

Management of Remotely Piloted Aircraft Systems (RPAS) in ATM operations

Operational Concept

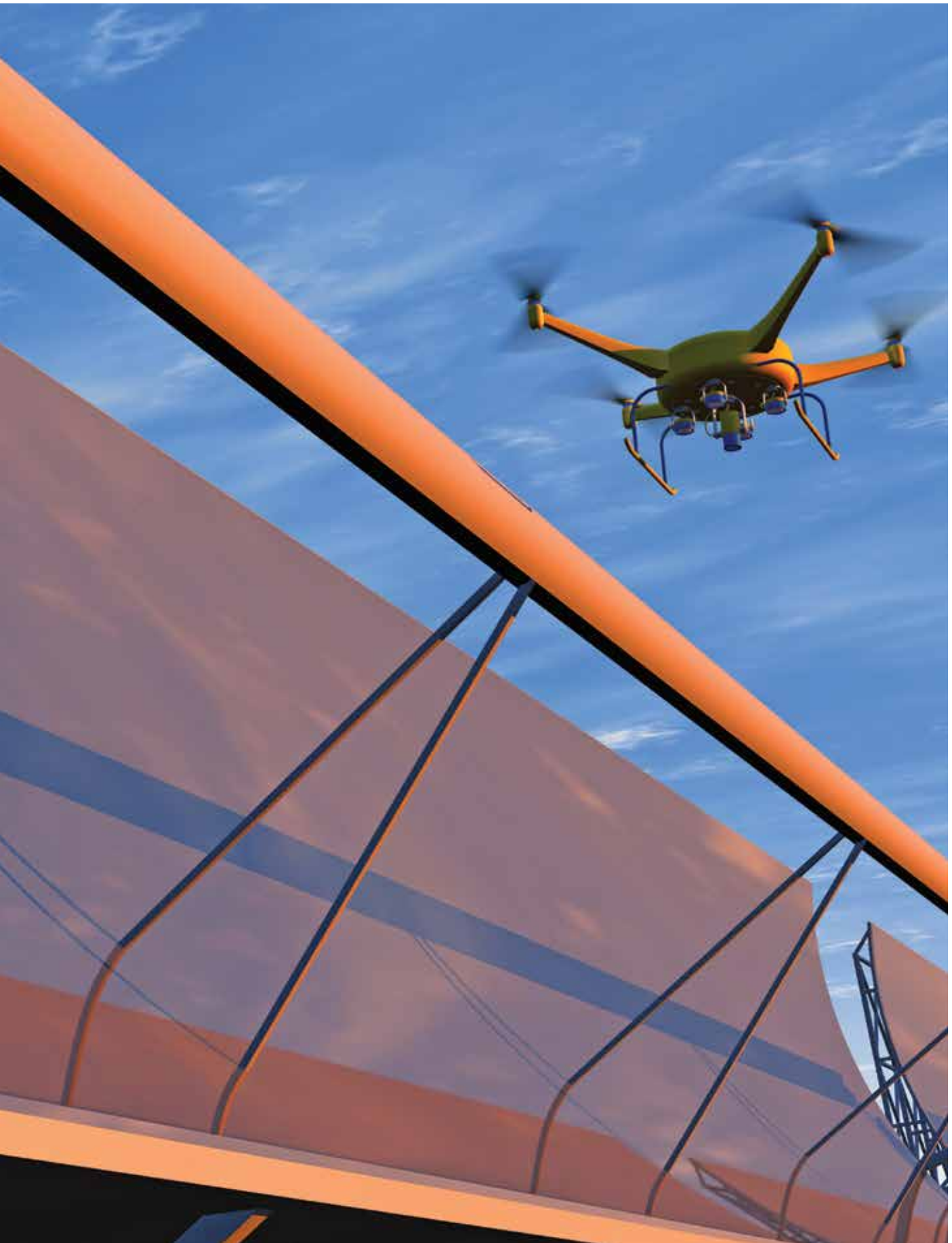


Welcome to Airservices Operational Concept for RPAS.

Unmanned aerial systems are a key feature of the future of aviation. At Airservices we are committed to the safe integration of RPAS in the National Airspace System. This presents challenges and opportunities as we adapt systems and processes to align with rapidly evolving technology, and an associated regulatory structure.

