



Ministry
of Defence

Joint Doctrine Publication 0-30.2

Unmanned Aircraft Systems

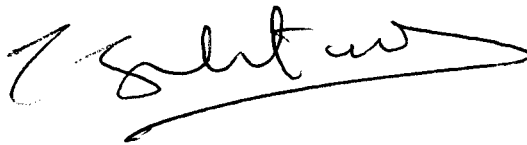


Development, Concepts and Doctrine Centre

Joint Doctrine Publication 0-30.2
Unmanned Aircraft Systems

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dated August 2017,

is promulgated
as directed by the Chiefs of Staff

A handwritten signature in black ink, appearing to read 'J. G. ...', with a long horizontal stroke extending to the right.

Director Concepts and Doctrine

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Abstract

Purpose

1. Joint Doctrine Publication (JDP) 0-30.2, *Unmanned Aircraft Systems* guides operational commanders and planning staff in understanding the terminology, tasking and employment of the UK's unmanned aircraft systems (UAS). You should note that this Edition also includes Change 1 to make it clear that the UK operates UAS in compliance with national and international law.

Context

2. Over the last five years, the UK military has gained considerable practical experience in operating a number of different UAS. Reaper has flown over 70,000 hours on military operations over Afghanistan, Iraq and Syria while Watchkeeper was brought into operational service in Afghanistan. At the same time, systems have moved from urgent operational requirements, with uncertain long-term support, to inclusion in the core equipment programme, thereby ensuring they will be properly supported and updated over their service lifetime. Plans are also now in place to conduct a high-altitude pseudo-satellite capability investigation using Zephyr and to replace Reaper with Protector. Unmanned aircraft operations have been at the leading edge of technology and doctrine development and thinking needs to keep pace. This document delivers the underpinning doctrine by consolidating current best practice on operating unmanned and remotely piloted aircraft systems.

Scope

3. JDP 0-30.2 describes, from a joint perspective, the use of UAS at the operational level, while recognising that platform capability is provided by the individual Services. JDP 0-30.2 includes UK and NATO terminology and definitions related to the operation of unmanned aircraft, and describes how each aircraft type is classified by size and capability. This publication updates much of the information previously presented in Joint Doctrine Note (JDN) 2/11, *The UK Approach to Unmanned Aircraft Systems*, which is now withdrawn. This JDP includes new detail on the UAS tasking process and explains the need to consider not only the 'collect' task, but also the process, exploit and disseminate (PED) functions. The conceptual elements of JDN 2/11 have been removed and will, where appropriate, be included in the forthcoming Joint Concept Note, *Future Force Concept*.¹ Chapter 4 of this publication,

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1 The Joint Concept Note, *Future Force Concept* is designed to build on the Development, Concepts and Doctrine Centre's *Global Strategic Trends* and *Future Operating Environment* publications and provide broad guidance for command-level conceptual force and capability development. It is scheduled to be published in the summer 2017.

covering the legal framework and moral and ethical issues, has been updated to include detail on the UK's position on using armed remotely piloted aircraft and developing automated and autonomous platforms. It provides the key facts and arguments that support how and why Her Majesty's Government uses its unmanned capability.

Audience

4. The guidance contained in this JDP is applicable to all joint and single-Service personnel and civilians employed in duties relating to procuring, operating and supporting unmanned and remotely piloted aircraft systems. The JDP may also serve as a guide on UK military thinking to politicians, the media and the general public as well as increasing transparency on UK unmanned and remotely piloted aircraft capability and operation.

Structure

5. JDP 0-30.2 is divided into four chapters and two annexes.
- **Chapter 1 – Introduction.** This chapter describes the context for the UK's fleets of unmanned aircraft and outlines the questions and issues raised by the widespread adoption of advanced unmanned aircraft.
 - **Chapter 2 – Terminology and classification.** Outlining standard UK terminology related to the use of unmanned and remotely piloted aircraft, as well as some NATO agreed terms for comparison.
 - **Chapter 3 – Task, employ, counter.** A chapter that describes how existing manned aircraft doctrine, particularly at the operational level, applies equally to unmanned aircraft. This chapter pulls together best practice from UK operators, as well as recent ideas from NATO and the United States. It makes the key point that, while the collect activity is important, how they are tasked and how the collected data is subsequently exploited, are just as important.
 - **Chapter 4 – Legal framework, moral and ethical issues.** This chapter provides an up-to-date UK military view of the legal framework under which unmanned aircraft systems are operated. It describes the process for conducting a legal review of a weapon system and considers moral and ethical issues and counters some of the common arguments levelled against the use of unmanned aircraft.
 - **Annex A – UK and NATO unmanned and remotely piloted aircraft systems.** This annex looks at the different unmanned aircraft systems operated by the UK military and NATO as well as future platforms.
 - **Annex B – Strengths, weaknesses, opportunities, and threats analysis.** This annex presents an analysis table.

Contents

Abstract	iii
Chapter 1 – Introduction	1
Chapter 2 – Terminology and classification	9
Chapter 3 – Task, employ, counter	23
Chapter 4 – Legal framework, moral and ethical issues	37
Annex A – UK and NATO unmanned and remotely piloted aircraft systems	51
Annex B – Unmanned aircraft strengths, weaknesses, opportunities, and threats analysis	67
Lexicon	69





Introduction

Chapter 1 describes the context for the UK's fleets of unmanned aircraft and how that will change over the next ten years. It further outlines the questions and issues originally raised by the widespread adoption of advanced unmanned aircraft and how the experience gained during that period has provided a firm basis on which to take the capability forward with confidence.

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The use of drones, or **unmanned aerial vehicles**, has **increased exponentially in the last 10 years**, and this trend is likely to **continue for the foreseeable future**. But with this increased use has come **controversy**, in particular **closer scrutiny of the legal and ethical dimensions** of the use of armed drones.

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The US Army War College,
Lethal and Legal? The ethics of drone strikes,
December 2015

Chapter 1 – Introduction

1.1. In 2010, the Royal Air Force (RAF) was still learning how best to operate its small fleet of remotely piloted Reaper aircraft, controlled from Creech Air Force Base in the Nevada desert, United States. The Royal Navy was experimenting with ScanEagle and seeking funds to buy the capability. By comparison, the British Army's unmanned aircraft operations were relatively mature, based on extensive use of the Hermes 450 and Desert Hawk III across Afghanistan and Iraq – although the introduction of Watchkeeper was still some way in the future. These systems were procured under the urgent operational requirement process and the Defence Lines of Development¹ needed to provide a complete capability were either weak, or absent. Although system and capability development was rapid, understandably regulations and standards lagged; very few early systems fully drew on, or fully complied with, manned aircraft design, build or safety practices.

1.2. It was in this context that Joint Doctrine Note (JDN) 2/11, *The UK Approach to Unmanned Aircraft Systems* was published in 2011. JDN 2/11 had many purposes. First it gathered existing unmanned aircraft doctrine, although there was very little available, and developed new terminology. Secondly, it proposed concepts for how unmanned aircraft might be used in future and highlighted the many associated technical and legal issues. Finally, and perhaps most importantly, its intent was to generate discussion and promote thinking amongst operators, academics and interested parties.

1.3. JDN 2/11 was referenced by a number of organisations outside the Ministry of Defence (MOD). An article in *The Economist*² referenced it extensively, as have academic articles, UK newspapers³ and other nations' doctrine. It has also been used to support debate on unmanned aircraft by the House of Commons Defence Committee, which has since recommended that the JDN be updated. The JDN has also been quoted on various 'anti-drone' websites indicating that it has reached a wide audience.

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1 The UK Ministry of Defence's (MOD's) Defence Lines of Development (DLoD) are arranged under the following groupings: training; equipment; personnel; information; concepts and doctrine; organisation; infrastructure; and logistics. Although not a DLoD in itself, interoperability is considered an intrinsic part of the framework.

2 'Flight of the Drones', *The Economist*, 8 October 2011, available at <http://www.economist.com/node/21531433>

3 For example, 'The air force men who fly drones in Afghanistan by remote control', *The Daily Telegraph*, 24 September 2012, available at <http://www.telegraph.co.uk/news/uknews/defence/9552547/The-air-force-men-who-fly-drones-in-Afghanistan-by-remote-control.html>

1.4. Much has happened in the six years since JDN 2/11 was published. The *National Security Strategy and Strategic Defence and Security Review 2015*⁴ determined, post Afghanistan, which unmanned aircraft systems (UAS) and remotely piloted aircraft systems (RPAS)⁵ would be taken into core funding and which would be discontinued. Since then, announcements have been made that a new system, Zephyr, will be bought and a fleet of more than 20 Protector aircraft will replace Reaper.

1.5. Barring unexpected developments, we now know the UK's unmanned and remotely piloted aircraft order of battle through to the early 2020s. The Army will operate Desert Hawk III and Watchkeeper, with Black Hornet withdrawn from service in 2017. The Royal Air Force (RAF) will continue to operate Reaper, until around 2020, when Protector will begin to replace it. The Royal Navy will end its contract for ScanEagle operations in 2017, with alternative options being considered. A small number of Zephyr aircraft have been bought and will be used to support a capability investigation into high-altitude pseudo-satellites.



A soldier from the Royal Artillery prepares a Desert Hawk III for flight

4 Available at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/478933/52309_Cm_9161_NSS_SD_Review_web_only.pdf

5 See Chapter 2 for a discussion on unmanned aircraft systems and remotely piloted aircraft systems terminology usage and meaning.

1.6. The last five years have seen much of the business of operating unmanned and remotely piloted aircraft normalised. Reaper flights are now conducted from their base at RAF Waddington and from Creech Air Force Base and considered routine with over 70,000 hours flown. Watchkeeper is operated by 47 Regiment Royal Artillery, based at Larkhill, and declared operational in Afghanistan in September 2014. ScanEagle routinely operates from Type 23 frigates and Royal Fleet Auxiliary Cardigan Bay, conducting surveillance tasks for counter-terrorism, maritime security and counter-drug operations in the Gulf and beyond. We have continued to develop the doctrine, with the terminology defined in JDN 2/11 being widely accepted and used. For small systems, tactical thinking has matured with considered tactics, techniques and procedures in place with UK operators and across the North Atlantic Treaty Organization (NATO). For larger systems, experience has shown that they are best tasked and employed in the same way as manned aircraft; the UK's air and space doctrine is as relevant for remotely piloted aircraft as it is for manned. Indeed, in many cases they are considered equivalent capabilities.⁶ There are differences though, and these are becoming more widely understood and appreciated as familiarity and confidence grow as we use them more.

1.7. Significantly, many of the legal and ethical issues raised by JDN 2/11 have been widely discussed. Unmanned and remotely piloted aircraft (although a platform rather than a weapon) are subject to multiple legal reviews under Article 36 of Additional Protocol 1 to the Geneva Conventions before entering service and operate under the same political authority, command chain supervision, international humanitarian law and rules of engagement as manned aircraft. The often-expressed fear that we would create a 'PlayStation generation' of operators, disconnected from the reality of their actions, has been shown to be without foundation. Similarly, there is no evidence that the availability of remotely piloted aircraft has reduced the threshold for going to war. In fact, there is the heartening possibility that the availability of remotely piloted aircraft better enable compliance with international humanitarian law during targeting and also increase the possibility of taking action to support humanitarian missions that may have been considered too risky previously.⁷ We have seen that remotely piloted aircraft crews are subject to the same psychological stresses as manned aircraft crews. This is recognised within command chains and appropriate mechanisms are in place to help manage them.

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Similarly, there is **no evidence** that the availability of remotely piloted aircraft has **reduced the threshold** for going to war.

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 6 Tasking is discussed in Chapter 3, Section 2.

7 "UAVs do a better job in protecting civilians because they provide real-time pictures of situations as they develop on the ground. You can act more quickly and more decisively." United Nations Head of Peacekeeping Operations, Hervé Ladsous. Available at: <http://www.un.org/africarenewal/web-features/unmanned-aerial-vehicles-are-effective-protecting-civilians%E2%80%944herve%C3%A9-ladsous>

1.8. An early concern, voiced by some, was that RPAS originated weapon attacks could lead to an increased number of civilian casualties. Experience shows that RPAS operators may actually be better placed than manned aircraft in this respect. The persistence of these aircraft means that crews can observe targets for long periods before an attack and ensure that they are considerably more aware of the detail of the target and its environment. Further, RPAS crews are not subjected to the physiological demands and stresses of manned flight, resulting in less fatigue. Additionally, access to legal and political advice throughout a sortie helps to ensure that informed decisions are made to achieve the best outcome. Of the UK's unmanned and remotely piloted aircraft fleets, only Reaper is weaponised and historically, more than 80% of Reaper missions have been tasked on intelligence, surveillance and reconnaissance rather than strike.⁸

'If used in strict compliance with the principles of international humanitarian law, remotely piloted aircraft are capable of reducing the risk of civilian casualties in armed conflict by significantly improving the situational awareness of military commanders.'

