

ANSP Considerations for Unmanned Aircraft Systems (UAS) Operations

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Contents

Acknowledgements	page 2
Foreword	page 4
1 Introduction to Modes of UAS Operations	page 5
1.1 UAS Data Link Configurations	page 5
1.2 Current UAS Operations approved by States.....	page 7
2 Accommodating UAS into ATM	page 8
2.1 General UAS Requirements from an ANSP Perspective	page 8
2.2 Separation.....	page 8
2.3 Aerodrome and Terminal UAS Operations.....	page 8
2.4 Special Handling.....	page 8
2.4.1 ATC Phraseology.....	page 9
2.4.2 C2 Data Link.....	page 9
2.4.3 In-Flight Characteristics.....	page 9
2.4.4 Flight Data Processing System (FDPS)	page 9
2.4.5 Alerting Services	page 10
2.4.6 IFR Procedures	page 10
2.4.7 Detect and Avoid, Collision Avoidance	page 10
2.5 Contingency and Emergency Operation Procedures	page 10
2.5.1 Loss of Radio Communication	page 10
2.5.2 Loss of C2 Link.....	page 11
2.5.3 Example of a Typical Lost Link Procedure.....	page 11
2.5.4 Flight Termination Procedures	page 13
3 Small UAS	page 14
3.1 Commercial vs Recreational Operations.....	page 14
3.2 VLOS vs BVLOS Operations	page 14
3.3 Uncontrolled vs Controlled Airspace	page 14
3.4 Regulatory Enforcement	page 14
3.5 NOTAMS.....	page 15
4 UAS Traffic Management (UTM)	page 16
5 Airspace above Controlled Airspace	page 17
6 Operations and Standards Guidance	page 18
6.1 Certification of RPAS (air ground), Airworthiness.....	page 18
6.2 Personnel/Pilot Licensing and Training.....	page 18
7 Future Considerations	page 19
8 UAS Training for ATM Personnel	page 20
9 Explanation of Terms	page 21
10 Abbreviations	page 23

Foreword

Background

Demand for unmanned aircraft systems (UAS) operations is on the rise and regulators around the world are beginning to permit small scale, local operations while researching opportunities to expand use in both uncontrolled and controlled airspace. The challenge for the air traffic management (ATM) industry is how to safely accommodate these new entrants to airspace and continue efficient and effective operations.

ICAO considers any aircraft flown without a pilot on board as an unmanned aircraft (UA) and all the components that enable that operation as part of a UAS. UAS come in a variety of shapes and sizes, and fulfil many diverse capabilities. Ranging in weight from a few grams to several tonnes, UAS are operating at altitudes from near the earth's surface to the edge of space. Some UAS fly at slow speeds, while others are capable of very high speed, and some can remain airborne for several days.

Drones, or small UAS (sUAS), are considered separately from those capable of flight in controlled airspace on an instrument flight rules (IFR) flight plan. Currently there is an increase in civil operations of smaller UAS, and day-to-day presence of UAS operating within, or in the vicinity of, controlled airspace may pose challenges for ANSPs to ensure separation of UAS from both manned and other unmanned aircraft in non-segregated airspace. UAS operations at low altitudes near airports are creating safety concerns from local air traffic control (ATC) providers. Speed, manoeuvrability, climb rate, performance characteristics, and avionics system equipment may differ substantially from conventional aircraft and may necessitate changes in standards and procedures governing ATM in the future.

Aircraft are referred to as remotely piloted aircraft systems (RPAS) when they are capable of interacting with ANSPs in a manner similar to traditional manned aircraft (i.e. on an IFR flight plan). RPAS are certified by a regulator and flown with a licensed pilot who is directly involved with flight operations. To date, RPAS are primarily used to support military and national security operations. Recent experiences of RPAS operations and their interaction with the ATM system indicate that currently, RPAS are unable to comply with many routine ATM procedures. This has not prevented RPAS operations, but has limited their integration. RPAS operators are now seeking greater freedom of access to airspace, thus increasingly their interaction with the wider ATM system.

ICAO is developing standards and guidance for the various unique operational needs of UAS, to include sUAS or drones and larger, more complex certified systems, such as RPAS. International regulations and standards now require that any new system, procedure, or operation that has an impact on the safety of ATM operations shall be subject to a risk assessment and mitigation process to support its safe introduction and operation.

The goal of safely integrating RPAS seamlessly into the ATM system with other airspace users is subject to standard Safety Management System (SMS) principles. UAS are classified as 'aircraft' and ultimately should comply with all the rules established for flying, certifying, and equipping aircraft. A key factor to safely integrating UAS in non-segregated airspace is their ability to act and respond in manner and there shall always be a pilot responsible for the UAS operation.

Objectives

The objectives of this document are to:

- Raise awareness of UAS operations to ANSPs
- Inform ANSPs how UAS can be accommodated safely into Member State ATM systems to date
- Identify some of the issues that need to be addressed to safely achieve greater UAS integration in the future
- Provide information to assist in developing UAS training materials for ANSPs. (Note – CANSO members can find additional guidance on the CANSO website at www.canso.org)

Scope

The audience for this document includes ATM and ANSP policy makers and management and staff, including those specifically responsible for ATM procedures.

It is recognised that technical solutions (i.e. detect and avoid) and future concepts (i.e. UAS Traffic Management (UTM)) must be addressed. Some of the challenges identified in this document are under consideration or development, and this document addresses ANSP considerations related to those activities.

This document is considered to be a living document and will evolve over time to incorporate updates to the UAS operational environment as they mature.

1

Introduction to Modes of UAS Operations

1.1. UAS Data Link Configurations

A UAS comprises a set of configurable elements including a UA, its associated remote pilot station(s) (RPS), the required command and control (C2) links, and any other system elements that may be required during flight operation.

The remote pilot controls the UA from a RPS using a C2 link. The UA can be flown within visual line of sight (VLOS) of the remote pilot (Figure 1), direct radio line of sight (RLOS) between the UA and the RPS (Figure 2), or beyond line of sight (BLOS) using satellite or other relays (Figure 3). Data links to the UA are used for C2 and may be required for communications with ATC. The C2 link is the critical mechanism for interaction between the UA and remote pilot, and requires a high degree of reliability to ensure seamless operation in non-segregated airspace.