As an important step in taking an inclusive approach to the facilitation and integration of RPAS this inaugural operational concept details the approach being taken at Airservices to the management of unmanned operations. The concepts within this document form the basis of current and future developments, and make clear the manner by which Airservices intends to foster RPAS sector growth.

We look forward to working closely with industry partners as we continue to refine our approach to the ongoing management of RPAS operations.



Contents

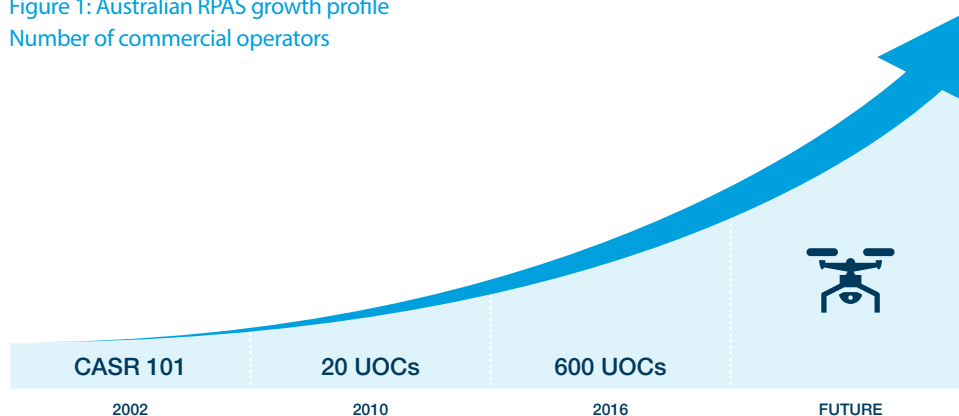
1	Introduction	3
2	Purpose	4
3	Principles and Responsibilities	5
3.1	Principles	5
3.2	Responsibilities	5
3.2.1	RPAS with advanced equipment levels	
3.2.2	RPAS with basic equipment levels	
4	Airservices RPAS Operational Concept	7
4.1	Concept of Airservices RPAS Fly Zone	7
4.2	Concept of Facilitation	11
4.3	Segregated Operations	11
4.4	Coordinated Operations	12
	Airservices RPAS Buffers	
	Individual Assessments	
4.5	Integrated Operations	13
5	RPAS Controlled Airspace Access Request Processes	14
6	RPAS Operations under 'Standard Operating Conditions' (SOC)	16
7	Regulatory Requirements	17
8	Concept of Cost Recovery	18
9	RPAS Safety Performance Management	19
10	Conclusion	20
	Appendix A Regulatory and International Framework (RPAS)	21
	Appendix B Remotely Piloted Aircraft Systems: Overview	24
	Appendix C Referenced Documents	27

Introduction

Traditionally referred to as Unmanned Aerial vehicles (UAV's), the term RPAS was introduced by ICAO in 2011 (Circular 328-AN/190) to more accurately reflect the human and technical elements required for the overall operational control of an aircraft with no pilot on board.

RPAS is the fastest growing area of civil aviation. By mid 2016, there were approximately 600 commercial RPAS operators registered with the Australian Civil Aviation Safety Authority (CASA) through receipt of an Unmanned Operator Certificate (UOC).

Figure 1: Australian RPAS growth profile
Number of commercial operators



Australia was the first to publish regulations under which all classes of RPAS can be operated in Australian airspace in 2002¹. These regulations require RPAS operations under certain circumstances to be approved by the ATS provider. RPAS operations are however exempt from many traditional areas of aviation legislation. The responsibility for aviation safety is shared between the Regulator, the ANSP and the RPAS operator.

The task of facilitating and ultimately integrating RPAS operations into a pre-existent conventionally piloted aviation system is recognised as a significant global challenge. Not all key technologies required for RPAS to fly in civil airspace are mature or standardised. By necessity the integration of RPAS will be gradual, proportionate and evolutionary.

Airservices key strategic objectives are formulated taking into consideration a number of obligations. One such objective is for Airservices to foster civil aviation. Airservices recognises the need to take an inclusive approach to RPAS and to take a leading role in the development of an operational framework to accommodate RPAS operations in controlled airspace. In focusing on Airservices RPAS responsibilities four key priorities will provide the framework for improvement initiatives. Those priorities are:

- ✓ Refining ATC processes and systems
- ✓ Contributing to regulatory and policy change
- ✓ Streamlining the application and approval process
- ✓ Enhancing RPAS and aviation community knowledge.