The United Nations Special Rapporteur on the promotion and protection of human rights and fundamental freedoms while countering terrorism⁸

September 2013

1.9. The context for unmanned and remotely piloted aircraft operations has evolved over time, and this publication reflects that. It updates the information in JDN 2/11 and introduces new doctrine gathered from best practice in the UK, NATO and allied nations. It is, though, primarily a doctrine document and reflects the normalisation of unmanned and remotely piloted aircraft operations – the conceptual element of JDN 2/11 is not included in this JDP. Many of the issues raised in JDN 2/11 have been resolved and conceptual issues are better dealt with in other Development, Concepts and Doctrine Centre documents⁹ where they can be placed in the appropriate context.

⁸ United Nations, Report of the Special Rapporteur on the promotion and protection of human rights and fundamental freedoms while countering terrorism, A/68/389, 18 September 2013. This can be found at <http://unispal.un.org>.

⁹ For example, *Future Operating Environment 2035* and *Global Strategic Trends – Out to 2045*, all available at <https://www.gov.uk/government/groups/development-concepts-and-doctrine-centre>

Key points

- Early unmanned aircraft systems were bought under the urgent operational requirement process; the supporting processes needed to provide a complete capability were less comprehensive than normal, as the procurement process was accelerated.
- At the tactical level, tactics, techniques and procedures developed rapidly, but operational doctrine lagged behind systems' operational use.
- The *National Security Strategy and Strategic Defence and Security Review 2015* determined which systems would be core funded and which discontinued.
- The UK unmanned aircraft system order of battle is known through to the early 2020s, providing further opportunities to normalise their use.
- The last five years have seen much of the business of operating unmanned and remotely piloted aircraft normalised.
- Earlier issues raised by some pressure groups surrounding the operating ethos, legality, morals, and ethics of unmanned aircraft use have been widely discussed.
- The Reaper remotely piloted aircraft is now tasked and employed in the same way as its manned equivalent.
- The context for unmanned and remotely piloted aircraft operations has evolved over time, and this publication reflects that.



Terminology and classification

Chapter 2 outlines standard UK terminology related to the use of unmanned and remotely piloted aircraft, as well as some NATO agreed terms for comparison. It details the Military Aviation Authority classification system and shows how this is applied to current UK systems. Finally, related terms are explained as well as a brief discussion of the importance of developing a disciplined intelligence, surveillance and reconnaissance tasking and delivery process.

Section 1 – Terminology	11
Section 2 – Related terms.	13
Section 3 – Intelligence, surveillance and reconnaissance terms.	17
Section 4 – Classification and regulation	18

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...the Committee also argued that the MOD needed to **rise to the challenge of overcoming public suspicion of RPAS and developing public understanding** of the capability.

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House of Commons Library Briefing Paper,
Number 06493,
October 2015

Chapter 2 – Terminology and classification

Section 1 – Terminology

2.1. This chapter covers UK terminology and describes the way that unmanned aircraft are classified. Common alternatives used by other nations and organisations are also described, as they may use the same terms but with a different meaning. Terms related to unmanned aircraft operations are then detailed. Particular care should be taken with the terms ‘automated’ and ‘autonomous’, which differ considerably between countries and equipment manufacturers. The way the UK defines these terms is important as they are tied to UK policy on the use of autonomous weapons and our interpretation of international law.¹⁰



A Royal Air Force Reaper at Kandahar Airfield in Afghanistan

Standard terminology

2.2. The UK developed the term ‘remotely piloted’ in 2011 to emphasise the human involvement in all critical decisions made during a mission. UK terminology was developed in recognition of our operating procedures and regulations, which may

¹⁰ These terms are discussed further in Chapter 3.

differ from those used by other North Atlantic Treaty Organization (NATO) nations. Current standard UK terminology is shown in Table 2.1.

Term	UK definition ¹¹
Unmanned aircraft	An aircraft that does not carry a human operator, is operated remotely using varying levels of automated functions, is normally recoverable, and can carry a lethal or non-lethal payload. ¹²
Unmanned aircraft system	A system, whose components include the unmanned aircraft and all equipment, network and personnel necessary to control the unmanned aircraft.
Remotely piloted aircraft	An aircraft that, whilst it does not carry a human operator, is flown remotely by a pilot, is normally recoverable, and can carry a lethal or non-lethal payload.
Remotely piloted aircraft system	The sum of the components required to deliver the overall capability and includes the pilot, sensor operators (if applicable), remotely piloted aircraft, ground control station, associated manpower and support systems, satellite communication links and data links.

Table 2.1 – UK standard terminology

2.3. Although military personnel may tend to use the term unmanned to describe Class I and II platforms¹³ and remotely piloted to describe Class III, either term may be encountered. The British Army and Royal Navy, which currently operate Class I and II aircraft, prefer the term unmanned aircraft system (UAS), while the Royal Air Force (RAF), which currently only operates Class III, prefers remotely piloted aircraft system (RPAS). The Military Aviation Authority (MAA) refers to all classes as being remotely piloted.

2.4. Unlike the UK, NATO has only agreed definitions for unmanned aircraft system and remotely piloted aircraft. These are shown in Table 2.2, where it can be seen that in NATO an unmanned aircraft system is broadly the same as in the UK, while the remotely piloted aircraft definition is more to do with pilot qualifications. It should be noted that in the United States, an unmanned aircraft 'is capable of flight with or without human remote control',¹⁴ whereas the UK definition simply requires remote operation.

¹¹ Joint Doctrine Publication (JDP) 0-01.1, *United Kingdom Supplement to the NATO Terminology Database*, 8th Edition.

¹² In the UK, cruise and ballistic missiles are not considered unmanned aircraft. The guiding rule is that if a system is designed principally for warhead delivery and is not designed to be recoverable, then it is not an unmanned aircraft.

¹³ See Table 2.5, page 18.

¹⁴ United States Joint Publication 3-30, *Command and Control of Joint Air Operations*, February 2014.

Term	NATO definition ¹⁵
Unmanned aircraft system	A system whose components include the unmanned aircraft, the supporting network and all equipment and personnel necessary to control the unmanned aircraft.
Remotely piloted aircraft	An unmanned aircraft that is controlled from a remote pilot station by a pilot who has been trained and certified to the same standards as a pilot of a manned aircraft.

Table 2.2 – NATO standard terminology

Section 2 – Related terms

Other terms relevant to remotely piloted aircraft

2.5. As previously noted, it is important to understand the difference between automated and autonomous systems, particularly when talking to external agencies and the media. The definitions, used by UK Armed Forces are shown below in Table 2.3.

Term	Definition
Automated system	In the unmanned aircraft context, an automated or automatic system is one that, in response to inputs from one or more sensors, is programmed to logically follow a predefined set of rules in order to provide an outcome. Knowing the set of rules under which it is operating means that its output is predictable. (JDP 0-01.1)
Autonomous system	An autonomous system is capable of understanding higher-level intent and direction. From this understanding and its perception of its environment, such a system is able to take appropriate action to bring about a desired state. It is capable of deciding a course of action, from a number of alternatives, without depending on human oversight and control, although these may still be present. Although the overall activity of an autonomous unmanned aircraft will be predictable, individual actions may not be. (JDP 0-30)

Table 2.3 – Automated and autonomous system definitions

¹⁵ Allied Administrative Publication (AAP)-06, *NATO Glossary of Terms and Definitions*, 2016.

2.6. For a number of years it has been common for unmanned and remotely piloted aircraft to have automated functions. Examples of these might include take-off and landing, height, speed or station keeping and automatic sensor operation. These functions are designed to:

- reduce operator workload;
- increase reliability;
- increase capacity to control or monitor the most important elements of the mission; and
- speed up decision-making.

Equipment manufacturers can use any terminology they wish in order to describe their products and will often describe systems as autonomous even though the UK military would consider them to be automated. Manufacturers' and non-UK forces' descriptions should always be checked to see exactly how the term is being used. The UK does not possess fully autonomous weapon systems and has no intention of developing them. Such systems are not yet in existence and are not likely to be for many years, if at all.

2.7. **Remote and automated systems.** The trend toward unmanned systems in all three environments (maritime, land and air and space), together with increased automation and the need to emphasise the presence of human control and oversight, means that the terms 'unmanned' and 'remotely piloted' look dated as umbrella terms for the capability. The Development, Concepts and Doctrine Centre's (DCDC's) publication *Future Operating Environment 2035*¹⁶ introduced the term 'remote and automated system' as a concept that covered all physical operating environments. 'Remote' and 'automated' capabilities are often taken to be interchangeable. However, an important distinction is that automated systems need not operate at range, and remote capabilities need not be automated (they could be controlled, at a distance, by a human operator). While the term 'remote and automated system' is generic, each environment has its own specific sub-classification. As an example, the air environment would use the term remote and automated air system. Proposed definitions for these terms are shown in Table 2.4.

“
For a number of years it has been common for **unmanned and remotely piloted aircraft** to have **automated functions**.
”

.....
16 Available at <https://www.gov.uk/government/publications/future-operating-environment-2035>.

Term	Proposed definition
Remote and automated system	A system comprising the platform, control and sensor equipment, the supporting network, information processing system and associated personnel where the platform may be operated remotely and/or have automated functionality.
Remote and automated air system	A remote and automated system designed to operate in the air environment.

Table 2.4 – Remote and automated terminology specific to the air environment

2.8. **Visual line of sight.** Visual line of sight is the maximum distance, with the unaided eye, at which the aircraft pilot is able to safely operate the aircraft, while maintaining the correct separation and collision avoidance from other aircraft (manned or unmanned), persons, vessels, vehicles and structures. In the UK this generally means the aircraft must remain within 500 metres horizontally and 400 feet¹⁷ vertically of the pilot.¹⁸ Note that a clear, unimpeded line of sight must be maintained between operator and aircraft at all times. When operating in complex terrain, such as the urban environment, these distances may be greatly reduced.

2.9. **Sense and avoid.** In manned flight, maintaining separation by visual means is called 'see and avoid'. When a remotely piloted aircraft is operated beyond visual line of sight, the pilot is unable to comply with see and avoid rules. To overcome this, sensor systems are being developed that provide an equivalent capability that is known as 'sense and avoid'. None of the current unmanned and remotely piloted fleets have this capability, but it is expected that Protector will. An accredited sense and avoid system should allow an unmanned or remotely piloted aircraft to access the day-to-day national airspace structure.¹⁹

2.10. **Segregated airspace.** Where, and how, we can operate unmanned and remotely piloted aircraft depends on a range of factors that include their class, sensor fit, operating area and operating altitude. Without accredited sense and avoid systems, aircraft must be operated either within visual line of sight of the operator, so that they can obey the rules of the air or, if beyond visual line of sight, in segregated airspace.²⁰ This is a block of airspace created specifically for unmanned and remotely piloted aircraft operations and to which entry is strictly controlled.

¹⁷ Horizontal distance is measured in metres and height in feet.

¹⁸ See Civil Aviation Publication 722, *Unmanned Aircraft System Operations in UK Airspace – Guidance*.

¹⁹ During operations in military controlled airspace, the air component commander will determine the airspace structure and operating rules which are promulgated through the airspace control order and special instructions.

²⁰ Royal Navy rules stipulate that unmanned aircraft systems must operate in Class G airspace and either within segregated airspace, a Notice to Airmen (NOTAM) area, or as detailed on the air tasking order (ATO).

2.11. **Remote-split operations.** Remote-split operations refer to the geographical separation of the launch and recovery crew from the mission crew who, in turn, employ the aircraft at a location other than where the aircraft is based.²¹ As an example of remote-split operations, a RAF mission crew could be connected via fibre-optic link to a satellite ground station in Germany that is connected, via satellite link, to a Reaper launched from a base in the Mediterranean and which was employed over the Middle East. This is illustrated at Figure 2.1. Due to the complicated and expensive assured command and control networks required to enable remote-split operations, few nations have this capability.

