communication should be adapted for remotely piloted and autonomous aircraft.

Potential options for adaptation

As we have described, the current rules of the air present difficulties for autonomous operations. They are predicated on there being a human pilot-in-command of the aircraft. The rules are also subject to caveats and instances where human discretion must be exercised. In some situations, the human pilot-in-command can be expected to operate outside the rules of the air to ensure the safety of the aircraft.

Earlier in this chapter, we described how the current rules of the air were never intended for operations where there was no crew onboard the aircraft. We have highlighted the difficulties this creates and asked for views on how certain rules might be adapted. Going forward, more rules of the air will need to be reviewed in light of remote and autonomous operations. A more systemic approach to adaptation is therefore desirable. We outline three options for adaptation below.

Amending the current rules

One option for adaptation is to amend the current rules of the air to account for operations which are autonomous or where there is no human pilot on board. This would have the benefit of having one set of rules of the air which were applicable to aircraft operations in general. This might also have the benefit of future-proofing the rules of the air as aviation technology progresses.

However, downsides include:

1. The size of the task. Although UK SERA is the main body of relevant rules, rules of the air, as well as cross references to the rules of the air, are also found in many different pieces of legislation and regulation.
2. It could be difficult to amend the rules in such a way to account both for flights with a pilot and those without. The set of rules would need to accommodate aircraft with and without pilots, and also factor into increasingly automated air navigation services.
3. Current rules of the air are largely taken from Annex 2 to the Chicago Convention. The UK is obliged to keep its rules consistent with Annex 2 "to the greatest extent possible".
4. Finally, as technology improves, it may become more possible for autonomous use cases to comply with existing rules of the air. For instance, it may be possible in the future for many autonomous and conventional aircraft to communicate information about their position and flight path without the need for human oversight or voice communications.[53] Attempting to amend the current rules of the air now would change the current rules for all airspace users whilst ultimately proving to be premature.

53 See 1.39 for a brief outline of electronic conspicuity which refers to technology which enable airspace user to share and receive information regarding other aircraft. See also CAA, Civil Aviation Authority, Airspace Modernisation Strategy 2023-2040 (January 2023)(CAP 1711) p 51.

Applying "applicable requirements"

As described in the earlier part of the chapter, UAS operations in the open category are not subject to the rules of the air, and operations in the specific and certified categories are only subject to what the law refers to as "applicable requirements". At the moment there is no guidance as to which requirements might apply to the certified category.

One possible approach for developing the rules of the air is to follow the pattern of the current law, and designate particular core rules of the air as applicable to the certified category. As part of operator licensing, the CAA could then put in place appropriate conditions or requirements to ensure that the operation is safe. This would increase flexibility for operators, and ensure that no rules applied that a UAS could not meet.

However, such a process would be intensive for both potential applicants and the regulator. Potential operators would need to be scrutinised more intensively so that appropriate conditions could be formulated for their particular operations. This would also create more uncertainty for potential operators.

This approach might also prove difficult when integrating UAS in the same airspace as crewed aircraft.

A new set of rules of the air for remotely piloted and autonomous operations

A third possibility is that an entirely new set of rules should be developed for remotely piloted and autonomous operations. These rules would stand alone and apply only to these types of operations.

This idea for a new set of flight rules for highly automated and autonomous flight is not new. In 2020, NASA proposed a new set of "digital" flight rules in order to accommodate and help facilitate new advances in aviation.[54] The NASA paper proposed the creation of these digital flight rules to complement the existing VFR and IFR.

The development of a new set of rules of the air for remote piloting and autonomous operations would increase certainty for those operations. It would however be time-consuming to develop a comprehensive set of rules for remotely piloted and autonomous flight. Both of these types of operation are still in a period of intense development and the relevant standards and best practices and technologies are still being developed.[55] We understand that the technology required to enable digital flight rules is not yet commonplace in aircraft.

Another issue is that a new set of flight rules will need to coexist alongside current flight rules, and enable remotely piloted and autonomous aircraft will need to interact with conventional aircraft.

Consultation Question 7

We ask for consultees' views on how the rules of the air might be adapted or developed for remotely piloted or autonomous flight.

54 National Aeronautics and Space Administration, *Digital flight: a new cooperative operating mode to complement VFR and IFR* (September 2022). https://ntrs.nasa.gov/api/citations/20220013225/downloads/NASA-TM-20220013225.pdf

55 EASA, Artificial Intelligence Roadmap 2.0 (May 2023) p 27. https://www.easa.europa.eu/en/newsroom-and-events/news/easa-artificial-intelligence-roadmap-20-published.

Chapter 6: VTOLs

This chapter focuses on the legal problems posed by the introduction of uncrewed, passenger carrying aircraft, and in particular uncrewed VTOLs. Several manufacturers are developing these aircraft. Initially, operations will still be controlled by a pilot within the aircraft, and as a next step we expect regulation to be introduced to cover these cases. In the future, many manufacturers intend to remove the pilot from the aircraft altogether. The UKRI's Future Flight roadmap envisages "autonomous advanced air mobility operations" (with a remote pilot in a control centre) being certified in the UK by 2030.[56]

Pilots and remote pilots

The pilot holds many responsibilities. The term often used in legislation is "pilot-in-command". The pilot-in-command is ultimately in charge of the flight and must ensure its safe conduct. The pilot-in-command may be the only pilot on an aircraft, or one of several pilots.

Definitions: "pilot" and "remote pilot"

"Pilot" is not often defined in the law. Annexes 1 and 2 to the Chicago Convention define a pilot as a person whose role is to "manipulate the flight controls of an aircraft during flight time". Annexes 1 and 2 to the Chicago Convention define a pilot-in-command as the pilot "in command and charged with the safe conduct of the flight".

The same definition of pilot-in-command is adopted by article 2 of Annex I to UK SERA, and a similar definition is used by the Aircrew Regulation. The Air Operations Regulation adds that "for the purpose of commercial air transport operations, the 'pilot-in-command' shall be termed the 'commander'".[57]

The definition of a "remote pilot" in the UAS Delegated Regulation is:

> 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 its course at any time.[58]

This requires a relatively low level of direct involvement with the flight controls. There is no suggestion that the monitoring must be continual, or active. We provisionally propose retaining the existing legal definition of remote pilot.

56 UKRI, *Future flight vision and roadmap*, (August 2021), p 14. https://www.ukri.org/wp-content/uploads/2021/08/UKRI-130821-FutureFlightVisionRoadmap.pdf.

57 UK Regulation (EU) 965/2012 laying down technical requirements and administrative procedures related to air operations, Annex I, para 96. A commercial air transport operation is defined in the UK Regulation (EU) 2018/1139 art 3 para 24 as "an aircraft operation to transport passengers, cargo or mail for remuneration or other valuable consideration".

58 UK Regulation (EU) 2019/945 on unmanned aircraft systems and on third-country operators of unmanned aircraft systems, art 3(27).

Consultation Question 8

We provisionally propose that a person overseeing a VTOL flying automatically, who monitors its course and is able to intervene and change its course at any time should continue to be classified as a "remote pilot".

Do you agree?