¹ Civil Aviation Safety Regulations Part 101

2

Purpose

The operational concept document will:

- ✓ Specify Airservices responsibilities and the principles that underpin both current processes and future developments for safe and compliant RPAS integration
- ✓ Provide an overview of current processes in place to manage RPAS operations where required by Civil Aviation Safety Regulations (CASR) Part 101 and
- ✓ Provide an overview of the continuous evolution required in Air Traffic Services (ATS) to keep pace with RPAS Industry growth, emerging technologies and regulatory developments.



Principles and responsibilities

3.1 Principles

The management of RPAS in ATM operations by Airservices will be guided by three principles;

1. In exercising its powers and performing its functions, Airservices must regard the safety of air navigation as the most important consideration². Airservices Safety Management System will be used to facilitate, and where possible, integrate RPAS operations to ensure that any identified risks will be managed to a level that is considered as low as reasonably practicable (ALARP)³
2. Where achievable, RPAS should be equipped for or demonstrate an acceptable means of compliance with the communication, navigation and surveillance requirements of the airspace within which they operate
3. A risk based approach to RPAS integration will be taken. This will include:
 - a. The application of risk management tools and techniques⁴ and consideration of Human Factors⁵; and
 - b. The development of RPAS specific segregation methodologies where existing standards and procedures are not applicable or the RPAS is not capable of providing real time navigational information using approved navigation systems.

3.2 Responsibilities

Airservices responsibilities for the management of RPAS in ATM operations are derived from a number of sources. Airservices responsibilities under aviation legislation administered by CASA, such as the Civil Aviation Act and CASR Parts 101 and 172, need to be considered alongside other responsibilities, such as the Airservices Act.

Airservices is responsible under certain conditions for assessing RPAS applications received from CASA. Airservices provide a response to CASA on whether access is approved and under what conditions. This is then relayed to an RPAS operator by CASA. Airservices meets its regulatory requirements, as detailed in CASR Part 101, through this process.

One of the challenges that Airservices face is that RPAS is a broad term. It can be applied to many types of remotely piloted aircraft or systems, with varying equipment levels and capabilities. Additionally the intended location for RPAS operations will determine the potential risk to manned aircraft.

2 Airservices Act 1995

3 Safety Management System Objectives and Requirements (AA-NOS-SAF-0002)

4 Safety Risk Management Tools and Techniques (AA-GUIDE-SAF-0105C)

5 Operational and Safety Change Management Requirements (AA-NOS-SAF-0104)

3

3.2.1 RPAS with advanced equipment levels

In general terms, where the equipment levels and capability of the RPAS are highly reflective of conventionally piloted aircraft, ATC is responsible for providing separation services to the RPAS. An RPAS is considered to have equipment levels and capability that are highly reflective of conventionally piloted aircraft if it is capable of presenting real time information from an approved navigation system and maintaining continuous two-way communications with ATC⁶.

3.2.2 RPAS with basic equipment levels

Where the equipment levels and capability of RPAS are not reflective of conventionally piloted aircraft, ATC responsibilities are dependent on the location and height of the RPAS operation. RPAS operations in controlled airspace do not automatically trigger responsibilities for ATC. If the RPAS operation is below 400 feet AGL and away from the movement area, runway or approach/ departure path of a controlled aerodrome, ATC do not have any responsibilities.

The movement area, runway or approach/departure path of a controlled aerodrome is generally considered to be within 3NM and below 400 feet AGL although there are some variations depending on the extent to which an aerodrome has been analysed.

If an RPAS operation is above 400 feet AGL in controlled airspace or over the movement area, runway or approach/departure path of a controlled aerodrome, ATC is responsible for the safety of other aircraft and the prevention of collisions between other aircraft and the RPAS, through segregation.

ATC traditionally exercise safety responsibilities and prevent collisions through the use of separation standards. The requirement in relation to RPAS is not a conventional separation standard per se, rather segregation so that operations do not overlap.

The development of the principles of segregation safety buffers and the interaction with RPAS operators is detailed in subsequent parts of this document.