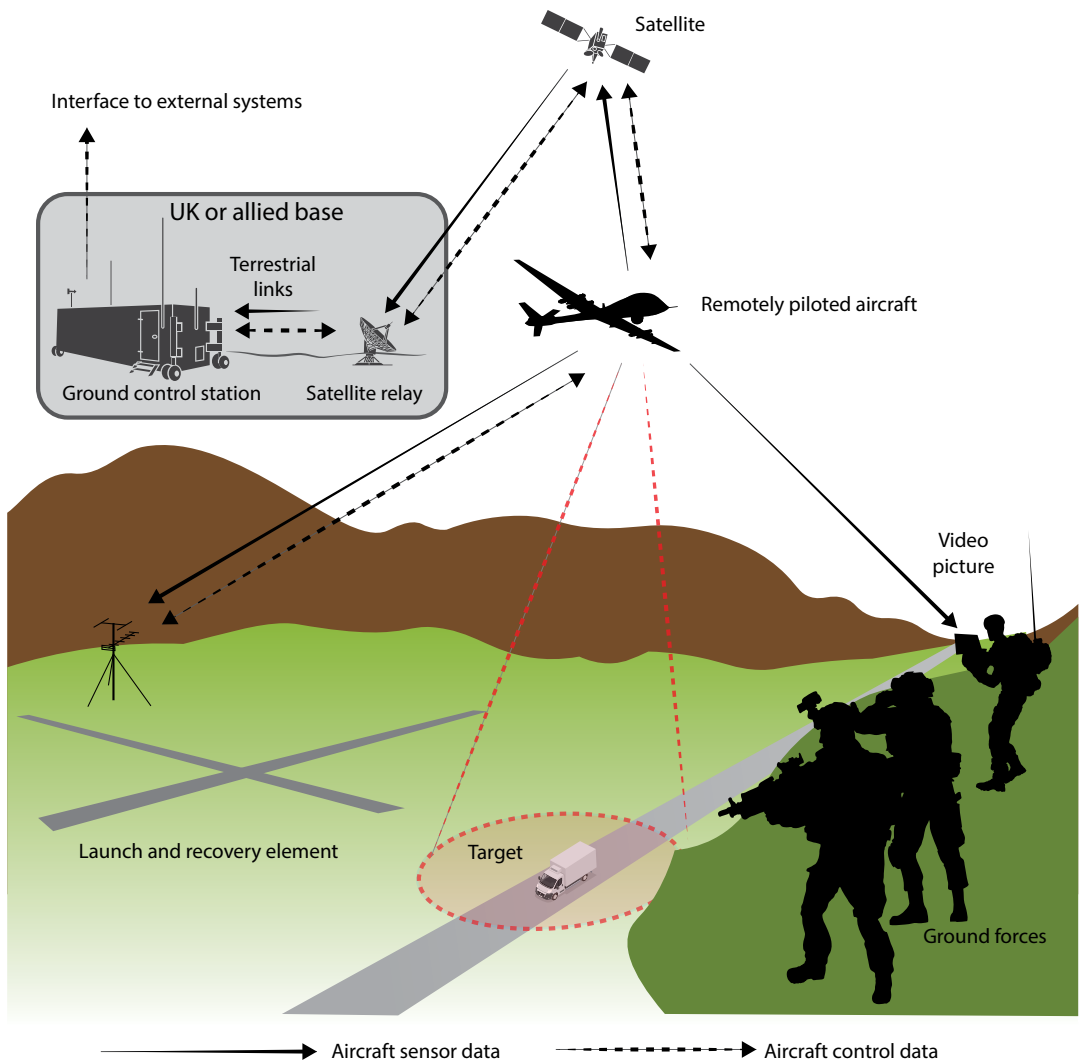


Figure 2.1 – Remote-split operations illustrate the complexity of the command and data links required for some remotely piloted aircraft system operations

²¹ As described in United States Joint Publication 3-30, *Command and Control of Joint Air Operations*, February 2014.

2.12. **Lost-link.** Most aircraft will have a lost-link procedure that determines what the aircraft will do following loss of the command or communication link.²² This might involve circling or climbing above the current position to re-establish the link, returning to the departure base or even flying in a safe direction or to a safe area so that the aircraft can be subsequently recovered. All armed remotely piloted aircraft have an assured lost-link procedure.

Section 3 – Intelligence, surveillance and reconnaissance terms

Terms related to intelligence, surveillance and reconnaissance tasks

2.13. An unmanned or remotely piloted aircraft is just one element of a much broader intelligence system. For that reason, staff officers should be familiar with the terminology and doctrine associated with intelligence, surveillance and reconnaissance (ISR) conducted within an intelligence cycle. The UK's intelligence and understanding doctrine is contained in JDP 2-00, *Understanding and Intelligence Support to Joint Operations*.²³ UK intelligence doctrine describes a coordinated cycle of the following activities: direct, collect, process and disseminate (known as DCPD). Within the context of ISR operations, NATO doctrine refines this to task, collect, process, exploit and disseminate (TCPED)²⁴ as shown in Figure 2.2. When TCPED activities are carried out in a coordinated process as part of an intelligence cycle, they are known as joint intelligence, surveillance and reconnaissance (JISR).²⁵ If any part of the JISR process is not resourced, a nation cannot achieve effective ISR operations.

2

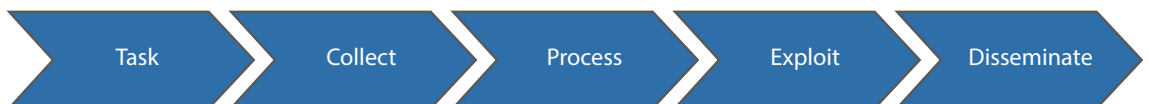


Figure 2.2 – The joint intelligence, surveillance and reconnaissance process

22 When talking to external agencies or the media, staff officers should be clear that lost-link does not mean the aircraft is completely uncontrolled as the aircraft will fly using its own sensors. Normally, the first response to lost-link will be for the aircraft to follow a flight path designed to help it re-establish the link connection.

23 Available at <https://www.gov.uk/government/publications/jdp-2-00-understanding-and-intelligence-support-to-joint-operations>

24 Also used by United States forces.

25 See Allied Joint Publication (AJP)-2.7, *Allied Joint Doctrine for Joint Intelligence, Surveillance and Reconnaissance*, Chapter 2.

2.14. The JISR provides the framework to synchronise and integrate intelligence and operational requirements into collection requirements. These are then further processed within the intelligence cycle to create the products required to meet the commander's objectives. This is described in Allied Joint Publication (AJP)-2.7, *Allied Joint Doctrine for Reconnaissance and Surveillance*.

2.15. **JISR asset versus joint intelligence, surveillance and reconnaissance capability.** A remotely piloted aircraft is an example of a JISR asset, which is defined as: an individual, detachment, unit, sensor, or platform, which can be tasked by respective authorities to achieve JISR results.²⁶ It is not until supporting activities are brought into play that it becomes a JISR capability. A JISR capability is defined as: an asset supported by organizations, personnel, collectors systems, supporting infrastructure, processing, exploitation and dissemination (PED) processes and procedures to achieve a designated JISR result.²⁷

Section 4 – Classification and regulation

UK classification and regulation methodology

2.16. In the UK, the MAA regulates the operation of military manned, unmanned and remotely piloted aircraft through a series of regulatory articles. Table 2.5 shows MAA classification categories together with their NATO equivalent.²⁸

Maximum take of weight	NATO class	Common taxonomy	Starting MAA category
<200g	Class I < 150kg	Nano	Class I(a)
200g – 20kg		Micro < 2kg	Class I(b)
		Mini 2 – 20kg	Class I(c)
20kg – 150kg		Small > 20kg	Class I(d)
>150kg	Class II 150kg – 600kg	Tactical > 150kg	Class II
>600kg	Class III >600kg	Male/Hale/Strike	Class III

Table 2.5 – NATO class, common taxonomy and starting MAA category

²⁶ AJP-2.7, Chapter 1, Section 1.4.

²⁷ *Ibid.*

²⁸ Taken from Regulatory Article 1600, *Remotely Piloted Air Systems*, Issue 4, page 12, dated 8 July 2016.

2.17. With the exception of Class I(a) aircraft, all unmanned and remotely piloted aircraft are placed on the military register under the authority of the person responsible for their military use. Unmanned aircraft in Class I(b) or I(c) are not individually registered; instead, each aircraft type is given a one-off collective military aircraft registration number. For Class I(d), II and III aircraft, each airframe is registered separately.²⁹ The MAA uses the term RPAS to describe all unmanned aircraft regardless of class or function. The MAA regulatory article that governs each aircraft type's class is Regulatory Article 1600, *Remotely Piloted Air Systems*, where the main criterion for classification is the potential risk to life that each platform presents to third parties during operation. The primary factor that affects this is aircraft maximum take-off weight (MTOW), which is then considered alongside other factors such as where and how the aircraft will be operated.

2.18. The MAA regulations require aviation duty holders³⁰ and accountable managers (military flying) to be appointed for each aircraft type on the register. Their duties include promulgating the criteria for the award, or recognition, of aircrew qualifications. This means that to fly, or operate, a remotely piloted aircraft, aircrew must have either an appropriate military flying badge or an approved remotely piloted air system pilot/operator qualification.³¹ In addition, they must hold a valid certificate of qualification on type. Questions arising over the operation, training or support of remotely piloted aircraft should be directed to the relevant duty holder. There are also different levels of duty holder – delivery, operating and senior. Individual posts rather than organisations hold these positions.

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29 Further detail in Regulatory Article 1120: *Military aircraft registration*.

30 Further detail on the duties of aviation duty holders is contained in Military Aviation Authority (MAA) Regulatory Article 1020, *Roles and responsibilities: aviation duty holder (ADH) and ADH-facing organisations*.

31 Further detail in Regulatory Article 2101, *Aircrew qualifications*.

Key points

- UK military users tend to call Class I and Class II platforms unmanned aircraft and Class III platforms remotely piloted aircraft.
- The MAA uses the term remotely piloted aircraft to describe all systems.
- Other countries and NATO have some different definitions to the UK.
- The terms 'automated' and 'autonomous' have specific meanings in the UK, which have legal, command and moral implications. Other countries and industry often have very different definitions or use the terms interchangeably.
- A new generic term, remote and automated systems, may be more useful in future.
- UAS and RPAS have associated specific terminology to describe them and how they are operated.
- UAS and RPAS must be resourced and operated as coherent task, collect, process, exploit and disseminate (TCPED) capabilities.
- UAS and RPAS 'collect', in isolation of effective, prioritised 'tasking' and the enabling PED, will not produce effective ISR results.
- In NATO doctrine, adopted by the UK, the TCPED cycle is known as the joint intelligence, surveillance, reconnaissance process or JISR.
- Unmanned and remotely piloted aircraft systems are classified by the UK Military Aviation Authority (MAA) into Class I (with four sub-classes a,b,c,d) and Class II and III.
- Classification is primarily determined by the aircraft's take-off weight, which is then considered alongside other factors such as where and how the aircraft will be operated.
- The NATO classification system has the same classes as the UK, but only the weight is used to determine classification.

Notes



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Task, employ, counter

This chapter describes how existing manned aircraft doctrine, particularly at the operational level, applies equally to unmanned aircraft. Specific UK unmanned doctrine is still developing and will continue to change as experience grows and the battlespace changes. This chapter pulls together best practice from UK operators, as well as recent ideas from NATO and the United States. It makes the key point that, while the collect activity is important, how it is tasked and how the collected data is subsequently exploited are just as important. It finishes by looking at how to counter the threat posed by an adversary's unmanned aircraft.

Section 1 – Introduction	25
Section 2 – UK doctrine and planning considerations . . .	27
Section 3 – Countering unmanned and remotely piloted aircraft systems	33

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...the **effects we create** with manned and unmanned aircraft are **essentially the same**, so remotely piloted air systems **change the way that we deliver air power** rather than its more fundamental outputs or capabilities.

//
Joint Doctrine Publication 0-30,
UK Air and Space Doctrine

Chapter 3 – Task, employ, counter

Section 1 – Introduction

3.1. **Existing doctrine, tactics, techniques and procedures.** Little published operational doctrine is specific to unmanned and remotely piloted aircraft systems. In general though, the principles of warfighting that apply to manned aircraft apply equally to unmanned and remotely piloted aircraft. Planning and execution of aircraft missions should, therefore, be in-line with the doctrinal guidance contained in Joint Doctrine Publication (JDP) 0-30, *UK Air and Space Doctrine* and other accepted doctrine.³²

3.2. **Doctrine development.** Small tactical systems, which are mainly used to support the activities of the units flying them, are operated under rules that keep them clear of other air users, removing the need for integration or coordination in most cases. Such systems are operated using locally agreed tactics, techniques and procedures rather than higher-level doctrine. More complex systems can either be tasked and employed using existing manned aircraft procedures, or bespoke procedures that support specific operations. Such arrangements tend to be captured in doctrine slowly, or may be relevant only to a specific operation and, therefore, not formalised.

3.3. **Operational-level doctrine.** At the operational level, Allied Joint Publication (AJP)–3.3, *Allied Joint Doctrine for Air and Space Operations* (Edition B) addressed unmanned aircraft doctrine for the first time within the North Atlantic Treaty Organization (NATO). Detail in Edition B is limited, but should increase in the next iteration, as NATO gains experience with its variant of the Global Hawk remotely piloted aircraft, procured as part of the NATO Alliance Ground Surveillance (AGS) programme.³³

3.4. **Tactical pocket guide.** The NATO Joint Capability Group on Unmanned Aerial Vehicles³⁴ has developed the *North Atlantic Treaty Organization (NATO) UAS*

32 For example, Allied Joint Publication (AJP)–3.3, *Allied Joint Doctrine for Air and Space Operations*, Edition B and Air Publication (AP) 3002, *Air and Space Warfare* (3rd Edition).

33 A brief overview of North Atlantic Treaty Organization (NATO) Alliance Ground Surveillance (AGS) is at Annex A.

34 Many NATO nations use the terms unmanned aerial vehicles and unmanned aircraft systems in preference to remotely piloted aircraft.