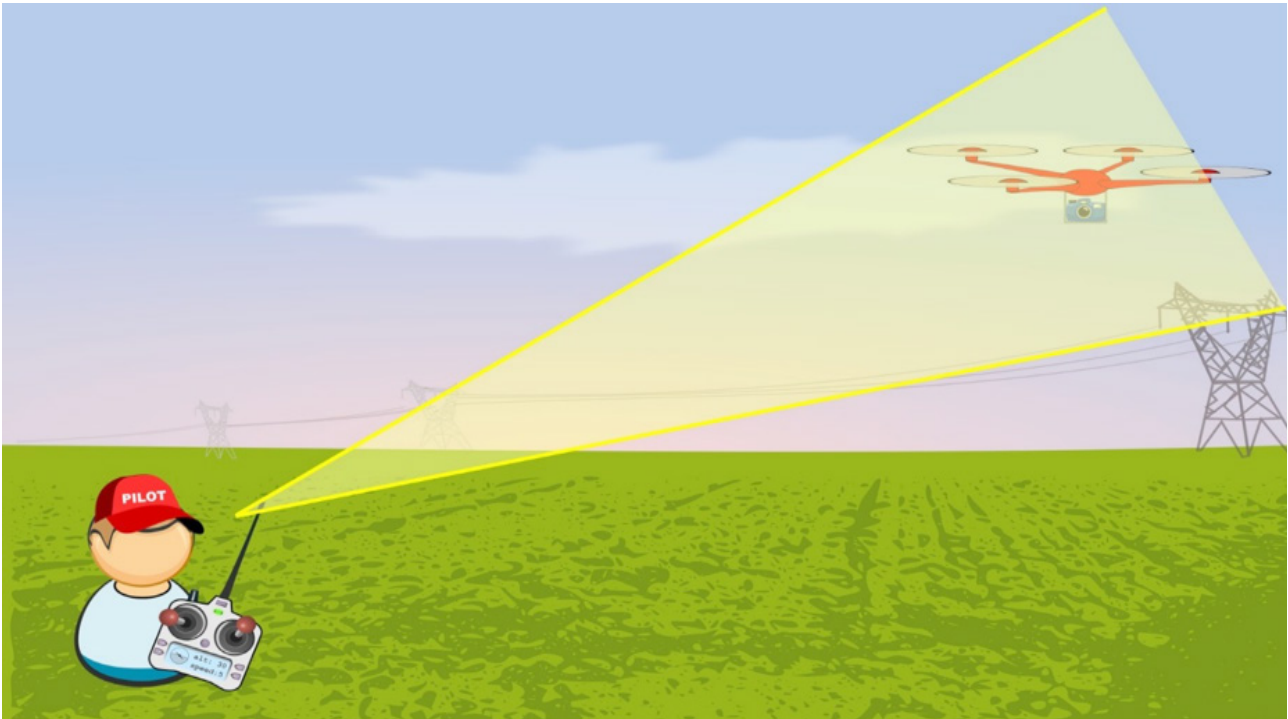


Figure 1. Visual Line of Sight Operation

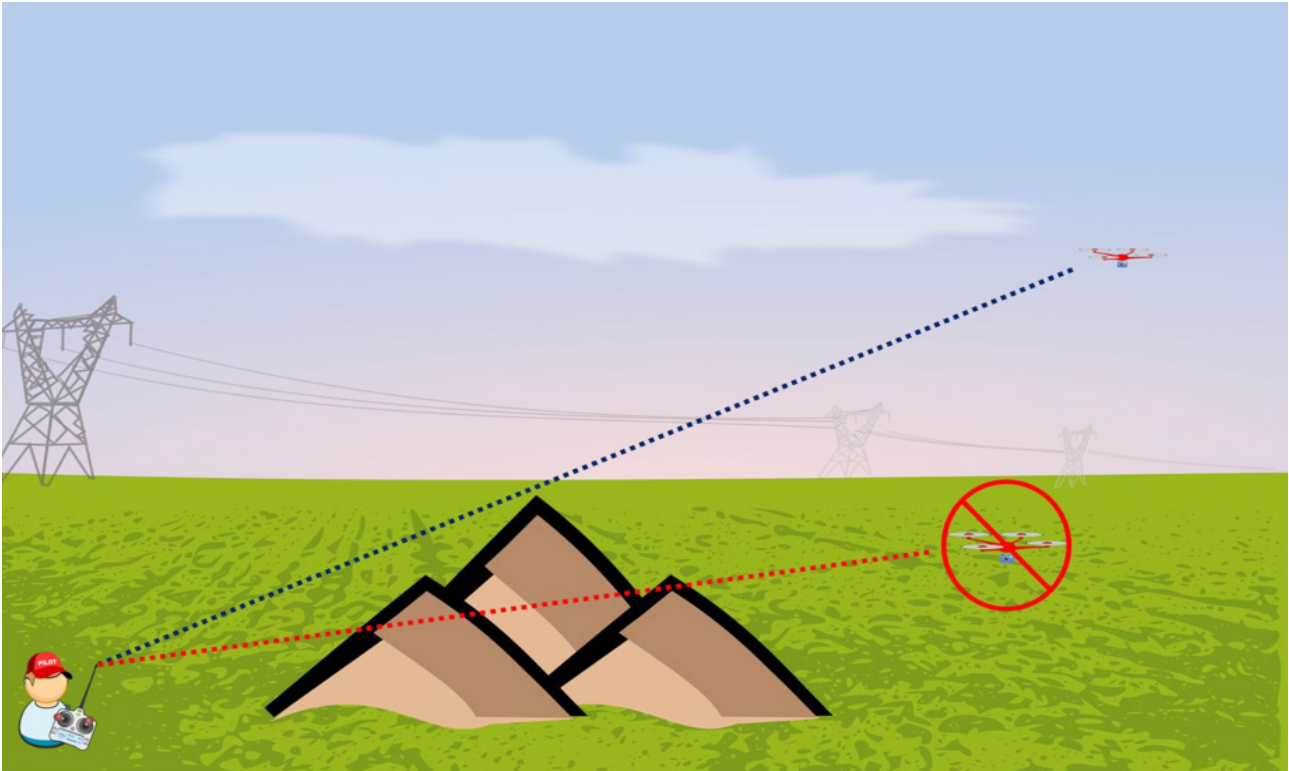
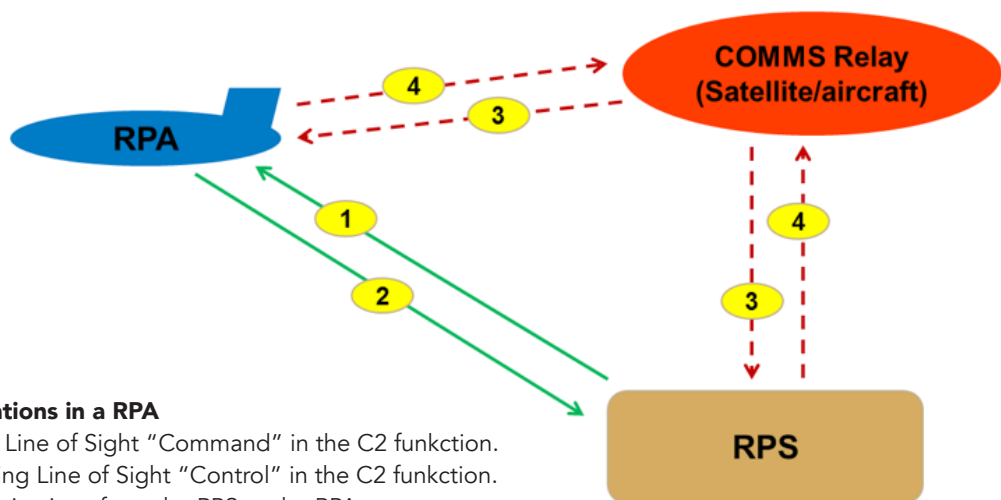