RPAS are exempt from many requirements for manned aircraft including IFR and VFR flight rules and associated airworthiness provisions. However, RPAS operators are accountable for the safe operation of RPAS. This is often supported by placing conditions on RPAS operators through the certification process or through the application process for specific operations which affect ATC. The regulatory exemptions and specific conditions issued to individual operators add to the complexity of managing RPAS in ATM Operations.

Airservices RPAS Operational Concept

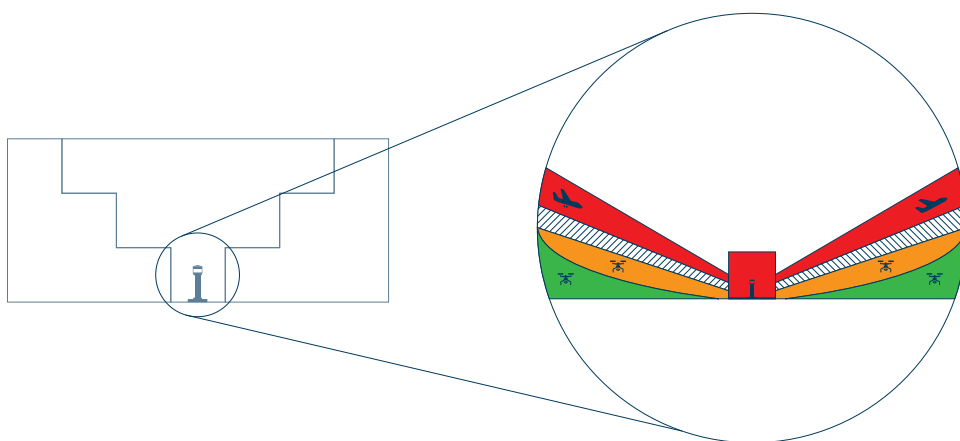
Airservices operational concept is formed within the current Regulatory and International framework⁷ and takes into account the characteristics of remotely piloted systems⁸. The operational concept is underpinned by three models of facilitation reflective of the principles and responsibilities described above. Each of these models describes the level of interaction required between the RPAS operator and ATC and is dependent on the location of the operation and the equipment levels and capability of the RPAS.

Additionally, for the purpose of this document, low level airspace surrounding controlled aerodromes is categorised into three zones according to how compatible RPAS operations are with other airspace users in these zones. These zones provide a proxy indication of how likely Airservices will be able to facilitate operations and will be categorised as Green, Amber and Red RPAS Fly Zones.

4.1 Concept of Airservices RPAS Fly Zones

To streamline the airspace access assessment process for RPAS operations low level airspace surrounding controlled aerodromes will be categorised into three zones (Red, Amber and Green) according to how compatible RPAS operations are with other airspace users in these zones.

Fig 2: Airservices RPAS Fly Zones



These zones typically relate to RPAS operations below 400ft AGL that potentially affect operations over the movement area, runway or approach/departure path of a controlled aerodrome. The zoning will initially consider below 400ft AGL and within 3NM of the controlled aerodrome as these are the significant parameters and assessment triggers contained in current aviation regulations. Notably, it is envisaged that the research and the evidence collected to

6 CASR Part 172 Manual of Standards 10.11.5

7 Refer Appendix A

8 Refer Appendix B

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support the RPAS Fly Zones concept will add significant value to the development of legislation for RPAS operations.

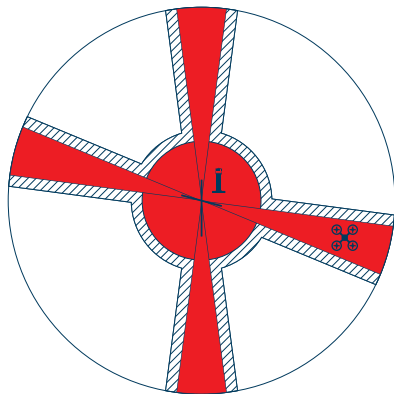
The RPAS Fly Zones concept will improve the information available to RPAS operators when planning to operate in areas where a specific clearance is required. Through ongoing refinement, the zones will be revised to improve flexibility and remove restrictions for RPAS operators.