Tactical Pocket Guide shown at Figure 3.1 below. Despite its title, it will be useful to operational-level staff.³⁵

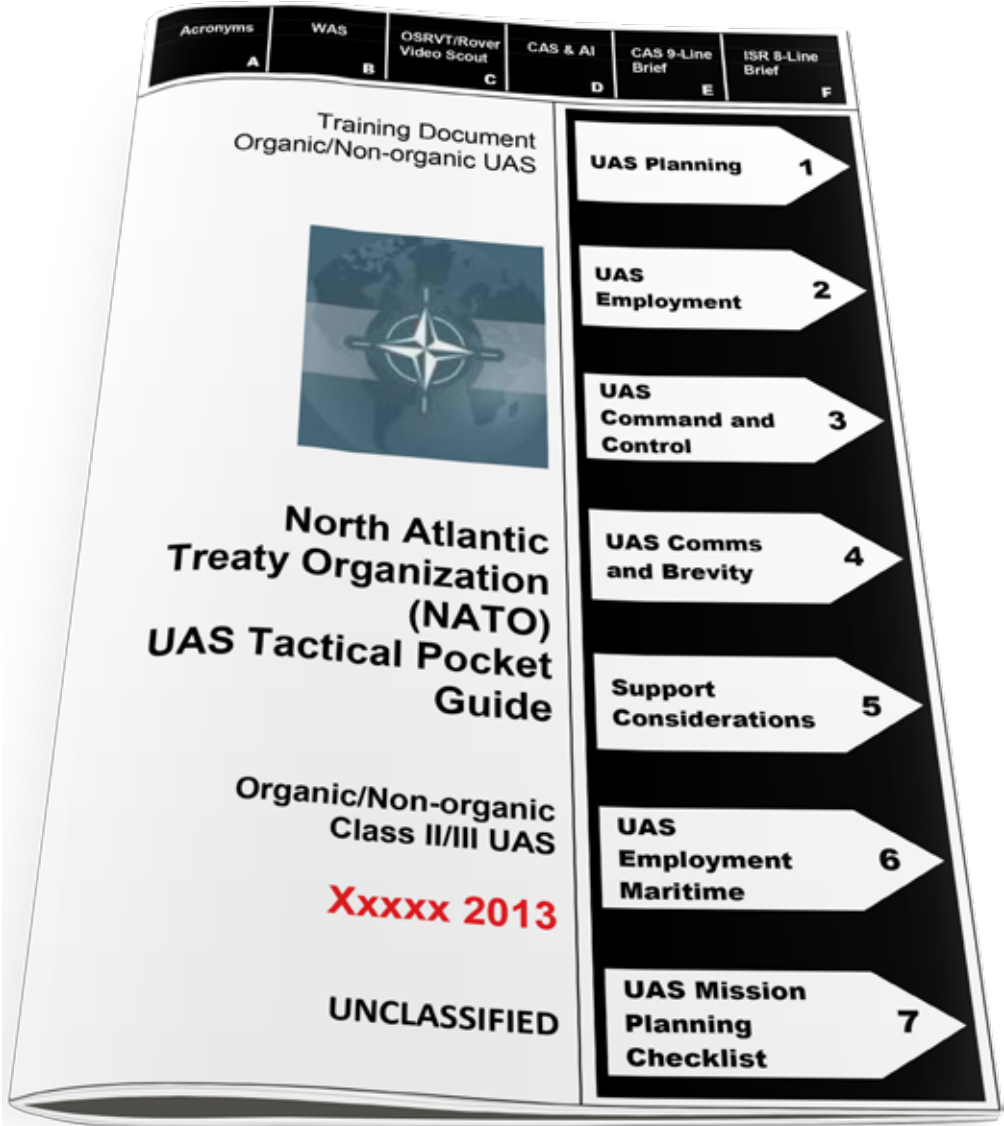


Figure 3.1 – Staff officers will find the *North Atlantic Treaty Organization (NATO) UAS Tactical Pocket Guide* useful

.....
³⁵ The *North Atlantic Treaty Organization (NATO) UAS Tactical Pocket Guide* is still in final draft and the publication date is unknown.

3.5. **Interoperability.** The key doctrinal issue for unmanned and remotely piloted aircraft systems is interoperability, the air platform should be considered as a part of a broader intelligence, surveillance and reconnaissance (ISR) effort that must be enabled by a sufficient level of interoperability to cue, and be cued by, other 'collect' and 'process, exploit and disseminate' (PED) capabilities. This collect capability itself forms but one element of a larger intelligence cycle that starts with an information or intelligence request³⁶ and ends with a joint intelligence, surveillance and reconnaissance (JISR) result.³⁷ Effective ISR operations will therefore only be possible if the capability can be interoperable with its complementary tasking, processing, exploitation and dissemination activities. Because there is no UK operational-level doctrine for ISR, this JDP includes relevant detail, because understanding of this area is central to exploiting unmanned and remotely piloted aircraft systems. At a national level, this doctrine will be developed further either in a future UK ISR doctrine publication, or as UK national elements to NATO's AJP-2.7, *Allied Joint Doctrine for Reconnaissance and Surveillance*.

Section 2 – UK doctrine and planning considerations

3.6. **Tasking mechanisms.** Black Hornet is tasked and employed at the lowest tactical level, within company and/or platoon formations. Desert Hawk III (DH3) is deployed with tactical command given to supported formations and units for use at that level. Although data from Class I aircraft is analysed and exploited locally in real time, headquarters staff should be aware which Class I assets are in theatre and where, and how, they are employed. Watchkeeper should not be tasked through the normal air tasking order (ATO) process. Recent experience has shown that the tactical employment of Watchkeeper requires flexibility and agility in the tasking process. The inherent flexibility in the ATO allows changes at all stages of the plan, refine and execute process. However, Watchkeeper operations may not be planned in the same timeframe, or to the same level of detail as traditional manned assets, but should be annotated on the ATO similar to other Land assigned assets (for example, aviation); their details should be appended to the ATO for other users awareness.

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 36 Once an information or intelligence request has been refined to its essential elements that can be individually answered, should information not already exist, the requirement can be developed into an intelligence, surveillance and reconnaissance (ISR) request. AJP-2.7 defines an ISR request (ISRR) as: a formal request from the operations staff to initiate ISR collection, with a specified capability or asset to support prioritized requirements for a specific mission. The ISRR is intended to deliver a Joint ISR result. Although this term appears in AJP-2.7, it is still awaiting NATO agreed status.

37 AJP-2.7 defines a JISR result as: the outcome of the JISR process disseminated to the requester in the requested format. Although this term appears in AJP-2.7, it is still awaiting NATO agreed status.

“ Data communication links for remotely piloted aircraft tend to be more complex and critical than for manned systems. ”

3.7. **Remotely piloted aircraft considerations.** As there are relatively few remotely piloted aircraft available, they are often in high demand and the Joint Force Commander and Joint Force Air Component Commander must make carefully considered judgements on apportionment and allocation decisions. These must aim to meet the needs of individual component commanders, while ensuring the Air Component Commander can also satisfy joint tasks across the joint operating area. Above all, commanders should be discouraged from requesting specific platforms; they should submit requests for information through the intelligence requirements management process. Where information is not already available, subsequent collection requirements should specify the desired ISR effect, rather than seeking an asset-based solution. The required support can often be provided by already planned manned missions.

3.8. **Intelligence/analysis issues.** Specialist advice from the operational intelligence (J2) community will be required to ensure that all components of the intelligence cycle are in place, or planned for, so that unmanned aircraft systems (UAS) and remotely piloted aircraft system (RPAS) capability can be fully exploited. This may include the need to burden share analysis between different platforms and, potentially, the wider intelligence community. Common to both communication and intelligence functions will be difficulties caused by a lack of common systems for aircraft control, sensor data processing and for intelligence and information exchange. The lack of common interfaces and ground control stations means that extracting raw or processed information from a system and making it available to other analysts or users can be impossible in a useful timescale. In the worst case, the only solution may be to manually export information from the originating system and import it into another system across an air gap. This is particularly likely to happen when transferring information between systems operating at different classification levels, or between different alliance members. If the exporting and importing systems are not in the same geographical location, delays will occur until procedures and systems are in place for rapid transfer. It is incumbent on all future unmanned and remotely piloted programmes that interoperability is designed in, and resourced, at the earliest stages of capability development.

3.9. **Communication link issues.** Data communication links for remotely piloted aircraft tend to be more complex and critical than for manned systems. Although remotely piloted aircraft are programmed to carry out a range of flight manoeuvres if control data is lost, including in *extremis* returning to base, they rely on a continuous stream of communications to successfully complete each mission. Therefore, communications security, specifically bandwidth protection, from both unintended friendly interference³⁸ and adversary action, is imperative.³⁹ In remote areas with

38 Adapted from United States Joint Publication 3-30, *Command and Control of Joint Air Operations*.

39 Different nations' equipment may use common frequencies for different purposes which may lead to mutual interference.

poor infrastructure, distributing collected data may be difficult and data use limited initially to local exploitation. If planning indicates a requirement for RPAS, then early input should be sought from communication and information systems (J6), or the environmental equivalent, to ensure provision is made for assured and adequate communication systems.

3.10. High-latitude operations. High latitude geographical areas may have limited satellite communications coverage or restricted bandwidth availability, making Class III aircraft operations difficult in these areas. Again, if planning for operations away from familiar areas, communications planning advice should be sought from a communication and information systems (J6) specialist.

3.11. Data volumes and analysis sharing. Aircraft sensors generate very large amounts of data and it is easy for one system's analysts to be overwhelmed while another's may be underused. Procedures aimed at pooling such resources, particularly when they are geographically separated, are immature and may need to be developed on a case-by-case basis. To optimise opportunities for greater PED burden sharing, future Class II and Class III programmes should ensure that all sensor data outputs are compliant with the relevant standardization agreement (STANAG).⁴⁰

3.12. Long duration flights and coordination. The ATO was designed around the operating cycle and flight times of manned aircraft. Very-long duration remotely piloted aircraft sorties may lead to coordination issues if they take place across several air planning cycles, including the ATO, which have not yet been agreed and promulgated. Long duration sorties are also more likely to service the requirements of several different tasking authorities, which will require additional planning, and coordination beyond the current ATO process. Clear procedures should be agreed for transferring authority or control. Full use should be made of the ability to add amplifying coordination and command instructions in the special instructions (SPINS) that accompany the ATO. These principles equally apply to the reconnaissance, surveillance and target acquisition (RSTA) annex, which provides tasking to RPAS sensor operators, and the PED tasking order for the assigned intelligence analysts.

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 40 A standardization agreement (STANAG) is defined as: a NATO standardization document that specifies the agreement of member nations to implement a standard, in whole or in part, with or without reservation, in order to meet an interoperability requirement. Allied Administrative Publication (AAP)-06, NATO Glossary of Terms and Definitions, 2016.

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 Aircraft sensors generate **very large amounts of data** and it is easy for one system's analysts to be **overwhelmed** while another's may be **underused**.

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3



Zephyr can fly for two weeks and will require extra coordination across air tasking order cycles and between tasking authorities

3.13. **Complex multi-unit operations and coordination.** In complex air scenarios the mix of friendly, adversary and neutral aircraft, both manned and unmanned, together with any mission constraints in place, will require the Joint Force Commander to strictly control air battlespace management to maximise each aircraft's freedom to operate. Adherence to the ATO, airspace control order (ACO) and SPINS by remotely piloted aircraft will be paramount in order to maintain safe operations. In such circumstances, the Air Component Commander may elect to augment theatre-based air system elements with additional planning personnel and training. In particular, either a remotely piloted aircraft subject matter expert or a liaison officer can facilitate the flow of information between operators and supported units, ensuring the supported units best understand the system's capabilities and how to get the most out of them. Additionally, sensitive tasks might require specialist political, legal and operating advice before and during a mission. Headquarters staff should consider how this advice would be coordinated so that it is consistent between the operators and the headquarters.

3.14. **Weather.** Weather can be a major factor in planning successful unmanned and remotely piloted aircraft missions. Planners may have to consider the weather at several geographically disparate locations, including satellite ground stations, the launch and recovery element,⁴¹ *en route* transit and the operating area (including potential diversion airfields and or lost-link recovery areas). In addition, space

.....
⁴¹ Detailed localised meteorological information for launch and recovery operations is vital.

weather, including sun activity, will affect high frequency, ultra-high frequency and satellite communication links as well as global positioning system availability and accuracy. Access to a reliable forecasting and weather distribution system should be established before operations commence.

3.15. Emergency planning. Detailed contingency planning is required to allow for lost-link events. It should include actions to be taken in the event of lost control links, lost sensor links and loss of Global Positioning System (GPS) derived position, navigation and timing signals, which may be required for operation of the aircraft. Pre-programmed recovery profiles must be safe and consistent with the guidance in the ACO and avoid other airspace users detailed in the ATO. De-confliction and safety are key priorities. Diversion requires careful thought as the diversion airfield must have compatible launch and recovery systems and, potentially, handle armed aircraft. If no suitable diversion airfields are available, consideration should be given to recovery areas controlled by friendly forces so that sensitive equipment or data can be recovered after landing.

3.16. Logistics considerations. For tactical UAS, the entire capability will deploy forward including pilots, sensor operators, image analysts and maintainers. For RPAS, with only maintenance personnel and a launch and recovery element in theatre, there will be a reduced forward logistics footprint. This has the advantage of reducing the load on in-theatre life-support systems allowing rapid deployment and redeployment. From a force protection perspective, keeping the main body of operators, analysts and other support personnel to the rear, exposes fewer personnel to enemy action. Overall though, the number of personnel required, rear and forward, is likely to be the same as, or greater than, that for manned systems.

3.17. Contractor support to operations. Unmanned and remotely piloted aircraft operations frequently use contractor support to operations (CSO). Common roles for contractors include:

- aircraft transportation;
- assembly and disassembly;
- maintenance and launch; and
- recovery duties.