The core duties of a pilot

The Basic Regulation states that the pilot-in-command is responsible for the "operation and safety of the aircraft and for the safety of all crew members, passengers and cargo on board".[59] The Air Operations Regulation adds that commanders of commercial air transport operations (such as those we expect to be conducted by VTOLs) are responsible for:

1. the safety of all crew members, passengers and cargo on board; and
2. the operation and safety of the aircraft.[60]

We propose that the law should make clear that a remote pilot is capable of being the commander of a commercial air transport operation, for the purposes of the Air Operations Regulation.

Consultation Question 9

We provisionally propose that in a commercial air transport operation a remote pilot as defined in the UK UAS Delegated Regulation 2019/945 should have the responsibilities of the commander of an operation within the meaning of the UK Air Operations Regulation 965/2012.

Do you agree?

Responsibilities: operating the aircraft

The core duties outlined above are complemented by numerous more specific ones. Some relate to the task of piloting and the operation of the aircraft. For example, a commander must ensure that all operational procedures and checklists are complied with in accordance with the operations manual.[61] In preparation for flight, the pilot-in-command must be satisfied that the aircraft is registered and airworthy, that instruments and equipment are installed and working, and that baggage and cargo has been properly stored.[62]

At present these requirements do not apply to uncrewed aircraft.[63] Some of them can be replicated by remote pilots easily. For example, it should be relatively simple for a remote pilot to check before the flight that an aircraft is registered.

59 UK Regulation (EU) 2018/1139 on common rules in the field of civil aviation and establishing a European Union Safety Agency, annex V, para 1.3.

60 Regulation (EU) 965/2012 laying down technical requirements and administrative procedures related to air operations, annex IV, CAT.GEN.MPA105(a)(1) and (2).

61 UK Regulation (EU) 965/2012 laying down technical requirements and administrative procedures related to air operations, annex IV, CAT.GEN.MPA105(8).

62 UK Regulation (EU) 2018/1139 on common rules in the field of civil aviation and establishing a European Union Safety Agency, annex V, para 2(c). For crewed aircraft, operating limitations are typically considered as part of the certification process and contained within the aircraft's flight manual.

63 UK Regulation (EU) 2018/1139 on common rules in the field of civil aviation and establishing a European Union Safety Agency, art 29.

Other pre-flight checks could be conducted through a mixture of information provided by the aircraft, and checks done by crew based on the ground. One responsibility that cannot be fulfilled by crew on the ground is that the aircraft operating limitations (such as the weather conditions an aircraft can operate in) will not be exceeded at any time during the flight. In our view, this should remain the responsibility of the remote pilot.

Consultation Question 10

We provisionally propose that the remote pilot of a VTOL should be required to ensure that:

1. the aircraft is airworthy;
2. specified instruments and equipment are installed and operative;
3. the mass of the aircraft and centre of gravity location are such that the flight can be conducted within prescribed limits;
4. all cabin baggage, hold luggage and cargo is properly loaded and secured; and
5. aircraft operating limitations will not be exceeded at any time during flight.

Do you agree?

Consultation Question 11

We seek views as to whether there are additional operational responsibilities that a remote VTOL pilot should need to fulfil.

Responsibilities: the conduct of the flight

Safety checks and briefings

The pilot-in-command has a number of specific duties to ensure that passengers know what to do to keep themselves safe, both during normal flight and in emergencies.

For example, they must make sure that passengers are properly seated and secured.[64]

In practice the completion of these tasks is usually delegated to cabin crew. With a remote pilot, these functions could be fulfilled by a mixture of remote or pre-recorded briefings, and video footage of the passengers. As such our initial view is that the pilot-in-command could remain responsible for these tasks.

64 UK Regulation (EU) 2018/1139 on common rules in the field of civil aviation and establishing a European Union Safety Agency, art 20 and annex V, point 3(a); Air Navigation Order 2016 SI No 765, para 71.

Consultation Question 12

We provisionally propose that the remote pilot-in-command should be responsible for, amongst other things, ensuring passengers are:

1. given a safety briefing; and
2. are seated and wear seat belts during take-off and landing.

Do you agree?

Maintaining good order

The pilot is also generally responsible for the good conduct of the passengers onboard the aircraft. They must take all necessary measures to minimise the consequences on a flight of disruptive passenger behaviour.[65]

A commander in commercial air transport has additional responsibilities. They must not allow a person to be carried in the aircraft who appears to be under the influence of alcohol or drugs (to the extent that the safety of the aircraft or its occupants is likely to be endangered).[66] They may also refuse to transport passengers if their carriage increases the risk to the safety of the aircraft or its occupants.[67]

The commander also has broad powers. They may take reasonable measures to protect the safety of the aircraft or of persons or property onboard; to maintain good order and discipline; or to disembark or deliver the person in question to a constable or immigration officer.[68] This includes physical restraint of a passenger.

These measures may be taken if a commander has reasonable grounds to believe that a person on board the aircraft has done, or is about to do anything which could jeopardise:

a. the safety of the aircraft, or of persons or property on board, or
b. good order and discipline.[69]

Any member of the aircraft or other person on board the aircraft may, at the request of the commander, render assistance in restraining a person if the tests above are met. Even without a commander's request, a crew member or other person can take reasonable measures if they are "immediately necessary to protect the safety of the aircraft or of persons or property on board the aircraft."[70]

Our provisional view is that a remote commander and passengers should continue to have these abilities in the case of remotely piloted VTOLs.

To enable the remote commander to exercise these powers, they will need to be able to communicate with passengers. Passengers should also be able to contact a representative of the operator (but not necessarily the remote pilot, who is likely

65 UK Regulation (EU) 2018/1139 on common rules in the field of civil aviation and establishing a European Union Safety Agency, art 29 and annex V, point 3(g). Art 29 makes clear that the requirements in annex V specifically do not apply to unmanned aircraft.

66 UK Regulation (EU) 965/2012 laying down technical requirements and administrative procedures related to air operations, annex IV, CAT.GEN.MPA.105(a)(5).

67 UK Regulation (EU) 965/2012 laying down technical requirements and administrative procedures related to air operations, annex IV, CAT.GEN.MPA.105(a)(6).

68 Civil Aviation Act 1982, s 94.

69 Civil Aviation Act 1982, s 94(2).

70 Civil Aviation Act 1982, s 94(3).

to need periods of time to focus on the operation of the aircraft without distractions).

In our view, it should be the responsibility of the operator (delegated to crew on the ground) to make sure that passengers cannot board if their carriage would endanger the safety of the aircraft or others, or they appear to be drunk or under the influence of drugs.

Consultation Question 13

We provisionally propose that air operators (rather than the remote pilot-in-command) should be responsible for preventing passengers from boarding:

1. who appear drunk or under the influence of drugs; or
2. whose carriage would, in the view of the operator's employees, endanger the safety of the aircraft or other passengers.

Do you agree?

Consultation Question 14

We provisionally propose that the remote pilot-in-command should have the power to take reasonable measures, including authorising the restraint of passengers, as set out in section 94 of the Civil Aviation Act 1982.

Do you agree?

Consultation Question 15

We provisionally propose that a person on board a VTOL aircraft (other than a crew member) should be able to take reasonable measures to protect the safety of the aircraft or of persons or property on board.

Do you agree?