Figure 2. Radio Line of Sight Operation

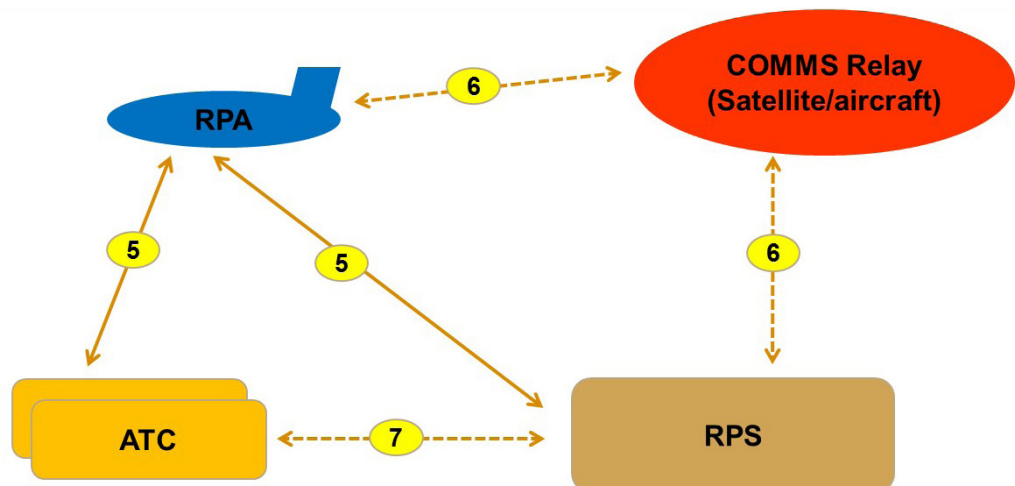


C2 Radio Communications in a RPA

- 1. Uplink representing Line of Sight "Command" in the C2 funktion.
- 2. Downlink representing Line of Sight "Control" in the C2 funktion.
- 3. Relay of C2 communications from the RPS to the RPA.
- 4. Relay of C2 communications from the RPA to the RPS.

Figure 3. Different communication link options for operating BVLOS

The diagram below (Figure 4) shows, in simplified terms, how UAS C2 operates and includes air traffic control (ATC) communications where it may be required. As the remote pilot is not on board the RPA, considerations that need to be taken in the development of a supporting safety case for the operation include any latency between an instruction given by ATC, the remote pilot complying with that instruction and the RPA acting upon the instruction.



RPA communications relayed to ATC

5. ATC communications relayed between ATC, the RPA and the RPS.
6. ATC communications relayed between ATC, the RPA, a satellite and the RPS.
7. Alternate direct link between ATC facility and RPS.

Figure 4. Different configurations for communicating with ATC

1.2 Current UAS Operations approved by States

- Border surveillance
- Police and security support
- Fire/rescue support
- Meteorological research and hurricane/typhoon monitoring
- Natural disaster support
- Oceanic research
- Advertising
- Aerial photography
- Agricultural monitoring
- Cinema/media applications
- Terrain mapping
- Oil and gas pipeline monitoring

Note: Information regarding how Member States have enabled these operations can be gained by contacting CANSO

2 **Accommodating UAS into ATM**

2.1 General UAS Requirements from an ANSP Perspective

The integration of UAS within the air traffic management (ATM) system will require the operation of UAS in non segregated airspace to be indistinguishable from that of manned aircraft operations. This means the remote pilot will be required to respond to air traffic services (ATS) guidance or requests for information and comply with any ATC instructions. While specific procedures for UAS should be kept to a minimum, experience shows that due to the unique attributes of UAS, some new procedures will be required.

The operation of UAS within visual line of sight (VLOS) should be assessed by ATM managers to limit their impact upon the wider ATM system. There may be a need to impose restrictions on height/altitude of their operation, or their proximity to airports, aerodromes and ongoing manned aircraft operations.

Beyond visual line of sight (BVLOS) operations have been permitted primarily in segregated airspace. Some BVLOS operations have been approved in non-segregated airspace where the proponent has demonstrated through a safety risk management process, that the operation could be conducted safely.

2.2 Separation

A remote pilot cannot operate under visual flight rules (VFR) when flying BVLOS in the same way as manned aircraft, primarily because an approved detect and avoid (DAA) system is not available and the remote pilot cannot comply with VFR or visual separation requirements. Properly equipped UAS may be able to operate under instrument flight rules (IFR) and can be provided IFR separation by ATS in controlled airspace with an approved flight plan.

2.3 Aerodrome and Terminal UAS Operations

Current UAS configurations prevent seamless interaction with the ATM system, but this does not necessarily inhibit UAS operations in the terminal area, though it has limited their integration. The following ATM expectations for normal terminal area operations illustrate some of the challenges of integrating UAS into the ATM system and what should be expected of UAS to meet ATM requirements.

To seamlessly interact within the terminal area, a UAS should be able to:

- Conduct a visual approach, comply with visual sequencing in a visual traffic pattern, be instructed to 'maintain visual separation' from another aircraft, including for dependent parallel runway operations, or conduct SVFR
- Fly a standard instrument approach or enter and hold in a standard holding pattern
- While taxiing:
 - Hold short of the Instrument Landing System's (ILS) critical area
 - Follow a conditional clearance, such as, "pass behind Cessna 172, then taxi across runway 28L"
 - Recognise and comply with aerodrome signs, markings, and lighting.
- Land at alternate aerodromes where an RPS is not present
- Perform standard or half-standard rate turns or arc about a NAVAID
- Comply with multiple ATC instructions
- Recognise visual signals (i.e. interception)
- Identify and avoid terrain
- Identify and avoid severe weather

Because UAS are not yet categorised, ATS may not be able to:

- Identify aircraft type as designated on a flight plan
- Identify an aircraft approach category
- Apply wake turbulence criteria spacing on final approach or on departure
- Apply same runway separation criteria
- Direct land and hold short operations (LAHSO)

2.4 Special Handling

The factors listed above mean that UAS operations may be subject to varying degrees of special handling by ANSPs to be able to safely operate outside segregated airspace. Below is a list of areas where such special handling may be required:

2.4.1 ATC Phraseology

Ideally, RPAS would require no special handling from ATC and therefore would not require any additional ATC phraseology. However, there is currently no approved, standard RPAS-related ATC phraseology and this will have to be developed and agreed upon prior to operations.