Operational planners should liaise with logistics staff (J4) to determine the likely contractor footprint in theatre and also determine any constraints to their use. This may include contractors' legal status in theatre and the MOD's liability to them for issues such as force protection and providing medical support. They should also be aware that contractors may be directly participating in hostilities, not have combatant status and be required to have training in the Law of Armed Conflict.⁴²

⁴² Relevant UK doctrine for logistics support is contained in JDP 4-00, *Logistics for Joint Operations*.



Weather can be a **major factor in planning** successful unmanned and remotely piloted aircraft missions.





In-theatre civilian contractors unload a Reaper from its transit container

3.18. **Stress and trauma.** Personnel operating tactical UAS will be deployed forward and will conform, where possible, with promulgated harmony guidelines.⁴³ Stress and trauma issues will be dealt with in the same way as for the other forward deployed forces that they are working alongside. Rear-based RPAS crews operate somewhat differently to their manned equivalents, whose time on operations is also managed by harmony guidelines. RPAS crews' only break from operations during a three year tour might be leave or essential courses. Operating from a home base introduces unique stressors as crews balance work and family life. While United States Air Force studies show that unmanned crews seem to suffer no more stress-related incidents than manned crews,⁴⁴ supervisors should monitor personnel carefully for indications of stress and fatigue. Fatigue in itself can exacerbate most other stresses and must be mitigated wherever predictable; this includes the diligent setting of, and adherence to, shift work schedules. Supervisory chains should also ensure that normal Trauma Risk Management (TRiM) processes are in place.

.....
43 Harmony guidelines are intended to strike a balance between time at work and time at home.

44 See Chapter 4, paragraph 4.24.

Section 3 – Countering unmanned and remotely piloted aircraft systems

3.19. Potential adversaries are also developing highly capable unmanned aircraft in all classification categories. Both Class I and Class II friendly and enemy unmanned aircraft present a detection challenge to air defence systems, as many have a low radar cross-section and fly at relatively slow speeds. This makes them hard to detect on radar systems optimised to detect manned aircraft or missiles approaching at high speed. Since not all friendly unmanned aircraft carry identification, friend or foe capability, it is very important that they follow promulgated airspace control and air defence identification procedures to prevent friendly fire incidents. Class I and II aircraft can be difficult to detect visually; smaller systems are hard to see from a distance of more than around 400 metres, or less, depending on whether the background is clear sky, cloud or terrain. These systems can also be inaudible at a range of as little as 40 metres, depending on wind direction and ambient noise levels. Since their sensor range is potentially greater than either of these figures, it is possible for hostile aircraft to monitor friendly activity without being noticed by ground personnel. Raising awareness of the threat can be difficult, as ground troops will expect to hear the background noise of manned and unmanned aircraft, and to see them overhead, as a regular activity. The appearance of an adversary in these conditions is unlikely to be noticed as unusual.

3.20. **Passive and active countermeasures.** In most cases, the problem of enemy unmanned aircraft can be treated as a force protection issue similar to that posed by manned missions. If a threat assessment indicates it is necessary, standard tactical measures such as concealment and camouflage should be implemented. The UK has adopted AJP-3.14, *Allied Joint Doctrine for Force Protection* (with UK national elements). Force protection specialists will advise on available measures for any particular theatre of operations. Once detected, slow moving unmanned aircraft are relatively easy targets for ground and helicopter weapons; control measures should consider how to avoid restricting their ability to engage. Other active countermeasures are in their infancy, but Defence contractors are developing technical solutions that could deny data links or damage sensors used by unmanned and remotely piloted aircraft. Friendly, unmanned and remotely piloted aircraft can be used to increase situational awareness around an operating base or forward patrol and to identify potential enemy launch and operating positions.

Key points

- Class I and most Class II missions are conducted at the tactical level and tasked directly by the operating unit or supported commander.
- Some Class II and all Class III missions are best tasked using standard air tasking procedures.
- AJP-3.3, *Allied Joint Doctrine for Air and Space Operations* and the *North Atlantic Treaty Organization (NATO) UAS Tactical Pocket Guide* provide the NATO perspective, while Joint Publication 3-30, *Command and Control of Joint Air Operations* describes United States joint doctrine.
- Effective ISR operations will only be possible if the capability can be interoperable with its complementary tasking, processing, exploitation and dissemination activities.
- The task, process, exploit and disseminate elements of the JISR process are just as important as collect.
- Assured data links with sufficient bandwidth are essential to some Class II and all Class III missions.
- The use of UAS/RPAS subject matter experts or liaison officers will enable the capabilities of these systems to be understood more easily and result in more effective planning.
- Emergency procedures for Class II and III operations need careful thought.
- Weather can more adversely affect unmanned and remotely piloted missions than it will for manned missions.
- Force protection from hard-to-detect enemy UAS is paramount. This is achieved, initially, through passive countermeasures.
- All arms air defence can contribute to the destruction of enemy unmanned aircraft and control orders should maximise opportunities for this.

Notes



Legal framework, moral and ethical issues

This chapter provides an up-to-date UK military view of the legal framework under which such systems are operated. It describes the process for conducting a legal review of a weapons system and discusses how the UK opposes the development of armed autonomous systems. The second half of the chapter considers moral and ethical issues and counters some of the common arguments levelled against the use of unmanned aircraft.

Section 1 – Introduction	39
Section 2 – Legal framework.	40
Section 3 – Moral and ethical issues	45
Section 4 – Commonly presented arguments against the use of ‘drones’ and factual responses	47

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The need for transparency and compliance with the legal, moral and ethical principles that uphold the legitimacy of the employment of force **will guide and limit** the scope of future air and space operations.

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Joint Concept Note 3/12,
Future Air and Space Operating Concept

Chapter 4 – Legal framework, moral and ethical issues

Section 1 – Introduction

4.1. Despite best efforts by the Ministry of Defence (MOD) to explain why and how unmanned aircraft systems (UAS) are used, some, often vocal, opposition continues. Given that manned aircraft regularly conduct, without issue, all of the tasks undertaken by remotely piloted aircraft, this can seem illogical to the military user. Arguments against using unmanned and remotely piloted aircraft are centred on worries that systems will be misused, or used illegally. But such concerns are not unique to UAS, and the use of armed force - whether delivered by manned or unmanned systems – will always be consistent with the UK’s national and international legal rights and obligations.⁴⁵ However remotely piloted aircraft activities are, in fact, closely scrutinised, simply because of the way they work, with in-mission and often post-mission analysis of all activities undertaken. All missions, including attack, are conducted under exactly the same rules of engagement and legal authority as manned missions.

4.2. There is a further concern that weapon delivery from a distance would leave operators mentally divorced from the consequences of their actions. In reality, remotely piloted aircraft operators can be far more aware of the consequences of their actions than their manned equivalent, since they will often remain on task after any weapon is fired to conduct damage assessment and to continue their mission. Additionally, there is an argument that these aircraft make conflict unfair or too one-sided. This is hard to understand from a military viewpoint; a fundamental tenet of Joint Doctrine Publication (JDP) 0-01, *UK Defence Doctrine* is to seek an asymmetric advantage against any adversary. The concept of deliberately putting personnel in harm’s way may be indefensible to the Government, the public and our Armed Forces and their families when an equivalent effect could be achieved remotely.

4.3. All military and civilian personnel who work in areas associated with procuring, tasking, operating or supporting unmanned and remotely piloted aircraft systems should be aware of the legality of such systems. In particular, the legal basis for their use should be understood and considered and where appropriate their use

⁴⁵ Attorney General’s Speech at International Institute for Strategic Studies: The modern law of self-defence 11 January 2017 available at: www.gov.uk/government/uploads/system/uploads/attachment_data/file/583171/170111_Imminence_Speech_.pdf

explained and justified. The UK has a balanced and informed position regarding its employment of unmanned and remotely piloted aircraft systems.⁴⁶

Section 2 – Legal framework

4.4. Unmanned and remotely piloted aircraft systems are operated in accordance with the same domestic and international legal framework (including international humanitarian and international human rights law) that regulates conventional manned aircraft, other weapons and other means or methods of warfare.

4.5. **Weapon reviews.** Article 36 of Additional Protocol 1 to the Geneva Conventions requires states to determine whether new weapons, means and methods of warfare may be lawfully employed under international law. The UK ratified Additional Protocol 1 in 1998. Article 36 weapon reviews ensure that commanders, military personnel, politicians, the UK public and our allies can be assured that UK weapons are lawful. UK weapon reviews are undertaken by Service lawyers with operational experience on the staff of the Development, Concepts and Doctrine Centre (DCDC). The UK weapon review process has been published by DCDC.⁴⁷

4.6. **Means or method of warfare.** The expression ‘means or method of warfare’ includes weapons in the broader sense of the word but it also includes ways in which weapons are used and warfare conducted. For example, this may include data links and software used for processing target data in a platform such as a remotely piloted aircraft system. Whilst an unarmed remotely piloted aircraft may not be a weapon *per se*, because weapons systems are a connected and integral part of the platform, a weapon review would still be undertaken.

4.7. **Article 36 and new technologies.** Article 36 requires new technologies to be assessed against all relevant rules of international law. While the text of relevant treaties and rules of customary law are applied, DCDC lawyers also take into account secondary sources, including relevant International Committee of the Red Cross commentary, academic and scholarly publications and reports and investigations together with the UK’s own reservations, its own interpretations and records of negotiation.

4.8. **Foreign sourced equipment.** Where the UK seeks to acquire equipment that is already in service with the armed forces of another state, even though that state may

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46 Other states have different interpretations of international law and different practices for their armed forces and agencies.

47 Available at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/507319/20160308-UK_weapon_reviews.pdf.

have conducted its own weapon review, the UK still conducts its own comprehensive legal review.

4.9. Weapon review information requirements. Service lawyers undertaking weapon reviews of remotely piloted aircraft under Article 36 will need comprehensive information on what data is, or is not, presented to the mission crew, to understand the level of situational awareness that can be achieved together with full disclosure of information on the platform and its weapons such as the technical design specifications, statements of intended use and results of performance tests. Although a remotely piloted aircraft will respond to commands in the same way as any manned aircraft, any system-induced delays between control input, aircraft response and feedback to the pilot will need to be quantified and understood. A remotely piloted aircraft with an automated control system that is designed to reduce pilot workload, so that it is monitored⁴⁸ rather than being directly controlled, may well react rapidly to self-generated inputs, but the operator will be less aware of what the platform is doing on a real-time basis. These factors, and others, are all considered during a weapon review.

4.10. System of systems issues. Remotely piloted aircraft systems (RPAS) are even more reliant on a 'system of systems' approach than manned aircraft. Each element of the system that delivers the end capability has to work before, during and after a mission if the aircraft is to be controlled effectively. There are, therefore, many more safety critical elements relevant to the operation of a remotely piloted aircraft system.⁴⁹ For example, a communications link that was only mission critical for a manned system may well be a safety critical issue for a remotely piloted aircraft, as it may provide a legally acceptable fail-safe mechanism. This will be considered by Service lawyers when conducting a weapon review.

4.11. During operations. Where a weapon is to be used in an armed conflict, the Law of Armed Conflict (LOAC) requires that our UK Armed Forces operate in accordance with the principles of humanity, proportionality, military necessity and ensuring that only appropriate military targets are selected. The same strict rules of engagement that govern use of conventional military aircraft also apply to RPAS and targets must always be positively identified as legitimate military objectives. One advantage of RPAS is they can provide better, more accurate intelligence to facilitate targeted decision-making.

4.12. Pre-attack activity. Before an attack is cued by Watchkeeper or executed using a remotely piloted aircraft, targets must be verified as military objectives. All feasible

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48 So called on-the-loop rather than in-the-loop.

49 Although this view could be considered over-simplistic when comparisons are made with some modern aircraft that require inputs from ground-based planning and maintenance systems if they are to be effective.

There is inaccurate reporting and misleading debate about the meaning of automated and autonomous in relation to weapons systems.

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precautions must be taken to minimise civilian losses and attacks must not cause disproportionate incidental losses. This process is the same as for a manned aircraft.

4.13. **Additional information.** The official UK position on the LOAC is contained in Joint Service Publication (JSP) 383, *The Joint Service Manual of the Law of Armed Conflict*, and guidance on rules of engagement in JSP 398, *United Kingdom Manual of National Rules of Engagement*. JSP 900, *United Kingdom Joint Targeting Policy* should also be considered.

4.14. **Automation and autonomy.** There is inaccurate reporting and misleading debate about the meaning of **automated** and autonomous in relation to weapons systems. The UK military definitions are explained in Chapter 2; however, many alternatives will be found in the media, academic literature and industry. It is worth remembering that an automated weapon system is capable of carrying out complicated tasks but is incapable of complex decision-making.⁵⁰ The limitation in such complex decision-making is the development of appropriate algorithms. Notwithstanding such limitations, there is no doubt that automated weapons systems are becoming more complex and sophisticated. Current UK policy is that the operation of our weapons will always be under human control as an absolute guarantee of human oversight and authority and of accountability for weapon usage. This information has been put on record a number of times, both in parliament and international forums.⁵¹ Although a limited number of defensive systems can currently operate in automatic mode, there is always a person involved in setting the parameters of any such mode.