Consultation Question 16

We seek views on whether the powers of crew on board a VTOL aircraft should be broadened to reflect those of the pilot-in-command under the Civil Aviation Act 1982 to:

1. take reasonable measures to protect the safety of the aircraft or persons or property on board;
2. maintain good order and discipline; or
3. enable the crew to disembark or deliver a person.

Consultation Question 17

We provisionally propose that passengers should be able to contact a member of crew at all times during an operation.

Do you agree?

Condition of the pilot

The pilot (along with the rest of the crew) must be sober and alert. Under sections 92 and 93 of the Railways and Transport Safety Act 2003 it is a criminal offence in the UK for a person to act as the pilot of an aircraft during flight when their ability to perform the function is impaired because of drink or drugs, or where the level of alcohol in their breath, blood or urine exceeds a prescribed limit.[71]

In our view, the standards that apply to the condition of a pilot of crewed aviation should apply to remote pilots of VTOLs.

Consultation Question 18

We provisionally propose that it should be a criminal offence for a remote pilot of a VTOL to act in that capacity when their performance is impaired through drink or drugs.

Do you agree?

Consultation Question 19

We provisionally propose that it should be a criminal offence for a person to act as the remote pilot of a VTOL when the level of alcohol in their blood, breath or urine is over a prescribed limit.

Do you agree?

Accidents and near-accidents

The pilot is responsible for making sure that flight recorders are operating properly.[72] They are also responsible for reporting bird strikes and potential bird hazards, and if the aircraft has to manoeuvre in response to an airborne collision avoidance system.[73] In our view, these responsibilities could be fulfilled by the remote pilot. In order for the pilot to fulfil these responsibilities, the aircraft itself must be able to alert the pilot to these situations.

Consultation Question 20

We provisionally propose that the remote pilot should be subject to the reporting obligations currently applicable to pilots under the Air Operations Regulation.

Do you agree?

Consultation Question 21

We provisionally propose that a remotely piloted VTOL should be required to be capable of detecting and recording information relating to accidents and near accidents for the purposes of reporting it.

Do you agree?

71 Railways and Transport Safety Act 2003, ss 92, 93 and 94.

72 UK Regulation (EU) 965/2012 laying down technical requirements and administrative procedures related to air operations, annex IV, CAT.GEN.MPA105(a)(10).

73 UK Regulation (EU) 965/2012 laying down technical requirements and administrative procedures related to air operations, annex IV, CAT.GEN.MPA105(c), (d)(1) and (2).

Licensing

We expect that licences for crewed VTOL pilots will be introduced before uncrewed VTOL come into service in the UK. The CAA's current position is that a specific type rating will be required for each VTOL flown by the pilot. Our expectation is that a similar type of licence would have to be issued for particular types of VTOL which are remotely piloted. Appropriate adaptations would have to be made to reflect the necessary skills for remote pilots.

Consultation Question 22

We provisionally propose that licences should be required for remote VTOL pilots. So far as appropriate, these should follow the classes and ratings adopted for crewed VTOLs.

Do you agree?

The role of the operator in commercial air transport

Because uncrewed VTOLs fall within the "certified" category of UAS, the UAS Implementing Regulation requires their operator to be certified.[74] This approach is consistent with that taken for commercial air transport, where the certification of the air operator is required. In practice, this involves the issuance of an air operator certificate and the adoption of a safety management system.

In our view, the requirement that operators of remotely piloted VTOL should be certified is a sensible one. We see the requirement for a safety management system, in particular, as being an important tool in ensuring the safety of uncrewed aircraft. We therefore provisionally propose that operators of remotely piloted VTOL should continue to require certification.

Further detail about how air operations are structured and regulated is likely to depend on how crewed VTOL are regulated in the UK. For example, EASA intends to divide its regulation of VTOL operations between those that operate over urban areas, and those that do not. Any similar decision the UK made along these lines for crewed VTOL is likely to be applicable to uncrewed VTOL.

Consultation Question 23

We provisionally propose that operators of remotely piloted VTOLs should be certified.

Do you agree?

74 UK Regulation (EU) 2019/947 on the rules and procedures for the operation of unmanned aircraft, art 6.

Consultation Question 24

We provisionally propose that operators of remotely piloted VTOLs should continue to be required to:

1. have the means necessary for the scale and scope of operations planned;
2. use only suitably qualified and trained personnel;
3. implement a management system to ensure safety;
4. ensure operations only take place in accordance with the operations manual;
5. establish procedures to minimise the consequences to safe flight operations of disruptive passenger behaviour;
6. develop and maintain security programmes suitable for the aircraft and type of operation;
7. have a management system to prevent fatigue;
8. ensure the continuing airworthiness of the aircraft; and.
9. establish procedures for any reasonably foreseeable emergency situation.

Do you agree?

Consultation Question 25

We seek views as to whether there are additional responsibilities that operators of remotely piloted VTOLs should need to fulfil.

Piloting multiple aircraft

The ability to remotely pilot multiple aircraft (often referred to as "multiple simultaneous operations", or "MSO") represents a large shift in aviation regulation, and a new challenge in aviation regulation generally. It is also a key issue for drones and is discussed on pages 37-38.

Piloting multiple aircraft is not, generally speaking, prohibited in the law, apart from in the open category.[75] This is probably simply because this has not been a possibility up until now. It is however a capability that we expect to be much in demand from operators in the future.

We seek views below on whether the law should allow this, and if it does, what safeguards should be required.

75 UK Regulation (EU) 2019/947 on the rules and procedures for the operation of unmanned aircraft, AMC1 UAS.OPEN.060(2)(d).

Consultation Question 26

We seek views as to whether the law should permit remote pilots to act as pilot-in-command for more than one VTOL at the same time.

Consultation Question 27

We seek views on whether there should be an upper limit to the number of VTOLs for which a remote pilot can act as pilot-in-command at the same time.

Consultation Question 28

We seek views as to what additional safeguards should be introduced for remote pilots piloting multiple VTOLs.

Autonomous operations

As far as we are aware, there are currently no manufacturers intending for their aircraft to provide a commercial service entirely autonomously (ie with no ability for a human to intervene and change the course of the aircraft). In the long-term, however, this may become a possibility.

In that case, we expect that the role of the operator would continue to exist in much its existing form. In addition to the operator, there may be room for a new role for a person fulfilling non-piloting tasks that have previously been allocated to the pilot. This person could be responsible for completing pre-flight checks and passenger safety. They could also act as the default point of contact in relation to the activities of a VTOL.

Referring to such a role as a "pilot" of any kind might be misleading. Another possibility would be to refer to them as a flight "supervisor". We seek views on whether there should be such a role and, if there is, what powers or responsibilities they should have.

Consultation Question 29

We seek views as to whether there should be a role for a person supervising the flight of an autonomous passenger-carrying VTOL and acting as a point of contact in relation to it. What powers or responsibilities should such a person have?

Moving between remotely piloted and autonomous flight

One question which is not addressed explicitly in the current UAS legislative framework is whether it should be possible to transition between remotely piloted and autonomously piloted phases of flight, within the same operation. At present, the UAS Implementing Regulation only contains a definition of an "autonomous operation", which suggests that breaking down operations into different phases of flight is not an option.[76]

Any change in status between a remotely and autonomously piloted phase of a mission would need to be signalled clearly to a remote pilot. There would need to be a timely "transition demand" to enable them to react to the change in status and the aircraft would have to be able to continue to operate safely even if the remote pilot failed to respond to the transition demand.