2.4.2 C2 Data Link

When the C2 data link is operating via a satellite or other than radio line of sight, there may be latency in the response to ATCO instructions. When the UAS C2 data link is operated via radio line of sight, the UA may have minimum flight altitudes below which it cannot operate safely, as illustrated in Figure 5 below.

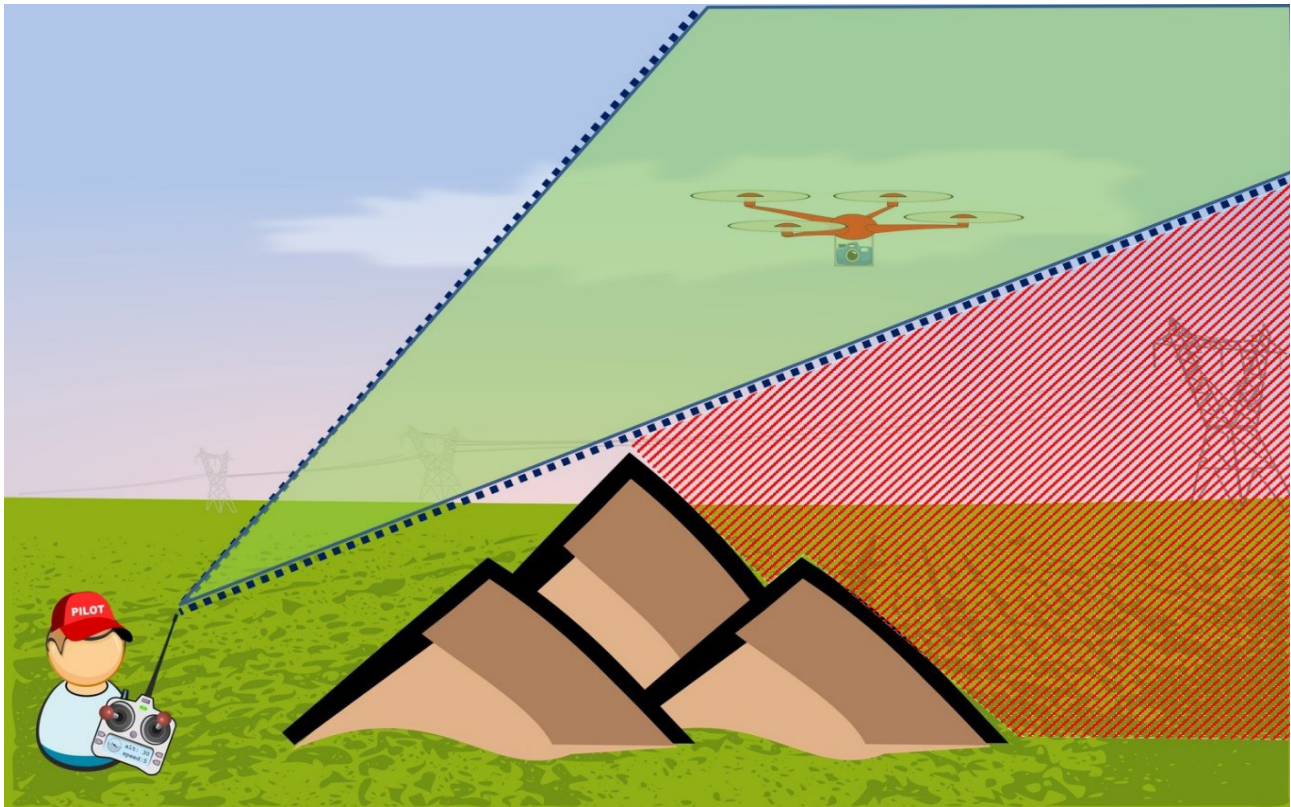


Figure 5. Radio Line of Sight Interference Areas

2.4.3 In-Flight Characteristics

A UAS may have in-flight characteristics which differ from manned aircraft, such as slower than expected airspeed, slower rates of climb or a requirement to spiral climb rather than climb en-route.

The flight profile of a UAS may also differ from manned aircraft, which normally route from A to B via C, whereas the UAS may take off and land at the same airport having conducted its mission, i.e. from A to A, having orbited at C. Therefore, it will be important for ATC to establish whether the UAS will be transiting through a sector, or remaining within a sector conducting aerial work.

2.4.4 Flight Data Processing System (FDPS)

An FDPS may have difficulty handling UAS flight plans, due to elements such as the flight profile, duration of the flight, inability to specify 'zero' persons on board and alerting requirements. For example, the remote pilot may need to complete a spiral climb from the aerodrome of departure or may remain airborne exceeding 24 hrs; both scenarios may be difficult for the FDPS to process.

The accommodation of a UAS by an FDPS may require 'work arounds' such as the submission of multiple flight plans or the issue of revised secondary surveillance radar (SSR) codes. UAS flight plans may need to be updated more frequently than others during its flight due to long mission duration and operational mission needs, or changes requested by the remote pilot. Such flight plans may require more input as it may involve entering many

route elements as latitude/longitude points as opposed to navigational aids, fixes, and routes. Furthermore, there may be no national set of UAS performance characteristics and such data would therefore not be available to the FDPS. The impact of UAS operations on the FDPS may necessitate software upgrades or adaptation, production of associated manuals, briefings and staff training, all of which have resource implications and require ample lead times.

2.4.5 Alerting Services

Alerting services should be provided for all aircraft afforded air traffic services. Current ICAO provisions do not differentiate between manned and unmanned aircraft; however, some States are reviewing and considering adapting the application of alerting services for UAS.

2.4.6 IFR Procedures

Most UAS are not fitted with standard, certificated avionics. This means that they cannot necessarily execute existing published IFR departure or approach procedures or comply with reduced vertical separation minima (RVSM) or performance-based navigation (PBN) requirements. Despite the absence of standard avionics, most (if not all) UAS are global navigation satellite system (GNSS)-equipped and may be able to navigate along known waypoints, emulate existing, or conduct alternate IFR procedures. This will allow ATC to give instructions according to the capabilities of the UAS.