4.15. **Existing automated systems.** Some automated weapon systems such as Phalanx entered service in the 1980s. For such systems, the required timeliness of response can make compliance with the LOAC easier to demonstrate if it can be clearly shown that there is insufficient time for a human initiated response to counter incoming fire. For example, Phalanx and a development of it called Counter-Rocket, Artillery and Mortar (C-RAM) have automatic modes that are designed only to destroy incoming rockets in self-defence, using self-destruct rounds, within very limited parameters.

4.16. **Future development.** While some companies and research organisations are trying to develop autonomous systems, the UK's view is that increasing automation, not autonomy, is required to improve capability. Potential improved capabilities that could be made through increased automation include greater assistance to pilots and operators, and in-system survivability in non-permissive, contested and congested

50 Birmingham Policy Commission, *The Security Impact of Drones: Challenges and Opportunities for the UK*, page 66. Available at <http://www.birmingham.ac.uk/Documents/research/policycommission/remote-warfare/final-report-october-2014.pdf>

51 Overseas Conflict: Explosive Weapons, available at <http://www.theyworkforyou.com/wrans/?id=2014-02-24a.221.0&s=explosive+weapons>

battlespace. For example, a mission may require a remotely piloted aircraft to carry out surveillance or monitoring of a given area, looking for a particular target type, before reporting contacts to a supervisor when found. A human-authorized subsequent attack would be no different to that by a manned aircraft and would be fully compliant with the LOAC, provided the human believed that, based on the information available, the attack met LOAC requirements and extant rules of engagement.

4.17. Autonomous development. Fully autonomous weapons systems as we describe them (machines with the ability to understand higher-level intent, being capable of deciding a course of action without depending on human oversight and control) currently do not exist and are unlikely in the near future. Commanders and politicians are also highly unlikely to want fully autonomous systems as this could both impede and limit their decision-making both strategically and on the battlefield. The growing recognition that narratives and information are of increasing importance further underlines this reluctance to hand control of lethal force to autonomous systems – no matter how sophisticated they may become. The MOD, with the Foreign and Commonwealth Office (FCO), is currently engaged in discussions on autonomous weapons systems at the United Nations (UN) Convention on Certain Conventional Weapons. We believe that building improved understanding at the international level is important for an informed debate on the issues.

4.18. UK policy. It is clear from the information above that the UK does not possess armed autonomous aircraft systems and it has no intention to develop them. The UK Government's policy is clear that the operation of UK weapons will always be under human control as an absolute guarantee of human oversight, authority and accountability. Whilst weapon systems may operate in automatic modes there is always a person involved in setting appropriate parameters.⁵²

4.19. Accountability. Civil and criminal legal responsibility for any military activity may lie with the government, the chain of command and with the last person to issue the command authorising a specific activity. This assumes that a system's basic principles of operation have, as part of its release to service, already been shown to be lawful, but that the individual giving orders for use will ensure its continued lawful employment throughout any task. This process has an implicit assumption that a system will continue to behave in a predictable manner after commands are issued; clearly this becomes problematical as systems become more complex and operate for extended periods and the need for ongoing testing and assessment becomes important. In reality, predictability is likely to be inversely proportional to mission and environmental complexity. For long-endurance missions engaged in complex

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52 UK delegation statement to the Informal Meeting of Experts on Lethal Autonomous Weapons Systems, Geneva, April 2015.

//
...the UK
does not
possess armed
autonomous
aircraft
systems and it
has **no intention**
to develop
them.

//

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New military regulations were published in 2015 by the MAA, which recognised the **broad range of remotely piloted aircraft types** and the appropriate level of regulation for each of them.



scenarios, the authorised entity that holds legal responsibility will be required to exercise some level of supervision throughout. If so, this implies that any fielded system employing weapons will have to maintain a two-way data link⁵³ between the aircraft and its controlling authority.

4.20. **Current civilian and military guidance.** Current guidance for civil aviation is laid down in Civil Aviation Publication (CAP) 722, *Unmanned Aircraft System Operations in UK Airspace – Guidance*⁵⁴ and for military aviation in the Military Aviation Authority (MAA) Regulatory Article 1000 series. New military regulations were published in 2015 by the MAA, which recognised the broad range of remotely piloted aircraft types and the appropriate level of regulation for each of them. These can be expected to change over time to reflect technological developments, particularly as sense and avoid systems approach maturity. The MOD's capability areas and integrated project teams need to ensure that the specification for new systems remains flexible enough to accommodate such changes.

4.21. **Airworthiness standards.** New manned aircraft are being built to well-defined European Aviation Safety Agency airworthiness standards. This is to both protect the crew/passengers of the aircraft and minimise third-party risk to people on the ground in the event of an accident. As there are no requirements to protect crew or passengers, few remotely piloted aircraft to date⁵⁵ have been built to any defined airworthiness standard, mostly being operated under a limited clearance. Whilst this may explain the different build standards, it does not address the question of minimising third-party risks on the ground. If unmanned and remotely piloted aircraft systems are to be integrated into civil unsegregated airspace, then it must be proven that they are at least as safe as manned aircraft and that the third-party risk is mitigated as much as possible.

4.22. **Export of remotely piloted aircraft system technology.** Export licence applications for all remotely piloted aircraft systems are assessed by the Government on a case-by-case basis against the Consolidated EU and National Arms Export Licensing Criteria (the Consolidated Criteria). Included within this criteria is assessment against the requirement to comply with the UK's international commitments; principally in the case of remotely piloted aircraft systems, the Missile Technology Control Regime (MTCR); and the Wassenaar Arrangement.⁵⁶ Although missile focused, the MTCR limits the export of unmanned and remotely piloted

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53 Although this link may not need to be continuous.

54 Civil Aviation Publications are produced by the UK Civil Aviation Authority.

55 Watchkeeper is the first UK system to be fully airworthiness certified to the same standards as a military manned aircraft. In the United States and the North Atlantic Treaty Organization (NATO), Global Hawk is the only system so certified.

56 The Wassenaar Arrangement on Export Controls for Conventional Arms and Dual-Use Goods and Technologies is a multilateral export control regime with 41 participating states that includes the UK, United States, China and the Russian Federation.

aircraft systems and associated technologies and includes 'complete unmanned aerial vehicle systems (including cruise missile systems, UAVs and RPAS) capable of delivering at least a 500 kilogram payload⁵⁷ to a range of at least 300 kilometres.⁵⁸ On 5 October 2016, the British Foreign Secretary signed a *Joint Declaration for the Export and Subsequent Use of Armed or Strike-Enabled Unmanned Aerial Vehicles* along with 49 countries. The Declaration recognised that existing international regimes (International Humanitarian Law, Law of Armed Conflict, national export control mechanisms) also apply to armed drones. This Declaration will serve as the basis for discussions on a more detailed set of international standards for the export and subsequent use of armed or strike-enabled UAVs. The UK remains supportive and is keen to ensure that any additional regulation will be in keeping with the UK's own stringent export controls and international obligations, notably through the MTCR.

Section 3 – Moral and ethical issues

4.23. Moral and ethical issues would normally be discussed elsewhere, but what some pressure groups see as the contentious nature of unmanned and remotely piloted aircraft systems merits a brief discussion of some of the key arguments made against such systems. Public discussion of these issues can lead to heated and emotional arguments; unfortunately, many of these arguments are based on subjective opinions or 'what ifs' rather than objective facts. Part of the remit of this document is to increase transparency, and understanding of how remotely piloted aircraft are used and to help 'debunk' the mythology associated with this subject. If challenged, and it is appropriate to respond, personnel should be careful to give only factual comment and avoid discussing non-fact based opinions.

4.24. **Stress and trauma.** Care must be exercised in the use of unmanned aircraft such that they do not unnecessarily subject innocent populations over which they are flown to unease. Manned and unmanned operations normally take place from a deployed base, with the aircrew and operators maintaining intense flying rates for up to six months at a time. During this period, supervisors monitor them closely for fatigue and indications of stress. Normally, the subsequent recovery to home base will include a decompression period, followed by further monitoring for signs of stress or trauma. Harmony rules, developed through experience of the effects of

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57 The Missile Technology Control Regime (MTCR) defines payload as: the total mass that can be carried or delivered by the specified rocket system or unmanned aerial vehicle system that is not used to maintain flight. It includes munitions, countermeasures, recording equipment and recovery equipment (for example, parachutes) amongst others.

58 MTCR, *Equipment, Software and Technology Annex*, 11 June 2010, page 16.



Part of the remit of this document is to increase **transparency**, and **understanding** of how remotely piloted aircraft are used and to help 'debunk' the **mythology** associated with this subject.



operations, aim to limit the time that can be spent deployed *versus* time spent at the home base.

4.25. **Stress and trauma – remotely piloted aircraft crews.** Remotely piloted aircraft crews work differently. Operating from their home base, the only break from operations might be annual leave or courses. Concerns have been expressed in the past over both the cumulative effect of operations over a long period of time and the psychological effect of conducting, for example, attack operations in the morning followed by normal family life in the afternoon. Operators have acknowledged these issues – crews based at Creech Air Force Base, in the Nevada desert, United States, have spoken of the useful travel time between their base and housing area, which allows for reflection and readjustment. United States Air Force studies in 2013⁵⁹ found no difference in the rates of mental health issues between manned and unmanned aircraft pilots, believing that a rigorous selection process and ongoing medical monitoring, better equipped aircrew to cope with stress issues. While this juxtaposition of work and home life is not without precedent (UK aircrew have flown combat missions directly from their homebase to theatres of operation, for example, during the NATO air campaign in Kosovo), it is a distinct variation from the more common immersive experience on operations. A study of UK Armed Forces in 2017⁶⁰ indicated that the chain of command should closely monitor cumulative fatigue and the potential emotional impact in personnel who conduct this type of operation.

4.26. **Further reading.** Several studies have been carried out recently to examine a range of issues associated with unmanned and remotely piloted aircraft. Areas considered include:

- contribution to UK security;
- effectiveness of command;
- control and oversight methods; and
- issues relating to the use of remote and automated systems.

In October 2014, the Birmingham Policy Commission published its report entitled *The Security Impact of Drones: Challenges and Opportunities for the UK*.^{61,62} The report covers the issues discussed in this document, and more, and is recommended to

59 Medical Surveillance Monthly Report March 2013, *Challenges in monitoring the health of pilots engaged in telewarfare and Mental health diagnoses and counselling among pilots of remotely piloted aircraft in the United States Air Force*, available at <https://health.mil/Reference-Center>

60 Submission to the All Party Parliamentary Group in Drones, dated 12 June 2017.

61 Birmingham Policy Commission, *The Security Impact of Drones: Challenges and Opportunities for the UK*, available at <http://www.birmingham.ac.uk/Documents/research/policycommission/remotely-warfare/final-report-october-2014.pdf>

62 The phrase 'drone' (or even 'killer drone') has become a colloquial term that is used in the media, by opponents, pressure groups and the All Parliamentary Group. From a military perspective this is an out-dated term and incorrect in this context. Military drones, historically, followed a pre-programmed flight path and did not have a human in control.

those who wish to consider this subject in more detail. Similarly, the cross-party House of Commons Defence Committee recently studied remotely piloted aircraft and its report,⁶³ and the Government's subsequent response⁶⁴ add useful ideas and information to the public domain. These reports cover existing systems, while also considering evidence on future technologies and the strategic choices to be made in partnering with other nations. The House of Commons Library Briefing Paper, *Overview of military drones used by the UK Armed Forces*,⁶⁵ also provides further useful detail and analysis as does the House of Lords and House of Commons Joint Committee on Human Rights, *The Government policy on the use of drones for targeted killing*, Second Report of Session 2015-16.⁶⁶

Section 4 – Commonly presented arguments against the use of 'drones' and factual responses

4.27. This final section lists allegations that are commonly levelled against remotely piloted aircraft systems and some of the facts and study findings that refute them.

Argument 1 – Remotely piloted aircraft systems are used, or could be used, illegally. Civilian casualties are disproportionate.

4.28. **Response.** The first section of this chapter describes the legal review process undertaken to ensure that weapon systems used by the UK comply with the law. This process has been exposed to a weapons review forum held at DCDC and is well regarded. Often the legal review will help guide the development of a system from conception to delivery to ensure it complies with the law when it is in service. While any system could, potentially, be used illegally the UK employs a series of checks and balances to reduce the possibility of this happening.

- a. Pilots and operators are trained and certified according to MAA regulatory requirements and supervised by the command chain in the same way as manned aircraft.
- b. On operations, systems are operated under the same domestic law, Law of Armed Conflict and the same rules of engagement as manned aircraft.

63 *Remote Control: Remotely piloted air systems – current and future UK use*. Available at <http://www.publications.parliament.uk/pa/cm201314/cmselect/cmdfence/772/772.pdf>

64 *Remote Control: Remotely piloted air systems – current and future UK use: Government response to the committee's tenth report of Session 2013-14*. Available at <http://www.publications.parliament.uk/pa/cm201415/cmselect/cmdfence/611/611.pdf>

65 Available at www.parliament.uk/briefing-papers/SN06493.pdf

66 Available at <http://www.publications.parliament.uk/pa/jt201516/jtselect/jtrights/574/574.pdf>

- c. Because of the way that the aircraft is flown and the way that its sensor outputs displayed, the crew's actions are very visible to the command chain and it is common for headquarters staff to monitor live sensor feeds from the aircraft.
- d. During missions, operators have access to trained and experienced legal and policy advisors.