We seek views on whether the law should permit an aircraft to transition between remotely piloted and autonomous flight during the course of a single operation.

Consultation Question 30

Should the law permit an uncrewed VTOL to transition between remotely piloted and autonomous flight during an operation?

Accessibility

UK Regulation (EU) 1107/2006 (the "UK Persons with Reduced Mobility Regulation") establishes rules for the "protection of and provision of assistance to disabled persons and persons with reduced mobility travelling by air".[77] Disabled persons cannot be refused carriage because of their disability, unless this would conflict with the safety requirements of the air operator's certificate or if the aircraft or its doors are too small to enable the passenger to board.

The Regulation also provides that free assistance must be provided by airports and air carriers. This includes carriage of assistance dogs, transport of mobility equipment, communication of essential information in accessible formats and reasonable efforts to arrange seating (subject to "safety requirements and availability"). Air carriers must also inform managing bodies of airports as soon as they become aware of a passenger's need for assistance.

A section of Annex 9 to the Chicago Convention also includes a number of recommended practices designed to improve accessibility at airports and during flight. In general, the focus of the section is on use of existing aircraft. However, Contracting States are also recommended to introduce minimum uniform standards of accessibility for aircraft which are coming into service for the first time, or which have undergone major refurbishment.[78]

76 UK Regulation (EU) 2019/947 on the rules and procedures for the operation of unmanned aircraft, art 2(17).

77 UK Regulation (EU) 1107/2006 concerning the rights of disabled persons and persons with reduced mobility when travelling by air, art 1(1).

78 Annex 9 to the Chicago Convention, Sixteenth Edition, July 2022, ch 8, section H, para 8.36.

Regulation of uncrewed VTOL

In principle, VTOL fall within the scope of the UK Persons with Reduced Mobility Regulation. Ensuring VTOLs are accessible requires coordination across multiple topics of aviation regulation, and we hope some of the potential issues (for example, around vertiport design) will be addressed in the initial, crewed deployment of the aircraft. Our focus in this project is on the impact of autonomous flight. Still, we envisage there will be some impacts on accessibility which are linked closely to the use of autonomous systems and the removal of cabin crew and the pilot from an aircraft.

At present, accessibility requirements in aviation do not extend to the design of the aircraft. Instead, the focus is on what additional help may be required to allow a person with disabilities or reduced mobility to use that aircraft. Some of that assistance can be replicated with passenger-only VTOL. For example, ground crew can assist with boarding and disembarking. This approach is however obviously more difficult when staff are not physically present in the cabin to offer assistance.

We invite views as to whether special conditions (or, in time, certification specifications) for passenger-only VTOLs should include standards in relation to accessibility for those with disabilities and reduced mobility. The advantage of this approach would be that passenger-only VTOLs designed and manufactured in the UK would be designed to fly safely with passengers with reduced mobility or disabilities from their introduction. There are however potential drawbacks. Having different standards in the UK from those recognised globally may put UK manufacturers at a disadvantage.

Another possible method for ensuring the provision of accessible services is through conditions placed in operators' licences. These could provide, for example, that a certain proportion of an uncrewed VTOL fleet should be capable of carrying mobility equipment, or an assistance dog. This approach depends, however, on uncrewed VTOL which meet these standards being commercially available. We invite views.

Consultation Question 31

We seek views as to whether initial airworthiness standards for uncrewed VTOLs should include accessibility standards for persons with disabilities and reduced mobility.

Consultation Question 32

We seek views as to whether the CAA should be able to include accessibility standards within the licences granted to uncrewed VTOL operators.

Consultation Question 33

We seek consultees' views on any other issues with the current legal framework as it relates to operations involving remotely piloted and autonomous VTOLs.

Chapter 7: Drones

We use the term "drones" to refer to uncrewed aircraft which are generally smaller than traditional aircraft and unoccupied. They can be remotely piloted or autonomous.

New applications of drone technology are being suggested and trialled on a regular basis. These include deliveries in remote and inaccessible locations, such as Orkney, and deliveries of vaccines and prescriptions. Beyond deliveries, drones are also being developed for use in: emergency response; infrastructure inspection; agriculture; wildlife and historical conservation; surveillance; construction and manufacturing; and temporary flying cellular networks.

Many of these use cases require a higher level of automation than has been common to date. Several of the use cases require a drone to be able to fly beyond the visual line of sight of an operator, or "BVLOS". This requires a high level of automation; the drone will need the technical capability to recognise objects in its path and take action to avoid a collision (a function known as "detect and avoid"). The detect and avoid function could be built into the drone or provided by ground infrastructure. Automation will also make it increasingly possible for one pilot to control multiple drones with very little intervention.

In Chapter 3 we gave an overview of the current regulatory regime for UAS, including drones. Here we outline some of issues with the regime.

Issues with the current regulatory framework

The current regulatory framework has many strengths. It takes a proportionate approach to risk: low risk drones are permitted subject to conditions, whilst higher risk drones and operations must be approved or certified. Innovation is also catered for via the specific category, which allows new drone operations outside the certified category to be authorised on a case-by-case basis.

Our provisional view is that the current regulatory framework also uses a definition of "remote pilot" which is appropriate for use in regulating drones. We provisionally propose to retain this definition of remote pilot for drone operations.

Consultation Question 34

We provisionally propose that a remote pilot for drones should continue to be 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 its course at any time".

Do you agree?

Autonomy in the open category

At present, autonomous operations and those involving flying beyond visual line of sight ("BVLOS") are generally considered more risky, and are therefore prohibited in the open category of operations. Instead, autonomous or BVLOS flying which falls outside the certified category must instead be performed in the specific category. These operations require individual scrutiny from the regulator, including a risk assessment and operational authorisation.

In the long term, the growth of the drone industry may be inhibited by the requirement for individual attention from the regulator. Even if PDRAs are available, large numbers of applications could be difficult to administer.

As the technology matures, and the CAA and industry gain more experience of these operations, the risk posed by such operations may change. In practice, some autonomous or BVLOS operations may be low risk and suitable for the open category subject to appropriate conditions being placed on their use. We ask for consultees' views on whether it is feasible for some autonomous or BVLOS drone operations to be conducted in the open category.

Consultation Question 35

We seek views on whether some low risk autonomous drone operations or drone operations conducted beyond visual line of sight might be accommodated in the open category. In particular:

1. whether there are any such use cases which might be suitable for the open category; and
2. if so, what conditions should be attached to these use cases if operated in the open category.

Lack of detailed rules – specific category

While the possibility of autonomous operations is briefly acknowledged in the UAS Regulations, there is a lack of detail in the legislation, applicable guidance material and AMC. In practice the rules in the specific category are designed for remotely piloted operations.

This is shown by the many responsibilities in the specific category which are placed on the remote pilot. The solution arrived at by the legislation for autonomous operations is to impose responsibility on the UAS operator to ensure that these functions are "properly allocated".[79] But in the case of the requirements applying during the flight, it is not clear whether and to whom these tasks can be allocated.