2.4.7 Detect and Avoid, Collision Avoidance

It is the remote pilot's responsibility to detect and avoid potential collisions and other hazards. In the absence of a certified detect and avoid (DAA) system, alternative means for UAS to comply with regulations to 'see-and-avoid' may include:

- Airborne radar systems
- Radar surveillance from the ground – often referred to as ground based detect and avoid (GBDAA) – that can detect cooperative and non-cooperative traffic.
- Sensors which may be in a variety of spectra including electro-optic and infra-red
- Chase aircraft
- A combination of the above

2.5 Contingency and Emergency Operation Procedures

Emergencies involving UAS should be handled similarly to those for manned aircraft. However, because of the unique attributes of UAS, new procedures may have to be developed by ANSPs to accommodate UAS operations. ICAO recognises that ANSPs should review contingency and emergency procedures to account for unique UAS failure modes. According to the ICAO Manual on Remotely Piloted Aircraft Systems (RPAS) Doc 10019:

"The absence of an on-board pilot will necessitate some unique procedures in the integration of RPA into non-segregated airspace. To the greatest extent practicable, procedures should be identical to those developed for manned aircraft."

ANSPs should be aware that a UA may lack system redundancies and independent functionality. The operator should be expected to provide an ANSP with detailed plans for contingency operations that mitigate the risk of collision during a loss of link (LL) event. These risks include collision with other aircraft, as well as those posed to persons and property on the ground. Contingency operations also includes factors contributing to the need to divert or terminate the flight.

These plans must take into consideration all airspace constraints and minimise risk to other aircraft. Contingency plans must address emergency recovery or flight termination of the UA in the event of unrecoverable system failure. These plans should include the LL procedures and routes, divert locations, and flight termination points (if required) for each operation plotted on aeronautical charts.

The coordination of procedures to integrate UAS operations into the existing ATM system will require a significant investment of time and resources by ANSPs and UAS operators; the scale of this task should not be underestimated.

2.5.1 Loss of Radio Communication

A loss of ATC-UAS radio communications differs from an LL event, which is explained separately below. Procedures following a loss of radio communications for UAS should be as described in ICAO Procedures for Air Navigation Services – Air Traffic Management, DOC 4444. The remote pilot may also have access to back-up communications (i.e. telephone service) to enable contact with the ATS facility directly. It would be beneficial for ANSPs and UAS operators to take advantage of this additional means of communication.

2.5.2 Loss of C2 Link

The C2 link from the RPS to the UA is the means for the remote pilot to manipulate the control surfaces of the UA. If the C2 link is lost, the remote pilot will be unable to exercise operational control of the UA. There are many possible causes of a loss of C2 link between the RPS and UA that include:

- Terrain masking
- Weather interference
- Man-made interference, either unintentional (i.e. television broadcast) or malicious (i.e. jamming)
- Out of range
- Equipment failures on the UA, in the RPS or the network (i.e. satellite)
- Human error in the RPS (frequency setting, switches)

The ICAO Document 10019 states that LL “is considered to be any situation in which the RPA can no longer be controlled by the remote pilot due to the degradation or failure of the communication channel between the RPS and the RPA.”

In the event of a lost C2 link, the UA should follow procedures and manoeuvres that have been programmed prior to the LL event, and coordinated with appropriate ATS facilities that minimise the impact on ATS and other airspace users to the greatest extent possible. UAS operations should include a means of automatic recovery in the event of LL that is acceptable to ATM. There are many approaches to satisfy the requirement, but the intent is to ensure airborne operations are predictable.

The goal is to standardise ATM procedures for a UA experiencing an LL and to ensure the UA performs in a predictable manner. Until there are standardised LL procedures, ANSPs should be aware that operators will apply different procedures based on the manufacture of the UA.

Once initiated, the UA will follow the programmed LL procedure for the remainder of the flight or until the C2 link is restored. In the event the C2 link is restored, the remote pilot is expected to request an amended clearance.

2.5.3 Example of a Typical Lost Link Procedure

The generic LL procedure that follows could be used as a basis for negotiation between ANSPs and UAS operators, where agreement of the timescales between each stage of the process is of critical importance.