The concept of the three fly zones within controlled airspace is designed to provide two primary operational advancements:

- ✓ Guidance to RPAS operators on when approval is required from Airservices for an operation and the likelihood of that operation being approved.
- ✓ Guidance to ATC when assessing or advising on airspace access applications

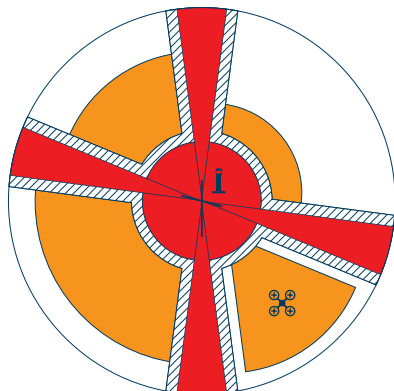
The Airservices RPAS Fly Zones are:

Fig 3: RPAS No Fly Zone



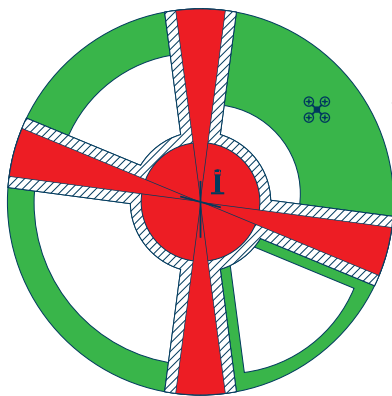
1. No Fly (RPAS Red Zone): An area of operation where RPAS operations are not compatible with other airspace users. Airservices must perform an assessment to determine if the operation can be facilitated. The assessment is complex and approval is not likely. If approval is provided, it will be accompanied with significant conditions or restrictions.

Fig 4: RPAS Apply to Fly Zone



2. Apply to fly (RPAS Amber Zone): An area of operation where RPAS operations may be compatible with other airspace users. Airservices must perform an assessment to determine if the operation can be facilitated.

Fig 5: RPAS Advise and Fly Zone



3. Advise and Fly (RPAS Green Zone). An operational area where RPAS operations are compatible with other airspace users. Airservices are advised by an RPAS operator prior to and following an operation but Airservices explicit approval is not required⁹.

The key enabler for the three fly zones is a suite of three dimensional maps that specify the location of the zones for each aerodrome where an ATS service is provided by Airservices.

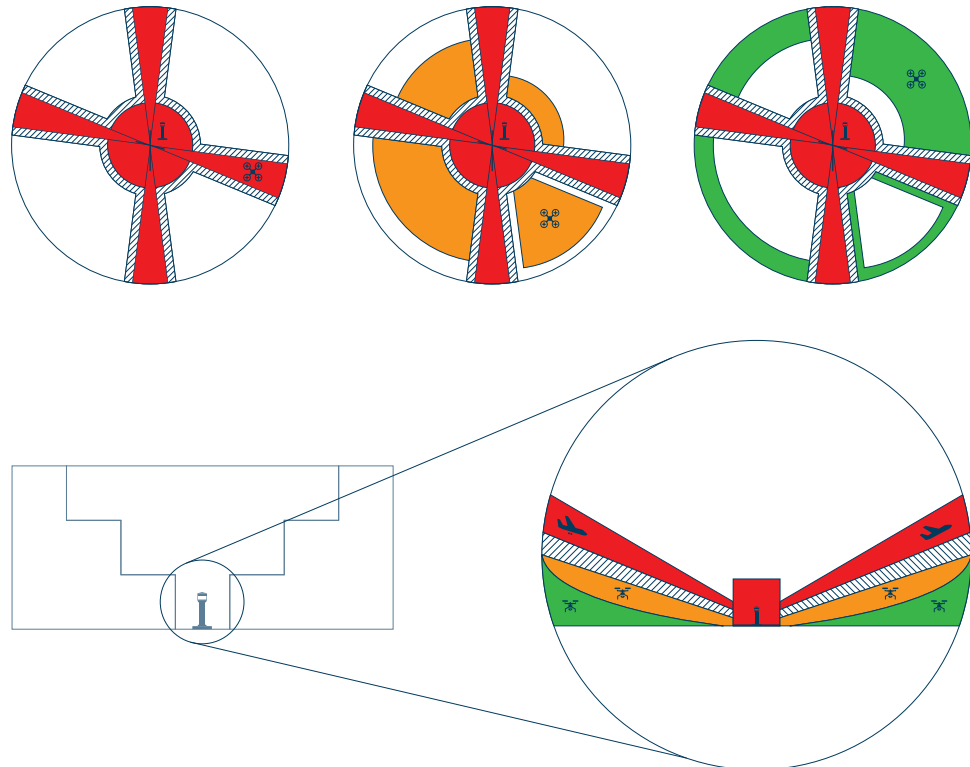
Work has commenced on this concept with the Operational Analysis Team in Safety, Environment & Assurance utilising Canberra as a proto-type. Discussions have also progressed with University teams on options for a research based approach to the proposed solution. It is expected the outcome will be refined over time as the models and assumptions for the production of the maps is advanced. It is also envisaged that these maps will be able to be used to educate manned aircraft on the possibility of RPAS activity in a control zone that is not under the control of ATC.