79 UK Regulation (EU) 2019/947 on the rules and procedures for the operation of unmanned aircraft, annex, part B, UAS.SPEC.050 para 1(b).

As an example, one requirement is that remote pilots should avoid the risk of collision with other aircraft and discontinue the flight when it may pose a risk to other aircraft. [80] It is unclear how this should be interpreted for autonomous operations. In practical terms, collisions will be avoided by the detect and avoid capabilities of the drone or supporting infrastructure.

If there is no remote pilot (at least for some stages of the flight), then there may be no one to whom the UAS operator can delegate these requirements. We therefore provisionally propose that the UAS operator should be made responsible for only using a UAS designed in a manner that it can comply with the requirements itself.

Consultation Question 36

We provisionally propose that for autonomous operations in the specific category, a UAS operator should be required to use a UAS which can:

1. comply with the authorised limitations and conditions;
2. avoid any risk of collision with any manned aircraft and discontinue a flight when continuing it may pose a risk to other aircraft, people, animals, environment or property;
3. comply with the operational limitations in designated geographical zones or airspace;
4. comply with the operator's procedures; and
5. not fly close to or inside areas where an emergency response effort is ongoing unless they have permission to do so from the responsible emergency response services.

Do you agree?

Lack of detailed rules – certified category

The UAS Regulations only contain detailed rules for drones in the open and specific category. For drones in the certified category, the regulations applicable to crewed aviation must be complied with.

This means that the applicable rules in place assume there is a pilot physically on board. This means that there is a particular gap for autonomous systems. By way of example, the application of the rules of the air is unclear.

As discussed on pages 18-19, "applicable operational requirements" of the UK SERA apply to operations in the specific and certified categories. One major issue going forward is the lack of clarity about what "applicable operational requirements" entails. While there is some guidance for the specific category, there is none yet for the certified category. We seek consultees' views about what "operational requirements" should be applied to autonomous and BVLOS drone operations in these categories.

80 Above, para 3(b).

Consultation Question 37

We seek views on what operational requirements should be applied to autonomous drone operations and drones that operate beyond visual line of sight in the specific and certified categories.

Using multiple drones simultaneously

Some use cases of drones may involve multiple drones working together to accomplish a task or objective. Recently the British Standards Institute has referred to such operations as "multiple simultaneous operations (MSO)" and defined them as "multiple uncrewed aircraft which are under collective control and are in flight simultaneously." The term "collective control" is defined as "multiple uncrewed aircraft being under the command of a single supervisory remote pilot-in-command".[81]

At the moment, MSO are not possible in the open category; remote pilots in that category may only operate one UAS at a time.[82] There is no such restriction for remote pilots of operations in the specific category, but there are no detailed provisions on how such operations should be conducted.

In practice the requirements placed on remote pilots for operations in the specific category assume a certain level of control over the aircraft and make them responsible for the safe flight of the UAS. The current definition of a UAS remote pilot is a pilot charged with "monitoring its course and remaining able to intervene and change its course at any time".[83] This may not be possible for drone MSO as operations become larger. We ask below whether there should be a maximum number of drones that can participate in MSO.

Consultation Question 38

We seek views on whether the current concept of a "remote pilot" is compatible with drone MSO. We also seek views on whether the remote pilots of drone MSO should continue to be subject to the same responsibilities as remote pilots for single drone operations.

Consultation Question 39

We seek views on whether there should be an upper limit to the number of drones for which an individual remote pilot is responsible.

81 British Standards Institution, BSI Flex 1903 v 1.0 2023-08, Future flight systems – vocabulary (August 2023). 3.1.65.

82 UK Regulation (EU) 2019/947 on the rules and procedures for the operation of unmanned aircraft, AMC1 UAS. OPEN.060(2)(d).

83 UK Regulation (EU) 2018/1139 on common rules in the field of civil aviation and establishing a European Union Safety Agency, article 3(31).

Consultation Question 40

We seek views as to what additional safeguards should be introduced for remote pilots responsible for multiple drones.

Flight data recording for autonomous operations

Investigating and learning from any accidents will be key to enabling autonomous operations to take place faster. To support investigations, it will be important that autonomous drones are capable of recording relevant fight data.

At present, whether a flight data recorder system or device is required will depend on the category of operation. In the specific category, it is recommended, but not compulsory. For autonomous operations, where there may be no remote pilot to observe unusual technical or operational occurrences, it will be particularly important to ensure that flight data recorder systems or are used to support any future investigations. We therefore provisionally propose that use of such systems should be mandatory for autonomous drone operations.

Consultation Question 41

We provisionally propose that use of flight data recorder systems or devices should be mandatory for autonomous drone operations.

Do you agree?

Consultation Question 42.

Should the law permit a drone to transition between remotely piloted and autonomous flight during an operation?

Further issues

We have attempted to highlight the major issues with the current regulatory framework for drones. However, we invite stakeholders to draw our attention to any other gaps, blockers or inconsistencies in the current legal framework, which relate to autonomous operations involving drones.

Consultation Question 43

We seek stakeholder views on any other issues with the current legal framework as it relates to operations involving autonomous drones.

Chapter 8: Civil liability and insurance

In this chapter we explore what civil liability attaches to those involved in the operations of uncrewed aircraft systems ("UAS"), both following an accident and in relation to their day-to-day operations. We also discuss insurance requirements placed on air carriers and operators and consider the application of the existing framework to uncrewed aircraft.

Civil liability in case of accidents

Air carrier liability for injury or death of passengers

The primary person liable for injury or death of passengers is the air carrier. UK air carriers are subject to UK Council Regulation 2027/97, which applies provisions of the Montreal Convention to both national and international air carriage.[84]

The Convention makes an air carrier liable for death or bodily injury which results from an accident occurring on board an aircraft.[85] Our view is that the provision applies to uncrewed aircraft.

For damages up to a set amount, the carrier may not exclude or limit its liability. At present the set amount is just under £140,000. Up to that limit the scheme is one of "strict liability"; meaning is not necessary to show that the air carrier was at fault. Above the limit, the carrier will not be liable for damages if the air carrier can prove that the damage was not negligent.[86]

In our provisional view, the replacement of a pilot by a remote pilot, or the removal of the pilot altogether, will not make any significant difference to the effectiveness of the current regime.

Consultation Question 44

We provisionally consider that the current law governing air carrier liability for injury or death of passengers in the UK is adequate for the introduction of remotely piloted and autonomous operations.

Do you agree?

Air carrier liability for cargo

Air carriers that carry cargo within the UK are liable for the destruction, loss of, or damage to cargo, if the event that caused the damage took place during the carriage by air. We are provisionally of the view that liability will apply to UAS.

As with liability for death or bodily injury, there is a limit to the liability, which operates by weight.[87] The weight limit may however be displaced if the sender makes a "special declaration" and, if required, pays an additional fee.

84 UK Council Regulation (EC) No 2027/97 on air carrier liability in the event of accidents, arts 1 and 3.

85 Montreal Convention 1999 art 17.

86 Montreal Convention 1999, art 21(2).

87 Carriage by Air Act 1961, sch 1B, part II, art 22(3) gives a limit of 17 SDRs per kilogram (as applied by the Carriage by Air Acts (Application of Provisions) Order 2004, sch 1).