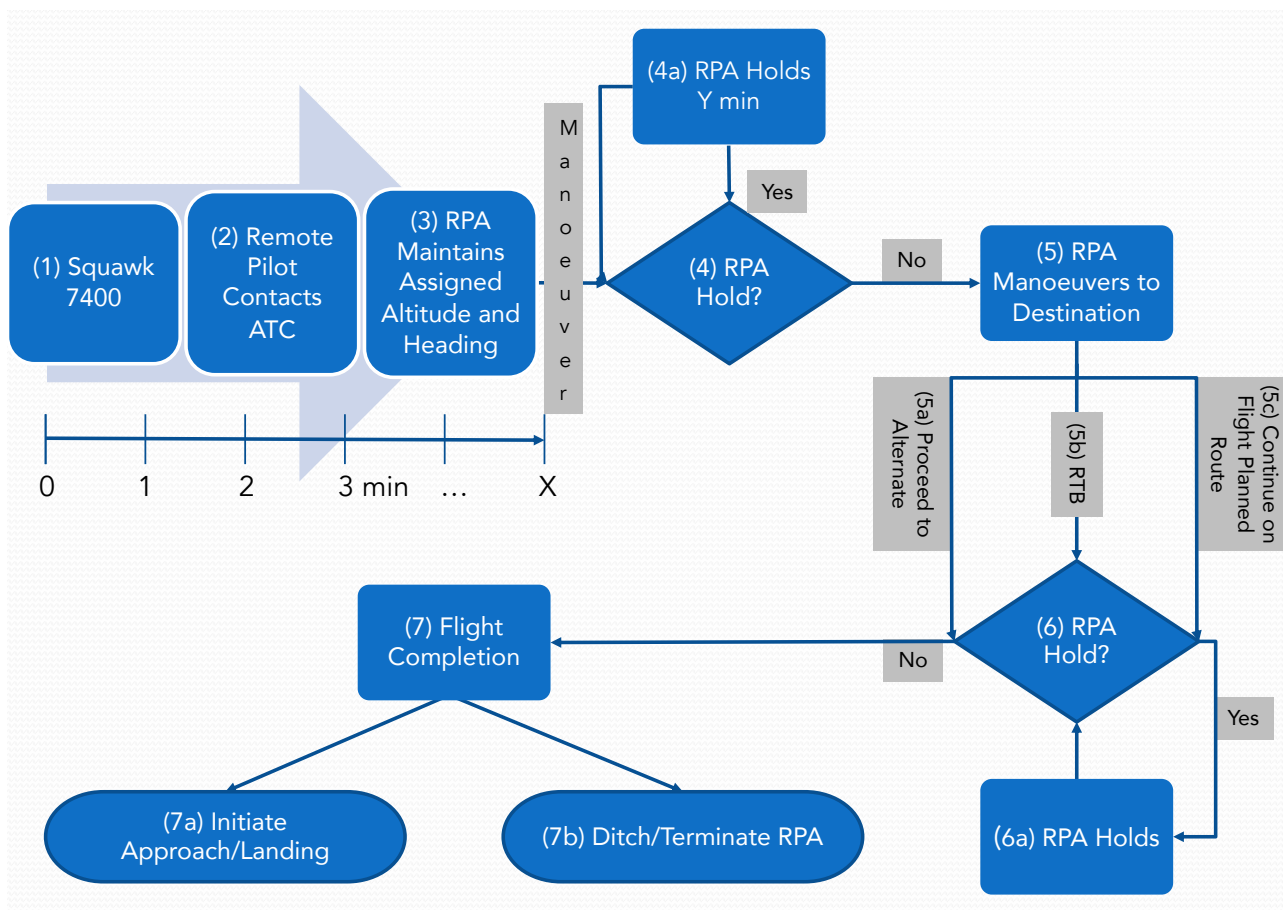


Figure 6: Typical Lost Link Procedures

1. Squawk 7400. When the RPA recognises that it has lost its C2 link with the remote pilot, after a predetermined time period, long enough to ensure the loss is not temporary, the RPA will automatically squawk its LL code (i.e. 7400) to inform ATC of the RPA condition. This code selection will be displayed on ATC surveillance systems and will notify the LL event to the Sector Controller.
2. Remote Pilot Contacts ATC. The RPAS software should automatically alert the remote pilot to the event. The remote pilot will collect as much information as possible on the event and, via alternative (probably landline) communications, contact ATC to coordinate the lost control link manoeuvre and pass on any further relevant information. While unlikely, it may occur that the remote pilot to ATC communications remains serviceable via the RPA during a C2 LL event.
3. RPA Maintains Assigned Altitude and Heading. Initially, the RPA should maintain its assigned altitude and heading, but the ATCO should be aware that the RPA will soon execute its LL manoeuvre and will be able to manage other aircraft under their control accordingly.
4. RPA Hold. After another pre-arranged time period, which could be different depending on the RPA position or stage of flight, the RPA should initiate an LL manoeuvre. Once again, while the ATCO will not be able to control the manoeuvre, they should know its headings, level and duration and thus be able to plan, sequence and separate other traffic under his/her control from the RPA. At this stage, it is anticipated that the RPAS crew and system will attempt to re-acquire the C2 link.
5. RPA Manoeuvres to Destination. After a pre-determined period of time, which the remote pilot should be able to confirm to ATC via direct communication, the RPA will proceed to its destination to land which will be either (a) its designated alternate aerodrome or (b) return to base. In most cases to date, the RPA returns to base, which is its aerodrome of departure.
6. RPA Hold. As the RPA manoeuvres to its destination, it could execute a number of turns or holds as part of its LL procedure; these will all be known and predictable to the ATCO.
7. Flight Completion. The final stage of the procedure will either be for the RPA to land at its designated alternate or original base or, in rare cases, terminate the flight by controlled flight into terrain (CFIT) at a pre-determined point that is known to be unpopulated.

2.5.4 Flight Termination Procedures

Flight termination is the intentional process of ending the flight of the UA in a controlled manner, in the event of an emergency. This should be considered a last resort when all efforts to recover the UA safely have been exhausted and continued flight cannot be safely achieved, or potential hazards exist that require the immediate end of the flight. A UA may be equipped with a flight termination system that can be activated by the remote pilot. Flight terminations should be conducted in sparsely populated areas or away from ground or maritime infrastructure. The remote pilot should be expected to advise ATS prior to initiating the procedure.

3 Small UAS

The use of small UAS (sUAS), or drones, is the most rapidly growing segment of UAS operations. Due to the low cost of entry, recreational use, and expanding regulatory authority for commercial operators, sUAS sales have continued to increase. The vast majority of these systems are being flown safely in uncontrolled airspace within VLOS of the operator, yet there have been a disturbing number of reports of sUAS being seen near or actually on commercial airfields that have disrupted operations.

While these instances represent the minority of sUAS operations and may most likely be due to a lack of understanding of airspace or risk (as opposed to intentional malice), these occurrences definitely pose a safety hazard for ANSPs to consider.

3.1 Commercial vs Recreational Operations

It is important for ANSPs to:

- Work with regulators to clearly define differences in the regulatory structure for each of the two categories
- Understand and agree to any responsibilities being incurred by the ANSP for those operations
- Participate in the development and implementation of educational programs designed to reduce airspace incursions by sUAS

3.2 VLOS vs BVLOS Operations

VLOS operations are being increasingly approved by regulators as they are perceived to pose the least risk to manned aviation and have the least impact on the use of airspace. As UAS operations increase in complexity and UA increase in capability, BVLOS operations will become a more desirable way to operate all types of UAS. The primary challenge to expanding BVLOS operations will be to mitigate the risk of visually identifying and avoiding hazards. These hazards include other aircraft as well as weather and terrain (for low altitude operations). It must also be determined how much interaction with ANSPs will be required as the numbers of BVLOS operations increase. Additional considerations will need to be given to equipage requirements, separation standards and certification of sUAS operations.

3.3 Uncontrolled vs Controlled Airspace

ANSPs should work closely with regulators to ensure UAS operations in controlled airspace do not adversely affect aviation safety and have minimal impact to the efficiency or procedures that exist today. Operations will continue to expand in uncontrolled airspace, especially by sUAS. ANSPs need to understand how to account for these operations, where necessary, to ensure the safe transit of traffic under ATC control into or through regions of uncontrolled airspace.

3.4 Regulatory Enforcement

Regulatory enforcement that is being pursued and of interest to ANSPs includes:

- Registration requirements for all UAS to include sUAS, drones and potentially even UAS for recreational use
- Identification of UAS both inflight and on the ground, to include information about the registrant and the location of the ground control station
- The ability to detect sUAS and drone operations in and around airports or other areas of public aviation interest (i.e. crime scenes, fire protection areas, etc.) without the need to first visually identify that UAS operations are present and creating a potential hazard
- The ability to disable UAS or drone operations by public agencies, not necessarily limited to law enforcement, to eliminate a threat to safety of operations in and around airports or critical infrastructure

3.5 NOTAMS

In many States there is ongoing discussion related to the use and effectiveness of publishing NOTAMS for sUAS operations. The question being asked is whether or not a NOTAM is an effective and useful tool as a safety mitigation. Many States have come to the conclusion that the use of NOTAMS for sUAS operations should not be imposed as a general requirement for all sUAS operations. The reasons behind this decision include:

- Many States have indicated in their rules related to sUAS that the sUAS pilot must give way to all other aircraft. As such the use of a NOTAM to indicate a potential hazard to other pilots is counter to their established rules.
- As NOTAMS are used to alert aircraft pilots of potential hazards along a flight route or at a location that could affect the safety of the flight, the use of NOTAMS for sUAS is counter to the idea of integration of sUAS.
- The broadness of most UAS operation areas does not lead to providing effective information to other pilots when published in a NOTAMS.