The United Nations appointed Special Rapporteur on the promotion and protection of human rights and fundamental freedoms while countering terrorism reported in September 2013.

"If used in strict compliance with the principles of international humanitarian law, remotely piloted aircraft are capable of reducing the risk of civilian casualties in armed conflict by significantly improving the situational awareness of military commanders."⁶⁷

Argument 2 – We have created a disconnected 'PlayStation' generation of operators who are divorced from the reality of their activities and kill indiscriminately.

4.29. **Response.** To address the matter of operators being divorced from the reality of their activities, the greater endurance of remotely piloted aircraft over their manned equivalent often gives remote crews more time to evaluate and understand a situation on the ground. Persistence over a target, combined with the lower speed of a remotely piloted aircraft when compared to a manned fast jet, means crews usually observe the target area for a significant period prior to, and following an engagement. This allows them to assess target validity and the likelihood of collateral damage.⁶⁸ Often, remotely piloted aircraft crews are tasked to conduct post-attack analysis of their own attacks, making them very aware of the consequences of their actions. They may also receive ground reports from local forces or special forces. Removing the physical and mental challenges of manned flight, particularly the high workload associated with single-seat aircraft, increases the operator's capacity to make informed decisions. Operators will have access to legal and political advisors during armed missions (including as part of a targeting board) to ensure that their activities comply with the LOAC, published rules of engagement and with policy and political intent. As part of its study into remotely piloted aircraft operations, the

67 United Nations, Report of the Special Rapporteur on the promotion and protection of human rights and fundamental freedoms while countering terrorism, A/68/389, 18 September 2013. Available at: <http://unispal.un.org>

68 Joint Doctrine Publication (JDP) 0-30, *UK Air and Space Doctrine*, paragraph 215.

House of Commons Defence Committee visited a Reaper squadron and noted the following.

“It was very clear ... that all were experienced professional personnel with a clear purpose and keen understanding of the rules of engagement which govern their operations. Despite being remote from the battlespace they exhibited a strong sense of connection to the life and death decisions they are sometimes required to take. This was in stark contrast to the image portrayed by some commentators of ‘drone’ pilots as video gaming ‘warrior geeks’. We record here our appreciation for the important role they continue to perform in Afghanistan.”⁶⁹

Argument 3 – Remotely piloted aircraft systems should be banned because their availability lowers the threshold for conflict.

4.30. **Response.** Any UK international military operation that uses armed force will require political authorisation. This authorisation is subject to parliamentary scrutiny and its associated checks and balances. The remotely piloted aircraft force elements are just a part of the inventory available to UK Armed Forces and operational planners will allocate the best asset for each task, manned or unmanned, land, maritime or air based, as appropriate. The Birmingham Policy Commission noted⁷⁰ the following.

“We do not consider that the threshold for the use of force will be lowered by the availability of RPA (remotely piloted aircraft) to UK Armed Forces, as long as Parliament plays its proper oversight function.”

On the other hand it also noted the following.

“Nor should it be forgotten that there are cases where the use of force to protect civilians is the right option, ethically speaking. And the availability of armed RPA (remotely piloted aircraft) makes it easier for governments in that circumstance to do the right thing.”

69 House of Commons Defence Committee, *Remote Control: Remotely Piloted Air Systems – current and future UK use*, page 21, paragraph 57. House of Commons report 772, 25 March 2014.

70 Birmingham Policy Commission Report, page 11.

Key points

- Every new UK weapon system is subject to a legal review before it enters service, to ensure compliance with the law.
- Foreign sourced new weapon systems are subject to an independent UK legal review before entering service.
- Remotely piloted aircraft are operated under the same political authority, command chain oversight, domestic and international law and rules of engagement as manned aircraft.
- Automation features, such as take-off, landing and route following are designed to reduce pilot workload not replace the pilot and to help make better and safer decisions.
- The UK does not own, and has no intention of developing, autonomous weapon systems as it wants commanders and politicians to act as the decision makers and to retain responsibility.
- Automated and autonomous mean different things to different organisations. Always check what is being described and use the UK terms as listed in publication.
- Export of certain remotely piloted aircraft technology is controlled by international agreements.
- Crews always seek to minimise civilian casualties in accordance with the Law of Armed Conflict; the United Nations Special Rapporteur noted that when used lawfully, commander's increased situational awareness reduces civilian casualties.
- Operators have 'a strong sense of connection to the life and death decisions they are sometimes required to take ... in stark contrast to the image portrayed by some pressure groups'.
- For the UK, there is no evidence that availability of remotely piloted aircraft has lowered the threshold for the use of force.

Annex A – UK and NATO unmanned and remotely piloted aircraft systems

Section 1 – General

A.1. The UK military currently operates five different unmanned and remotely piloted aircraft systems. The Royal Navy operates ScanEagle, the Army; Black Hornet, Desert Hawk III and Watchkeeper, while the Royal Air Force operates Reaper. Despite the media's 'killer drone' image, the first four systems are unarmed and carry out only intelligence, surveillance and reconnaissance (ISR) missions. Although Reaper is armed, it is tasked mostly on ISR missions. For example, during sorties conducted over Iraq between October 2014 and September 2015, Reaper expended weapons on only 20% of missions⁷¹ and fewer in total than manned UK missions during the same period.

A.2. As we covered in Chapter 2, the UK Military Aviation Authority (MAA) introduced a new classification system for unmanned aircraft in January 2015.⁷² Each type's classification is included in this publication. The allocated class determines the exact rules and regulations under which each type is operated and the level of supervision required.

A.3. Following the *National Security Strategy and Strategic Defence and Security Review 2015*, the UK Government announced that it intends to buy two more unmanned aircraft systems. Three Ministry of Defence (MOD) procured Zephyr high-altitude pseudo-satellites are currently being used to investigate a range of (ISR) capabilities for future use. Reaper will be replaced by a new platform, called Protector,⁷³ from around 2020.⁷⁴ These are briefly described in the future systems section, toward the end of this annex, but details may change as the programmes develop. QinetiQ

71 Taken from figures released into the public domain by the Ministry of Defence (MOD) following freedom of information requests.

72 More information at <https://www.gov.uk/government/collections/maa-regulatory-publications>

73 The programme to replace Reaper was originally called Scavenger, but this was recently changed to Protector.

74 France and the UK have committed to jointly develop an unmanned Future Combat Air System. The programme is expected to produce a prototype system that could serve as the basis for a platform that may provide intelligence, surveillance and reconnaissance, targeting and strike capabilities beyond 2030.

also provide Mirach 100 series target drone services to all three Services under the Combined Aerial Target Service contract, but these are not described here.

A.4. This annex concludes with a description of the new North Atlantic Treaty Organization (NATO) variant of Global Hawk. UK personnel posted to NATO positions may expect to encounter and work with this system and the UK will receive intelligence data from it, alongside other NATO nations.



A Watchkeeper remotely piloted air system on a test flight over the UK

Section 2 – UK unmanned aircraft systems

Black Hornet



British Army personnel launch a Black Hornet in Afghanistan

Operator and class	British Army – Class I(a)
Weight	16 grams
Speed	10 metres per second
Range	300 metres
Endurance	20 minutes
Operating altitude	n/a
Power source	Electric battery with a recharge time of 20 minutes
Sensors	Live video/still imagery
Launch/recovery method	Hand-launched
Weapons	Nil
Number of systems	160
Other users	Norway
Notes	<ul style="list-style-type: none"> • The system packs into a single ruggedized briefcase that contains two aircraft, a recharging system, a hand-held observation screen and controller • Wind speed can limit when it can be operated • Included for completeness, however, withdrawn from service in 2017.

Desert Hawk III



A 32 Regiment Royal Artillery operator launches a Desert Hawk III

Operator and class	British Army – Class I(c)
Weight	3.2 kilograms
Speed	32 knot cruise, 44 knot dash
Range	Up to 15 kilometres, but must be within line of sight of control station
Endurance	Up to 60 minutes
Operating altitude	Normally between 200 feet and 1,000 feet
Power source	Electric battery
Sensors	360 degree colour electro-optical camera or thermal imager
Launch/recovery method	Hand-launched
Weapons	Nil
Number of systems	34 (each system has between 8 and 10 aircraft)
Other users	United States
Notes	<ul style="list-style-type: none"> • Provides tactical video and still imagery with day/night capability • Maximum wind speed of 25 knot and must remain clear of rain and thunderstorms • Recovery and re-launch time of less than five minutes

Desert Hawk III considerations

A.5. Employed at the tactical level, Desert Hawk III should be used as part of an integrated ISR plan that includes all assets available. Given the small footprint of its sensors it is best tasked against specific areas of interest, unless other wide area sensors are available to provide cueing. Staff officers responsible for ISR matrix development should be aware of which units have attached Desert Hawk III capability and consider how its product is best processed, evaluated and disseminated when it collects information that has wider use. Desert Hawk III is particularly useful for:

- overwatch of patrols and route reconnaissance;
- force protection;
- deterrence and information activities;⁷⁵
- targeting;
- battle damage assessment; and
- monitoring of improvised explosive device related activities and explosive ordnance disposal.



A 32 Regiment Royal Artillery Desert Hawk III ground station

75 Information activities are described in Allied Joint Publication (AJP)-3.10, *Allied Joint Doctrine for Information Operations*.

ScanEagle



ScanEagle being used during operations in the Gulf

Operator and class	Royal Navy – Class I(d)
Weight	22 kilograms
Speed	60 knot cruise, 80 knot dash
Range	Up to 70 nautical miles from the controlling ship
Endurance	12 – 16 hours depending on the task
Operating altitude	Normal operating altitude 1,500 feet, but can operate up to 15,000 feet
Power source	Internal combustion engine
Sensors	Stabilised day/night optical sensor
Launch/recovery method	Pneumatic launcher, Skyhook recovery system
Weapons	Nil
Number of systems	Two task-lines provided on a service basis
Other users	Australia, Canada, Italy, Netherlands, Poland, Spain, United States and others
Notes	<ul style="list-style-type: none"> • Regularly deployed on Royal Navy Type 23 Frigates and Royal Fleet Auxiliary ships • 700X Naval Air Squadron personnel direct operations but the aircraft is flown and maintained by civilian contractors • Unfunded after 2017

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A ScanEagle is launched from the deck of HMS Kent – once its mission is complete, ScanEagle is recovered using a suspended cable

Watchkeeper



A Watchkeeper being manoeuvred in Afghanistan

Operator and class	British Army – Class II
Weight	450 kilogram take-off weight, includes up to 150 kilogram payload
Speed	65 knot cruise, 95 knot dash
Range	Up to 150 kilometres, but must be within line of sight of control station
Endurance	12 – 16 hours depending on the task
Operating altitude	Up to 15,000 feet
Power source	Internal combustion engine
Sensors	Electro-optical and infra-red high definition day/night video and still imagery, laser range-finder, designator and target marker, synthetic aperture radar, ground moving target indicator
Launch/recovery method	Semi-prepared strip, arrestor cable landing
Weapons	Nil
Number of systems	12 x Task Lines, 54 aircraft
Other users	N/A
Notes	<ul style="list-style-type: none"> • Maximum 15 knot crosswind and 25 knot headwind for launch • IFF transponder modes 3 and 3C • Automated radar based system for take-off and landing with INS/ GPS backup

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Watchkeeper considerations

A.6. The role of Watchkeeper is to provide tactical level imagery and intelligence to unit and formation commanders in the land environment. Its electro-optical and infrared sensors provide high definition still and video imagery with day and night capability and up to ten times optical zoom. The laser subsystem can range-find, designate or mark targets. The aircraft also has a synthetic aperture radar sensor that provides high quality strip map and spotlight images. In ground moving target indicator mode, commonly referred to as GMTI, the radar can track moving targets such as foot patrols and vehicles. The aircraft is operated by 47 Regiment Royal Artillery.



A Watchkeeper in its transportation container awaits assembly at Camp Bastion, Afghanistan

A.7. Watchkeeper is capable of producing large amounts of tactical and operational level information and intelligence. Joint staff officers in headquarters should understand how it is being tasked and how it fits into a wider ISR collection plan. Liaison may be required on tasking and support provided. Also, consider the need to establish, or arrange for, appropriate external processing, evaluation and dissemination capabilities.

MQ-9A Reaper



© PA

A Reaper pilot and sensor operator controlling an aircraft

Operator and Class	Royal Air Force – Class III
Weight	Maximum gross weight 4,760 kilograms
Speed	160 knot cruise, 250 knot dash, 120 knot loiter
Range	Approximately 5,900 kilometres depending on payload
Endurance	Around 18 hours depending on payload
Operating altitude	Normally 25,000 feet and below with a maximum of 50,000 feet
Power source	Turboprop
Sensors	Infrared sensor, colour/monochrome daylight camera and image intensifier, Lynx II synthetic aperture radar and ground moving target indicator, laser rangefinder and designator
Launch/recovery method	Runway take-off and landing
Weapons	Up to four Hellfire missiles and two 500 pound Paveway II guided bombs
Number of systems	10 aircraft
Other users	France, Italy, Netherlands, Spain, United States
Notes	<ul style="list-style-type: none"> Controlled via satellite datalink Separate colour nose camera to assist pilot with flight control

A

Reaper considerations

A.8. Reaper is primarily tasked in the intelligence and situational awareness role to provide real-time data to commanders and intelligence specialists at the tactical, operational and strategic levels. It provides an armed ISR capability equivalent to that of many manned aircraft. Reaper can also provide geographic location information to commanders on the ground or to other systems capable of employing global positioning system guided weapons. Tasking Reaper requires careful thought and input from subject matter experts is essential. Providing the Reaper intelligence product to external agencies and internally to processing, exploitation and dissemination analysts and experts is likely to be challenging, particularly if not accounted for in the early planning stages.