In practice it seems likely that cargo carried by smaller drones will be of a greater value than the current limit of just under £18 per kilogram. As a result, greater use is likely to be made of special declarations and additional fees. At present we do not see that this requires a change to the existing law.

Consultation Question 45

We provisionally consider that the current law governing liability for damage to cargo in the UK is adequate for the introduction of remotely piloted and autonomous operations.

Do you agree?

Liability for surface damage

Section 76(2) of the Civil Aviation Act 1982 Act provides compensation for damage sustained at ground level. It enables damages to be claimed "where material loss or damage is caused to any person or property on land or water by, or in a person in, or on an article, animal or person falling from, an aircraft while in flight, taking off or landing".[88]

Liability for surface damage is strict and the person liable for any damage is the owner of the aircraft.[89] However, if the aircraft has been demised, let out or hired for a period exceeding 14 days to any other person and no pilot, commander, navigator or operative member of the crew of the aircraft is in the employment of the owner (a situation often referred to as a "dry lease"), the liability falls on the lessee.[90]

In the case of UAS, it is less likely that they will have crew which will continue to be employed by the owner. In that case, any lease of over 14 days would result in liability shifting from the owner to the lessee. We suggest that liability should also transfer for shorter leases where the parties agree that the lessee will be responsible for operating the aircraft. If the existing pattern of aircraft leasing in the UK is replicated for UAS, most leases will be for longer than 14 days.

Consultation Question 46

We provisionally propose that liability for surface damage, in the case of UAS, should transfer to the lessee when the lease:

1. is for more than 14 days; and
2. specifies the aircraft is to be operated under the responsibility of the lessee.

Do you agree?

Trespass and nuisance

Private nuisance is a wrongful interference with the claimant's enjoyment of rights over land.[91] It is possible that the use of UAS might constitute a private nuisance if its use constituted a substantial and unreasonable interference with a claimant's land or their use or enjoyment of that land.

88 Civil Aviation Act 1982, s 76(2).

89 The term "owner" is not defined in the Civil Aviation Act 1982. We suggest that it means someone with a general property interest in the aircraft: see s 61, Sale of Goods Act 1972.

90 Civil Aviation Act 1982 s 76(4).

91 *Fearn and others v Board of Trustees of the Tate Gallery* [2023] UKSC 4.

Trespass concerns unlawful presence on someone else's land. It is not necessary to prove that the presence has caused damage.[92] If a UAS flies over land belonging to someone else, it is possible that this may amount to trespass, particularly if the UAS is moving slowly at very low altitude.

The Civil Aviation Act 1982 excludes liability for trespass or in nuisance in respect of a flight or the "ordinary incidents" of a flight, so long as:

1. the flight is "at a height above the ground which, having regard to wind, weather and all the circumstances of the case is reasonable"; and
2. provisions of any Air Navigation Order, or order under section 62 of the Civil Aviation Act 1982 are complied with.[93]

In our provisional view, section 76(1) of the Civil Aviation Act 1982 applies to uncrewed aircraft. However, drones in particular are expected to operate differently to traditional aircraft, with more frequent flights at a lower altitude. This raises questions about whether they will be able to take advantage of the "reasonable height" defence. In addition, the majority of the ANO does not apply to UAS. We therefore provisionally propose that the range of legislation referred to in section 76(1) of the Civil Aviation Act 1982 is increased.

Consultation Question 47

We provisionally propose that the conditions of exemption from liability for private nuisance and trespass in section 76 of the Civil Aviation Act 1982 should be modified in their application to UAS so as to require compliance with requirements of aviation legislation that are relevant to limiting intrusion into the claimant's land.

Do you agree?

Liability for designers and manufacturers

As aircraft systems become more sophisticated, more attention is likely to be directed at the potential liability of manufacturers and software designers.

It is possible that, following an accident, an air operator could sue a manufacturer or software developer in negligence. However, it may be difficult to demonstrate that the actions of the software developer had fallen below the standard of care expected. The difficultly will only increase with the addition of machine learning, which can be opaque.

The Consumer Protection Act 1987 sets out a strict liability regime covering damage caused by "products", a term which explicitly applies to aircraft.[94] Where damage is caused wholly or partly by a defect in a product, the producer of the product will be liable (as well as any person who held themselves out as the producer or imported the product).

92 M Hones and A Dugdale, Clerk & Lindsell on Torts (23rd Edition), 19-02.

93 Civil Aviation Act 1982, s 76(1). The section also requires compliance with any orders made under section 62 of the Civil Aviation Act 1982, which was repealed by the Transport Act 2000.

94 Consumer Protection Act 1987, s 45(1).

Liability does not extend to the designer of a product. In our view the problems with product liability are not unique to aviation and require a joined up approach.

Consultation Question 48

We provisionally propose that there should be a review of product liability law (including the Consumer Protection Act 1987) to take account of the challenges of emerging technologies. The review should cover product liability as a whole, rather than be confined to aviation or automated vehicles.

Do you agree?

Liability for mid-air collisions

There is no specific legal regime for mid-air collisions. We expect that the majority of claims will fall under the headings of injury or death of passengers, or damage to cargo or baggage, or surface baggage. As we set out above, our preliminary view is that the current law is adequate to deal with these types of damage. However, we seek views from stakeholders as to whether the current law is satisfactory.

Consultation Question 49

We seek views as to whether the current law regarding liability for mid-air collisions is satisfactory in the case of collisions involving uncrewed aircraft systems.

Insurance

Regulation 785/2004 (the "Insurance Regulation") establishes minimum insurance requirements for air carriers and air operators.[95] The Insurance Regulation requires that "each and every flight" must be covered by insurance.[96] Model aircraft with a maximum take off mass of less than 20kg are excluded.[97] The CAA defines model aircraft as "any unmanned aircraft which is being used for sport or recreational purposes only."[98] As a result, UAS under 20kg which are not used for commercial purposes are not currently required to have insurance.

Air carriers must have minimum insurance cover for passengers, cargo, baggage during commercial flights and third parties.[99] Third-party insurance covers personal injury and property damage to third parties as a result of the operation of aircraft.

95 Regulation (EC) 785/2004 on insurance requirements for air carriers and aircraft operator, Official Journal L 138 of 30.04.2004 p 1.

96 UK Regulation (EU) 785/2004 on insurance requirements for air carriers and aircraft operators, art 4(2).

97 UK Regulation (EU) 785/2004 on insurance requirements for air carriers and aircraft operators, art 2(2)(b).

98 CAA, Unmanned Aircraft System Operations in UK Airspace (2022) (CAP 722) para 1.3. This definition in CAP 722 is informed by those set out in UK Regulation (EU) No 923/2012 laying down the common rules of the air and operational provisions regarding services and procedures in air navigation.

99 UK Regulation (EU) 2020/1118 amending Regulation (EU) No 785/2004 on insurance requirements for air carriers and aircraft operators, art 1, art 7.

The Government has committed to updating the regulation of insurance for UAS. At present the extent of insurance requirements is largely dependent on the maximum take-off mass of the individual aircraft, with that being used as a proxy for the risk of its operation. However, in future it might be necessary for insurance requirements to reflect the risk posed by multiple simultaneous operations.