4 **UAS Traffic Management (UTM)**

There is an assumption that to integrate UAS into low, very high, and controlled airspace, a new airspace management system is needed. There are several projects being explored by regulatory and research bodies to develop a UTM (or U-Space in Europe) system that will enable scheduling and de-confliction of UAS operations in all classes of airspace.

UTM is a system that could allow sUAS operators to connect to a central coordinating service that manages unmanned operations at very low levels. UTM is envisioned to be an ecosystem that is separate but complementary to the ATM system. UTM development focuses on identifying services, roles/responsibilities, information architecture, data exchange protocols, software functions, infrastructure, and performance requirements for enabling the management of low-altitude uncontrolled UAS operations.

General principles currently being discussed regarding UTM include:

- UTM would provide services to the UAS in an automated manner rather than the traditional human-in-the-loop services currently provided by ATM
- Separation would be a function performed in an automated manner between the UAS operating within the UTM environment
- UAS would give way to all manned aircraft that may have a requirement to operate in airspace being managed by a UTM function

UTM is being discussed in many locations globally as a possible means to offer an interoperable solution that could ultimately allow for routine beyond-visual-line-of-sight (BVLOS) flights and highly automated operations.

It is critical that ANSPs participate in these efforts to ensure there is:

- Compatibility with existing ATM infrastructure
- An understanding of the interaction between a UTM system and ATC
- An understanding of any changes to the responsibilities of an ANSP
- No degradation to the safety of current operations
- Regulatory and procedural guidance regarding the interaction of aircraft being controlled by ATC and those operating within a UTM system

5

Airspace above Controlled Airspace

With the increase in likelihood of near-term development of revenue-generating suborbital flights and the increase in high-altitude-long-endurance (HALE) operations above FL600, the importance of addressing operations above this altitude has never been more pressing.

In a 2017 working paper from the FAA to the Twenty-Fourth Meeting of the Cross Polar Trans East Air Traffic Management Providers' Work Group the FAA stated, "As the need for additional services above FL600 increases, so does the need to reevaluate standards to ensure the safety of users at these higher altitudes. The reconsiderations include, but are not limited to altitude stratum, surveillance, communications, procedural applications, navigation, mission requirements, Class E structure, resources and New Entrants."

UAS operations above controlled airspace pose unique challenges of their own. In practice, the sovereignty of airspace belongs to each State over their territorial boundaries from the surface to the edge of space. However, the upper altitude limits of where that airspace is controlled by ANSPs differs from State to State, and there is no common threshold for where controlled airspace ends. It varies greatly due to radar and radio coverage as well as the need to exercise control over very high altitudes due to lack of use. There are efforts underway by ICAO and other aviation organisations to propose standards for harmonising operations at upper airspace to support operations of HALE UAS.

It is logical to assume that elements of a fully developed and implemented UTM environment may be applied to the airspace above controlled airspace, but there are unique attributes that must be considered.

It can be assumed that operations at very high altitudes will not be confined to the lateral boundaries of a single State, thus requiring each State to adopt a common definition of 'upper airspace', or more likely that HALE aircraft may transit between controlled and uncontrolled airspace as they proceed along the flight planned route. Additionally, UTM operating to support HALE UAS will have an even greater need to be interoperable between States and ANSPs.

Even with a fully developed UTM system, ANSPs will be responsible for coordinating HALE UAS transitions through controlled airspace during both departure and arrival phases of flight. This coordination will be critical to integrate UAS that may have significant differences in performance characteristics of traditional aircraft operating in that airspace. This coordination may require changes to operational standards and guidance in order to maintain the safety and efficiency of the existing airspace structure.

6 **Operations and Standards Guidance**

6.1 Certification of RPAS (air ground), Airworthiness

As certification standards for RPAS are being developed, it is imperative that ANSPs participate in those efforts to ensure that ATS requirements and concerns for airspace integration are incorporated. ICAO published the Manual on Remotely Piloted Aircraft Systems (RPAS) (Doc 10019), which provides guidance regarding RPAS operations to Member States, but does not define certification standards. ICAO is currently developing Standards and Recommended Practices (SARPs) and Procedures for Air Navigation Services (PANS).

6.2 Personnel/Pilot Licensing and Training

Remote pilots are expected to have qualifications commensurate with the class of airspace within which they intend to operate. Although the RPS may vary for differing UAS, the fundamental requirements and training for remote pilots are expected to mirror those of manned aircraft pilots.

7

Future Considerations

Several ANSPs have safely and successfully allowed UAS operations in non-segregated airspace. However, this has been achieved on a case-by-case basis and universally applicable procedures have not yet been developed. Experience shows that while safe operations are possible, current UAS do not have the capability to operate seamlessly with other air traffic. This requires ANSPs to be flexible and imaginative to accommodate them.

Looking into normalizing UAS operations as the technologies improve and additional operations are requested ANSPs need to consider taking the following actions:

1. Current Operations - It will be essential for ANSPs to collaborate with UAS stakeholders to safely, and more fully, integrate UAS into existing and future air navigation systems. Collaboration will be required across all ATM development programmes.

As these discussions occur, it is critical that the ANSPs consider and address the following areas (not a complete list):

- Unique operating characteristic of unmanned aircraft
- Possible contingency operations
- Spectrum issues
- Phraseology

2. Future Operations (Global Perspective) – States and ANSPs should work with UAS related groups

(e.g. CANSO RPAS/ET Working Group, ICAO RPAS Panel, etc.) and other stakeholders in establishing appropriate standards for UAS operations

3. Future Operations (State and ANSP Perspective) – States and ANSPs should work to establish local regulations and policies that reflect the unique operating parameters of their local airspace

Integration of UAS into national airspace comes with many challenges. As a State or ANSP it is vital to engage early in discussions and begin planning and policy development in order to help avoid future issues.

8

UAS Training for ATM Personnel

CANSO provides a training package as well as an *Instructor Guide* for basic UAS training for ATM personnel. This information is accessible to Members via the CANSO Global ATM Net (www.canso.org/operations-standing-committee-osc). The training is specifically developed in a manner that allows those States providing the training to add area specific information such as State and local regulations or policies. States should focus on unique information that makes UAS operations unique and challenging from an air traffic perspective. This is the outline of the training covered in the CANSO training package.