A.9. The Royal Air Force's ten MQ-9A Reaper are operated by No 13 Squadron, based at Royal Air Force Waddington, and No. 39 Squadron, based at Creech Air Force Base in the United States. A complete Reaper system includes four aircraft, two ground control stations, communications equipment and links, spares and personnel from all three Services supported by contractor ground crew.



A Royal Air Force Reaper being assembled by civilian contractors at Kandahar airfield, Afghanistan

Section 3 – Future UK unmanned aircraft systems

Zephyr



A Zephyr high altitude surveillance aircraft takes to the air

Operator and Class	To be confirmed, Class I(d)
Weight	60 kilograms, payload five kilograms
Speed	30 knot
Range	n/a
Endurance	Three months
Operating altitude	Over 70,000 feet
Power source	Solar electric
Sensors	To be confirmed
Launch/recovery method	Hand-launched (requires up to five people)
Weapons	Nil
Number of systems	Two, possibly three
Other users	N/A
Notes	<ul style="list-style-type: none"> • This type of unmanned aircraft is also known as a 'high-altitude pseudo-satellite' • Potential payloads include: high definition optical and infrared video and still imagery; mobile communications and automatic identification system • Still in development, details may change • Expected in service in 2017

A

Zephyr considerations

A.10. Zephyr was originally developed by QinetiQ in the UK, but is now part of the Airbus high-altitude pseudo-satellite (HAPS) programme. An earlier Zephyr 7 development aircraft holds the official endurance record of 14 days airborne and attained an altitude of over 70,000 feet.

A.11. While the payload is small, current technology allows capable video or communications equipment to be carried. As an example, during test flights of Zephyr 7 above 65,000 feet, high-definition video with a ground resolution of 50 centimetres was downlinked in real-time.⁷⁶ Because the aircraft operates in the stratosphere, it is largely unaffected by weather and can be 'parked' for prolonged periods over a fixed position on the Earth's surface to provide satellite-like services. This is why such systems are often referred to as 'pseudo-satellites'. Weather would, however, potentially limit where and when the aircraft could be launched and recovered and cloud cover below the aircraft would affect the amount and type of imagery that could be collected.

A.12. Because of the time taken to deploy and recover the aircraft (one day to climb to 70,000 feet) and its slow transit speed, the aircraft is likely to be tasked in support of specific operations or specific geographical areas. It will take some time to achieve a new orbit if repositioning is required; as an example, relocating by 700 miles would take a day. As it is solar powered, year round operations should be achievable up to latitudes of 40 degrees north and south, with operating periods restricted increasingly to just the summer months as operations move toward the poles. By operating above the upper limit of Class A airspace, which extends up to 60,000 feet, de-confliction with normal air traffic is greatly eased, although national restrictions will still limit where the aircraft can operate during climb and descent and for overflight of third-party nations. Several civilian technology companies are considering using similar systems that aim to provide broadband services to remote locations that are not connected to the fixed communications infrastructure.

Protector

A.13. In April 2016, the MOD announced that it had selected the General Atomics Aeronautical Systems Certifiable Predator B aircraft for its Protector programme. More than 20 Protector will replace the current Reaper fleet approximately 2020. Details may change as the programme matures, but in comparison with Reaper, the Protector airframe is expected to have an increased wingspan and greater endurance, with a slightly lower flying speed. It is expected to have a certified sense and avoid system to allow it to fly in UK and European airspace, alongside general aviation.

⁷⁶ More information is available at <http://www.bbc.co.uk/news/science-environment-35478489>

Section 4 – NATO

NATO RQ-4B Global Hawk



© Northrop Grumman Corporation

NATO AGS Global Hawk first flew in December 2015

Operator and Class	North Atlantic Treaty Organization – Class III
Weight	Maximum take-off weight 14,628 kilograms
Speed	310 knot cruise, 340 knot dash
Range	12,000 nautical miles
Endurance	Up to 32 hours
Operating altitude	Up to 60,000 feet
Power source	Turbofan
Sensors	Optical and infrared sensors, ground moving target indicator, synthetic aperture radar with air track information and high resolution ground mapping
Launch/recovery method	Runway take-off and landing
Weapons	Nil
Number of systems	Five
Other users	Australia, Japan, South Korea, United States (different variants)
Notes	<ul style="list-style-type: none"> Controlled via satellite datalink Known as NATO Alliance Ground Surveillance System

NATO RQ-4B Global Hawk considerations

A.14. Fifteen members of the North Atlantic Treaty Organization (NATO) are procuring the Alliance Ground Surveillance System (AGS), known as NATO AGS. It consists of five RQ-4B Global Hawk remotely piloted aircraft and associated ground command and control stations. NATO will operate and maintain the system on behalf of all 28 members. Although the UK is not one of the procuring nations, its contribution in kind, information from UK operated ISR aircraft, means that it will have access to the capability. The first flight took place in December 2015 and the system in-service date is expected in the 2017 to 2018 timeframe.⁷⁷

A.15. The main operating base for AGS will be at Sigonella Air Base, in Italy, which will serve a dual purpose as a NATO joint intelligence, surveillance and reconnaissance (JISR) deployment base and data exploitation and training centre. UK staff officers working in NATO headquarters or deployed on NATO operations should expect to encounter, and hence should be familiar with NATO AGS.

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⁷⁷ More information is available at http://www.nato.int/cps/sl/natohq/topics_48892.htm.

Notes

A

Annex B – Unmanned aircraft strengths, weaknesses, opportunities and threats analysis

Strengths	Weaknesses
<ul style="list-style-type: none"> • Useful for dull, dirty, dangerous tasks. • Class I and II can support tactical activity where manned assets would not be available. • Class I and II operations cheaper than manned. • Class III (and potentially II) removes risk to manned aircrew. • Class III operations reduce theatre footprint compared to manned. • Persistence gives improved situational understanding. • Class III operation from home base reduces harmony issues. • Can be hard to detect and counter, Class I and II in particular. • Class III good with time-sensitive targets. 	<ul style="list-style-type: none"> • Vulnerability to data link attacks. • Weak in contested airspace. • Smaller systems constrained by weather. • Slow speeds may limit the extent of re-tasking. • Requirement for new systems to be built to airworthy standards driving up cost. • Overall manpower footprint can be higher. • Sense and avoid still not available, limiting operations to segregated airspace. • Public opposition (though gaining wider acceptance through increased exposure). • Lack of long air carriage life weapons.
Opportunities	Threats
<ul style="list-style-type: none"> • Conceptual ideas still hard to translate into practice. • Pseudo-satellite capabilities could be a game changer. • Civil use. • Make use of commercial solutions for non-lethal purposes. • Cross governmental cooperation, particularly once certified sense and avoid arrives. • 3D printing solutions (quick, cheap, throw away). • Reduce opposition through transparency and education. 	<ul style="list-style-type: none"> • 3D printing solutions (cheap, easy mass attack). • Easy availability to adversaries. • Class III unaffordable as airworthiness standards drive up costs. • Cyber attack. • Competition for spectrum and bandwidth. • Still uncertainty over manned/unmanned mix. • Difficulty with long-term planning. • Increasing complexity removes flexibility in development.

B

Notes

Lexicon

Part 1 – Acronyms and abbreviations

AAP	Allied administrative publication
ACO	airspace control order
ADH	aviation duty holder
AGS	Alliance Ground Surveillance programme
AJP	Allied joint publication
ATO	air tasking order
DCDC	Development, Concepts and Doctrine Centre
DCPD	direct, collect, process and disseminate
DLoD	Defence Lines of Development
FCO	Foreign and Commonwealth Office
ISR	intelligence, surveillance and reconnaissance
ISTAR	intelligence, surveillance, targeting and reconnaissance
JDN	joint doctrine note
JDP	joint doctrine publication
JISR	joint intelligence, surveillance and reconnaissance
MAA	Military Aviation Authority
MOD	Ministry of Defence
MTOW	maximum take-off weight
PED	processing, exploitation and dissemination
PTO	PED tasking order
RAF	Royal Air Force
RPA	remotely piloted aircraft
RPAS	remotely piloted aircraft system
RSTA	reconnaissance, surveillance and target acquisition annex
SPINS	special instructions
STANAG	standardization agreement (NATO)

TCPED	task, collect, process, exploit and disseminate
TRiM	trauma risk management
UAS	unmanned aircraft system
UN	United Nations

Part 2 – Terms and definitions

This section is divided into three areas. First, we list terms and their descriptions used as reference for this publication only. We then list proposed new definitions that will be added to the UK Terminology Database. We finish by listing endorsed terms and their definitions (source in brackets) that may be helpful to the reader.

A fuller reference to extant terminology is provided by Allied Administrative Publication (AAP)-06, *NATO Glossary of Terms and Definitions* and Joint Doctrine Publication (JDP) 0-01.1, *The UK Supplement to the NATO Terminology Database*.

Terms used for reference in this publication only

lost-link

Temporary or permanent loss of the command and control link between a control station and aircraft.

remote-split operations

Unmanned aircraft operations where there is geographical separation of the launch and recovery crew from the mission crew who, in turn, employ the aircraft at a location other than where the aircraft is based.

sense and avoid

A sense and avoid system has one or more sensors that can detect other airspace users or hazards and take appropriate action to maintain safe separation.

segregated airspace

Airspace that is specifically designated for remotely piloted aircraft system operation. (Military Aviation Authority Regulatory Article 2320).

visual line of sight operation

An operation in which the remote pilot or remotely piloted aircraft observer maintains direct unaided visual contact with the remotely piloted aircraft. (Civil Aviation Publication (CAP) 722, *Unmanned Aircraft System Operations in UK Airspace – Guidance*, March 2015). Note: Visual line of sight is normally taken to be within 500 metres horizontally and 400 feet vertically of the remote pilot or observer.

New definitions

remote and automated system

A system comprising the platform, control and sensor equipment, the supporting network, information-processing system and associated personnel where the platform may be operated remotely and/or have automated functionality.

(JDP 0-30.2)

remote and automated air system

remote and automated system designed to operate in the air environment.

(JDP 0-30.2)

Endorsed definitions

automated system

In the unmanned aircraft context, an automated or automatic system is one that, in response to inputs from one or more sensors, is programmed to logically follow a pre-defined set of rules in order to provide an outcome. Knowing the set of rules under which it is operating means that its output is predictable. (JDP 0-01.1)

autonomous system

An autonomous system is capable of understanding higher level intent and direction. From this understanding and its perception of its environment, such a system is able to take appropriate action to bring about a desired state. It is capable of deciding a course of action, from a number of alternatives, without depending on human oversight and control, although these may still be present. Although the overall activity of an autonomous unmanned aircraft will be predictable, individual actions may not be. (JDP 0-01.1)

intelligence

The product resulting from the directed collection and processing of information regarding the environment and the capabilities and intentions of actors, in order to identify threats and offer opportunities for exploitation by decision-makers.

(AAP-06)

joint force commander

A general term applied to a commander authorised to exercise operational command or control over a joint force. (JDP 0-01.1)

logistic footprint

The impact of logistic activity in the joint operations area. It identifies the utilisation of real estate and the consumption of resources, including manpower, equipment, infrastructure, supplies and Host-nation Support that logistic activity in support of an operation will require. (JDP 4-00 4th Edition)

Note: It includes those resources that are deployed along lines of communication, where they are required for logistic activity and any liability for additional force protection assets.

reconnaissance

A mission undertaken to obtain, by visual observation or other detection methods, information about the activities and resources of an enemy or potential enemy, or to secure data concerning the meteorological, hydrographic, or geographic characteristics of a particular area. (AAP-06)

remotely piloted aircraft

A remotely piloted aircraft is defined as an aircraft that, while it does not carry a human operator, is flown remotely by a pilot, is normally recoverable, and can carry a lethal or non-lethal payload. (JDP 0-01.1)

remotely piloted aircraft system

A remotely piloted aircraft system is the sum of the components required to deliver the overall capability and includes the pilot, sensor operators (if applicable), remotely piloted aircraft, ground control station, associated manpower and support systems, satellite communication links and data links. (JDP 0-01.1)

surveillance

The systematic observation of aerospace, surface or sub-surface areas, places, persons or things, by visual, aural, electronic, photographic or other means. (AAP-06)

targeting

The process of selecting and prioritizing targets and matching the appropriate response to them, taking into account operational requirements and capabilities. (AAP-06)

unmanned aircraft

An unmanned aircraft is an aircraft that does not carry a human operator, is operated remotely using varying levels of automated functions, is normally recoverable, and can carry a lethal or nonlethal payload. (JDP 0-01.1)

unmanned aircraft system

An unmanned aircraft system is a system, whose components include the unmanned aircraft and all equipment, network and personnel necessary to control the unmanned aircraft. (JDP 0-01.1)



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