Consultation Question 50

We seek consultees' views on whether they expect any difficulties applying existing insurance requirements to uncrewed aircraft systems.

Consultation Question 51

We provisionally propose that multiple simultaneous operations should be considered as the Government develops proposals for the insurance requirements applicable to uncrewed aircraft.

Do you agree?

Chapter 9: Criminal sanctions in civil aviation

There is no single piece of legislation that imposes criminal sanctions for breach of aviation law. The Civil Aviation Act 1982, the Aviation and Security Act 1982, the Aviation and Maritime Security Act 1990 and, in particular, ANO all contain important provisions addressing criminal liability.

Uncrewed operations: the current law

The ANO sets out a broad regime of criminal law offences, penalties and defences which apply to operators and pilots of aircraft. Most of the provisions of the ANO do not apply to UAS within the scope of the UAS Implementing Regulation. There are however a number of provisions which apply to uncrewed aircraft in the open and specific categories.

Criminal liability under the ANO

Article 265 of the ANO is the principal provision creating criminal liability. It creates criminal offences for the breach of many articles of the ANO and other pieces of legislation. In total, article 265 attaches criminal liability to over 500 provisions, listed in schedule 13. The least serious are punishable by low fines, while the most serious (endangering the safety of an aircraft) is punishable by an unlimited fine and a maximum of five years' imprisonment.[100]

Anyone who has "contravened" the relevant provision will be criminally liable. In addition, the operator and pilot-in-command are "deemed" to have contravened a provision if it is breached by someone else.[101]

For autonomous operations in the certified category, the deemed liability of the operator for a contravention under article 265(1) applies whether or not there is a pilot. The result is that, subject to the available defences, there will always be a party – the operator – who can be held criminally liable for any offences listed in parts 1 to 4 of schedule 13.

Article 265(3) provides for a defence for those who have directly contravened a provision if they have exercised reasonable care. Article 265(2) provides for a "due diligence defence" for those who have been "deemed" to contravene a provision.

We are not aware of any concerns about how the due diligence defence works where an operator has been deemed to contravene a provision. Nor are we aware of concerns about its application to autonomous flight.

The "reasonable care" defence is untested in the context of autonomous operations. An important question is whether the defence of reasonable care continues to work where an offence has occurred because of the behaviour of an autonomous aircraft. Our preliminary view is that the defence will work for autonomous flight, but we seek views.

100 SI 2016 No 765, art 265(8) and sch 13(4).

101 Defined by sch 1, art 2 to the Air Navigation Order 2016 as the Basic Regulation and any implementing rule made under that regulation.

Consultation Question 52

We provisionally consider that the current approach in the Air Navigation Order 2016 placing criminal liability on an operator is adequate for autonomous operations.

Do you agree?

Consultation Question 53

We provisionally consider that the "reasonable care" defence in article 265(3) of the Air Navigation Order 2016 applies adequately for "direct contraventions" under Article 265(5) to (8) involving autonomous operations.

Do you agree?

Consultation Question 54

We seek views on whether for autonomous operations the reasonable care defence should be applicable to the vicarious liability created in article 265(1) of the ANO.

Liability of remote pilots

As outlined in Chapter 2, there is a distinction between those aircraft which are intended to operate autonomously and those intended to be overseen by a person. Under our provisional proposals a person who can intervene and change the course of the aircraft would be considered a pilot.

An important question is whether the remote pilot of an uncrewed aircraft should be treated as a pilot-in-command for the purposes of criminal liability. For operations in the open and specific categories, the UAS Regulations already place responsibilities on remote pilots. Failure to comply with these responsibilities is a criminal offence under the ANO.[102]

We considered the responsibility of the remote pilot of a certified, passenger-carrying UAS Chapter 6. In line with our proposal that those pilots should retain the operational responsibilities of a pilot-in-command, our view is that the remote pilot should also retain criminal liability for breaches of those responsibilities.

If transitions between autonomous and remotely piloted operations are permitted, our initial view is that a remote pilot should only be criminally liable until the end of any transition period. We seek views on this point. We also provisionally propose that remote pilots responsible for MSO should also be subject to criminal liability for beach of requirements that the regulatory system places upon them.

102 SI 2016 No 765, arts 265A and 265B.

Consultation Question 55

We provisionally propose that a remote pilot of an uncrewed aircraft operating in the certified category should be treated as a pilot-in-command for the purposes of criminal liability pursuant to article 265(1) of the Air Navigation Order 2016.

Do you agree?

Consultation Question 56

We ask for consultees' views on the criminal liability of pilots (or remote pilots) when an aircraft operating autonomously returns control to the pilot or vice-versa. In particular, should a pilot only become criminally liable for the piloting of the aircraft at the end of a transition period?

Consultation Question 57

We provisionally propose that the pilot-in-command of aircraft in a multiple simultaneous operation should be criminally liable for breach of operating requirements in the same way as a pilot-in-command of a single aircraft would .

Do you agree?

Air Traffic Management and Unmanned Aircraft Act 2021

The Air Traffic Management and Unmanned Aircraft Act 2021 gives the police and prison officers specific powers relating to the use of "unmanned" aircraft. The Act (and in particular schedule 8) confers powers on police officers and prison authorities, including, amongst other things:

1. the power to require such an aircraft to be grounded;
2. the power to stop and search persons or vehicles; and
3. the power to enter and search premises under warrant in relation to certain offences involving an unmanned aircraft.

Schedule 9 to the Act makes provisions regarding the powers of police officers relating to requirements in the ANO.[103] Police officers may, for example, ask a remote pilot to provide evidence of their competency to pilot an unmanned aircraft.[104]

At present, we are not aware of any legal issues presented by increased automation or autonomy in relation to the Act. We seek consultees' views as to whether there is any need for adaptation of the Act to the use cases being considered in this project.

Consultation Question 58

We invite consultees' views on whether the Air Traffic Management and Unmanned Aircraft Act 2021 operates satisfactorily in the case of highly automated and autonomous flight.

103 Air Traffic Management and Unmanned Aircraft Act 2021, s 14.

104 Air Traffic Management and Unmanned Aircraft Act 2021, sch 9, 1.

Carriage of dangerous goods

There is a demand for uncrewed aircraft to carry "dangerous goods" like medicines, blood samples and batteries. Currently, only UAS in the specific category can be approved by CAA to carry dangerous goods.[105] The carriage of dangerous goods is not allowed in the open category and there are, as yet, no provisions for the certified category.

The Air Operations Regulation contains three provisions regarding the carriage of dangerous goods. Breach of these is a criminal offence under schedule 13 to the ANO.

The first provision places restrictions on the carriage of weapons or other munitions of war. The second requires that the transport of dangerous goods be conducted in accordance with annex 18 to the Chicago Convention (as amended by technical instructions). This places obligations primarily on the operator and shipper, with the pilot-in-command responsible for informing air traffic services of the carriage of dangerous goods in the event of an emergency. The final provision stipulates that, subject to exceptions, an operator must only transport dangerous goods by air if approved by the CAA.