CANSO UAS Training Package (Sample)

UAS Training Guide

- Introduction
- Explanation of Terms
- Background
- RPAS configuration
- Remotely piloted aircraft performance examples
- Challenges posed by integration of RPAS operations
- Conducting routine operations
- National/regional regulations and authorisations
- Standards and procedures under development
- Conclusion

9 Explanation of Terms

The following terms are taken from ICAO Annex 11, Air Traffic Services (Fourteenth Edition, July 2016), or Document 10019, Manual on Remotely Piloted Aircraft Systems (RPAS) and are used in the context of this document. Definitions which have no official status within ICAO, but are common terms currently in use, are indicated with an asterisk (*).

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

- a) a person is fatally or seriously injured as a result of:
 - being in the aircraft, or
 - direct contact with any part of the aircraft, including parts which have become detached from the aircraft, or
 - direct exposure to jet blast

The exception is when the injuries are from natural causes, are self-inflicted or inflicted by other persons, or when the injuries are to stowaways hiding outside the areas normally available to the passengers and crew.

- b) the aircraft sustains damage or structural failure which:
 - adversely affects the structural strength, performance or flight characteristics of the aircraft, and
 - would normally require major repair or replacement of the affected component

The exception is engine failure or damage, when the damage is limited to a single engine, (including its cowlings or accessories), to propellers, wing tips, antennas, probes, vanes, tires, brakes, wheels, fairings, panels, landing gear doors, windcreens, the aircraft skin (such as small dents or puncture holes), or for minor damages to main rotor blades, tail rotor blades, landing gear, and those resulting from hail or bird strike (including holes in the radome).

- c) the aircraft is missing or is completely inaccessible.

Note 1 For statistical uniformity only, an injury resulting in death within thirty days of the date of the accident is classified, by ICAO, as a fatal injury.

Note 2 An aircraft is considered to be missing when the official search has been terminated and the wreckage has not been located.

Note 3 The type of unmanned aircraft system to be investigated is addressed in ICAO Annex 13, 5.1.

Note 4 Guidance for the determination of aircraft damage can be found in ICAO Annex 13, Attachment E.

Command and control link (C2). The data link between the remotely-piloted aircraft and the remote pilot station for the purposes of managing the flight.

Controlled airspace. An airspace of defined dimensions within which air traffic control service is provided in accordance with the airspace classification.

Note Controlled airspace is a generic term which covers ATS airspace Classes A, B, C, D, and E

Controlled flight. Any flight which is subject to an air traffic control clearance.

Detect and avoid (DAA). The capability to see, sense or detect conflicting traffic or other hazards and take the appropriate action to comply with the applicable rules of flight.

Drone. A publically used term synonymous with sUAS (Small unmanned aircraft system). sUAS would be considered on a more formal professional term. Drones, or small UAS (sUAS), are considered separately from those capable of flight in controlled airspace on an instrument flight rules (IFR) flight plan.

Flight plan. Specified information provided to air traffic services units, relative to an intended flight or portion of a flight of an aircraft.

Handover. The act of passing piloting control from one remote pilot station to another.

IFR flight. A flight conducted in accordance with the instrument flight rules.

Incident. An occurrence, other than an accident, associated with the operation of an aircraft which affects or could affect the safety of operation.

Lost C2 link (LL)*. A situation in which the RPA can no longer be controlled by the remote pilot due to the degradation or failure of the communication channel between the remote pilot station (RPS) and remotely piloted aircraft (RPA).

Operational control. The exercise of authority over the initiation, continuation, diversion or termination of a flight in the interest of safety of the aircraft and the regularity and efficiency of the flight.

Operator. A person, organisation or enterprise engaged in or offering to engage in an aircraft operation.

Radio line-of-sight*. A direct electronic point-to-point contact between a transmitter and a receiver.

Remote flight crewmember. A licensed crewmember charged with duties essential to the operation of a remotely piloted aircraft system during a flight duty period.

Remote pilot. A person charged by the operator with duties essential to the operation of a remotely piloted aircraft and who manipulates the flight controls, as appropriate, during flight time.

Remote pilot in command. The remote pilot designated by the operator, or in the case of general aviation, the owner, as being in command, and charged with the safe conduct of a flight.

Remote pilot station. The component of the remotely piloted aircraft system containing the equipment used to pilot the remotely piloted aircraft.

Remotely piloted aircraft (RPA). An unmanned aircraft that is piloted from a remote pilot station.

Remotely piloted aircraft system (RPAS). A remotely piloted aircraft, its associated remote pilot station(s), the required command and control links and any other components as specified in the type design.

RPA observer. A trained and competent person designated by the operator who, by visual observation of the remotely piloted aircraft, assists the remote pilot in the safe conduct of the flight.

Safety. The state in which risks associated with aviation activities, related to, or in direct support of the operation of aircraft, are reduced and controlled to an acceptable level.

Safety management systems (SMS). A systematic approach to managing safety, including the necessary organisational structures, accountabilities, policies, and procedures.

Safety risk. The predicted probability and severity of the consequences or outcomes of a hazard.

Segregated airspace. Airspace of specified dimensions allocated for exclusive use to a specific user(s).

Small unmanned aircraft system (sUAS). A professional term used synonymously to denote the more publically understood name; drone.

Visual flight rules (VFR) flight. A flight conducted in accordance with the visual flight rules.

Visual line-of-sight (VLOS) operation. An operation in which the remote pilot or RPA observer maintains direct unaided visual contact with the remotely piloted aircraft.

10

Abbreviations

Abbreviation	Definition
ANSP	Air Navigation Service Provider
ATC	Air Traffic Control
ATCO	Air Traffic Control Officer
ATM	Air Traffic Management
ATS	Air Traffic Services
BVLOS	Beyond Visual Line of Sight
C2	Command and Control
CFIT	Controlled Flight Into Terrain
DAA	Detect and Avoid
FDPS	Flight Data Processing System
GNSS	Global Navigation Satellite System
HALE	High Altitude – Long Endurance
ICAO	International Civil Aviation Organisation
IFR	Instrument Flight Rules
ILS	Instrument Landing System
LL	Lost Link
PANS	Procedures for Air Navigation Services
PBN	Performance Based Navigation
RPA	Remotely Piloted Aircraft
RPAS	Remotely Piloted Aircraft System
RPS	Remote Pilot Station
RVSM	Reduced Vertical Separation Minima
SARP	Standards and Recommended Practices
SMS	Safety Management System
SSR	Secondary Surveillance Radar
UA	Unmanned Aircraft
UAS	Unmanned Aircraft System
UTM	UAS Traffic Management
VFR	Visual Flight Rules
VLOS	Visual Line of sight



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