The transport of dangerous goods is also subject to the Air Navigation (Dangerous Goods) Regulations 2002. The Regulations contain provisions regarding: requirements for the carriage of dangerous goods, including obligations of the operator and pilot-in-command.[106]

Some of these requirements may need to be adapted in future. In particular the 2002 Regulations assume that there is a pilot-in-command to inform air traffic services of dangerous goods on board in the event of an emergency. For autonomous operations, it will be important to make sure this can be done without the involvement of a remote pilot. We invite views on how operator responsibilities for dangerous goods might need to be adapted in light of autonomous operations.

Consultation Question 59

We invite views on how operator responsibilities for dangerous goods might need to be adapted in the case of autonomous operations.

Other aviation offences

This section analyses aviation-specific offences that can be committed by persons who are not involved in the operation of aircraft.

Hijacking

Hijacking occurs when a person unlawfully, by the use of force or threats, seizes an aircraft in flight or exercises control of it.[107] The offence can only be committed by a person on board an aircraft. Taking control of an uncrewed aircraft by the use of force or threats outside the aircraft would not qualify as hijacking.

105 Dangerous goods that "may result in high risk for third parties in case of accident" are restricted to the certified category.

106 Air Navigation (Dangerous Goods) Regulations 2002 SI 2002 No 2786.

107 Aviation Security Act, s1(1).

Destroying an aircraft in service

Section 2 of the Aviation Security Act 1982 makes it an offence punishable by life imprisonment to unlawfully and intentionally:

1. destroy an aircraft in service; or
2. damage an aircraft in service to render it incapable of flight or so that it is likely to endanger its safety in flight;[108] or
3. place a device or substance on an aircraft which is likely to destroy the aircraft or damage the aircraft to render it incapable of flight or dangerous to fly.

"Unlawful" in this context means the act must amount to a criminal offence.

Interfering with air navigation

Section 3 of the Aviation Security Act 1982 makes it an offence liable to life imprisonment to unlawfully and intentionally interfere with property used for air navigation purposes. This includes damaging or destroying the property. The property may be on board an aircraft or elsewhere.

It is also an offence under subsection (3) for any person intentionally to communicate information which is false, misleading or deceptive, where the communication endangers (or is likely to endanger) the safety of an aircraft in flight.

There are two defences available under section 3(4). The first is that the defendant believed and had reasonable grounds for believing that the information was true. The second is that the defendant was lawfully employed to perform duties which involved the communication of information, and communicated the information in good faith.

Carrying weapons

Under the Aviation Security Act 1982, it is an offence to carry a firearm, explosive or article made, adapted or intended to damage people or property in an aerodrome or air navigation installation or on an aircraft in or flying over the UK.[109]

Offences against the aircraft: our provisional view

Our initial view is that the introduction of autonomy is unlikely to cause any fundamental problems with the operation of offences under the Aviation Security Act 1982. One exception is the offence of hijacking. The current offence can clearly only be committed by a person on board the aircraft. It seems more likely that an autonomous or remotely piloted aircraft would be hijacked by exploiting weaknesses in its computer systems or programming ("hacking") or by the use of threats or force at a remote operations centre.

The current hijacking offence does not apply to hacking or coercion at a remote operations centre. At the international level, the Hague Hijacking Convention has been supplemented by a 2010 "Beijing Protocol". The protocol has expanded hijacking to include "coercion" and "technological means" as a way to commit the offence. It also removed the requirement that someone hijacking the plane must be on board the aircraft. Though the UK has signed the Beijing Protocol, it has yet to ratify or implement it.

108 Aviation Security Act 1982, s 2(1)(a).

109 Aviation Security Act 1982, s 4.

We seek consultees' views on whether the offence of hijacking in domestic law should be updated to reflect the fact that autonomous or remotely piloted aircraft could be hijacked by technological means or by persons not on board the aircraft. We also seek views on whether any other offences against aircraft need to be updated to account for increased autonomy in aviation.

Consultation Question 60

We ask for consultees' views about whether the offence of hijacking in domestic law should be updated to:

1. include the unauthorised seizure or control of autonomous or remotely piloted aircraft by technological means or by persons not on board the aircraft; and
2. expand the period in which hijacking can occur from the period when an autonomous or remotely piloted aircraft is "in flight" to the period when it is "in service".

Consultation Question 61.

We also ask consultees for views on whether any offences against the aircraft other than hijacking need to be updated to account for increased autonomy in aviation.

Chapter 10: Impact

The introduction of more highly automated and autonomous aircraft is expected to lead to numerous benefits, including increased safety. We set out in Chapters 6 and 7 the types of operation that VTOLs and drones are expected to undertake.

One of the difficulties with assessing the impact of our project is that it is future-looking. While there has been work to try and assess the future value of the drone and advanced air mobility industries to the UK economy, which we refer to the full Consultation Paper, this is inevitably speculative. A further problem of assessing the impact of this project is that our focus is on the impact of greater autonomy. We are not considering other developments that are expected to change the future of aviation in this area: for example, the adoption of electric propulsion.

An example of the difficulty is that of VTOLs. As yet, there are no VTOLs providing transport services in the UK. Almost all manufacturers expect that when they are first introduced, they will be piloted. A progression to remotely piloted and, eventually, autonomous VTOLs is expected further in the future.[110] That development and its impact on the UK economy is therefore dependent on the success of the initial, crewed stage.

Updating the air traffic management and air navigation services provided to uncrewed aircraft in the UK will also be key to unlocking many of the benefits outlined below. We intend to return to this topic in a second consultation paper, later in 2024.

We ask consultees for any quantitative and qualitative evidence on what they believe to be the costs and benefits of our provisional proposals. The information which we receive from consultees in response to the questions below will inform an impact assessment to be published with our final report.

Consultation Question 62.

We invite consultees to tell us if they have views on, or have experience or data to indicate, the likely costs and benefits of our provisional proposals in relation to VTOLs.

Consultation Question 63.

We invite consultees to tell us if they have views on, or have experience or data to indicate, the likely costs and benefits of our provisional proposals in relation to drones.

110 For an overview of estimated timelines, see Bryce Tech, *Advanced air mobility: an assessment of a coming revolution in air transportation and logistics* (September 2023) part 3.5 https://assets.publishing.service.gov.uk/media/6571b635049516000f49be06/advanced-air-mobility-evidence-review.pdf.

Equality impact assessment

As part of our policy formation process we consider how our provisional proposals could affect particular groups, or those with particular characteristics. One of the areas in which we think our provisional proposals could have an impact is in relation to uncrewed VTOLs. Without a pilot or other crew in the aircraft, it will be important for the needs of those with disabilities and reduced mobility generally to be considered at an early stage, when designing both the aircraft itself and the support systems that are provided alongside it. We discuss this in more detail on page 33.

We also ask a more general question below. This is an opportunity for consultees to inform us if the remainder of our proposals could have equality impacts and, if so, what those might be. Data provided by consultees will be used to produce a full equality impact assessment, which will be published alongside our final report.

Consultation Question 64

We invite consultees to tell us if they believe or have evidence or data to suggest that any of our provisional proposals could result in advantages or disadvantages to certain groups or based on particular characteristics (with particular attention to age, disability, transgender identity, marriage and civil partnership, pregnancy and maternity, race, religion or belief, sex or gender, and sexual orientation).