Note: The Airservices facilitation models and fly zones suggest no changes to existing regulatory requirements or airspace classifications. Rather they are a material enhancement to current requirements and processes.

9 Note: It is a current CASA requirement for Airservices involvement in all operations within 3nm of a towered aerodrome. As the RPAS environment matures it is envisaged that this may be less frequently required.

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Fig 6: Airservices three RPAS Fly Zones



4.2 Concept of Facilitation

Three models of RPAS facilitation are considered in the concept of operations. These models will evolve as knowledge and regulations improve and experience drives efficiencies in processes. RPAS can also move between the models as global capability and technology develops.

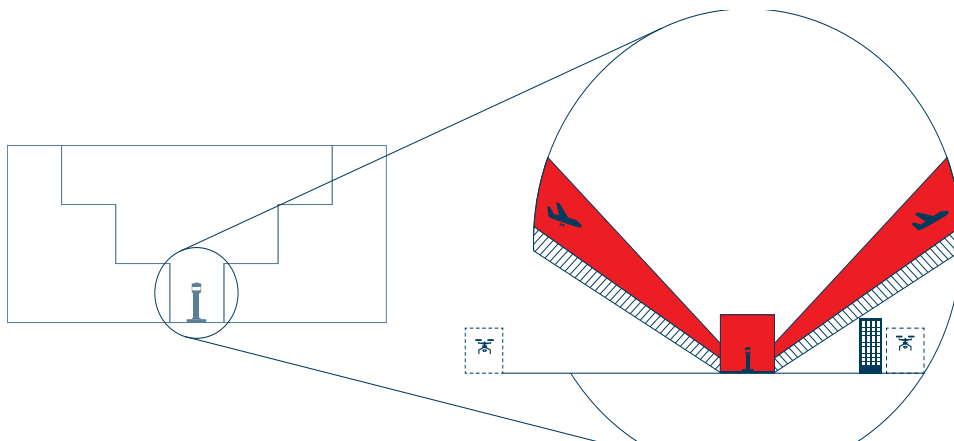
1. Segregated Operations: Operations which would normally impact on ATC but the characteristics of the requested location mean that direct interaction with ATC is not required and ATC can work independently around the RPAS operation. (E.g. contained within a PRD Area or operations in airspace "shielded" by terrain or obstacles);
2. Coordinated Operations: Operations where interaction with ATC is required as determined through assessment of the characteristics of the location and equipment levels and capability of the RPAS. These operations may require extensive assessment or may have an "RPAS Buffer" applied;
3. Integrated Operations: Operations where the equipment levels and capability of the RPAS are highly reflective of conventionally piloted aircraft and can be largely managed through pre-existent systems and processes.

4.3 Segregated Operations

Segregated Operations refer to RPAS operations at a location which would normally impact on ATC but the characteristics of the requested location mean that direct interaction with ATC is not required and ATC can work independently around the RPAS operation.

Prohibited/Restricted/Danger (PRD) Areas are the most easily identifiable locations for segregated operations and existing military PRD Areas will be increasingly used for RPAS operations. For civil operations, CASA is responsible for assessing the level of risk and determining if a Temporary PRD Area is required. For RPAS operations within PRD Areas, existing procedures are used by ATC to segregate other airspace users from the PRD Area.

Fig 7: Segregated RPAS Operations



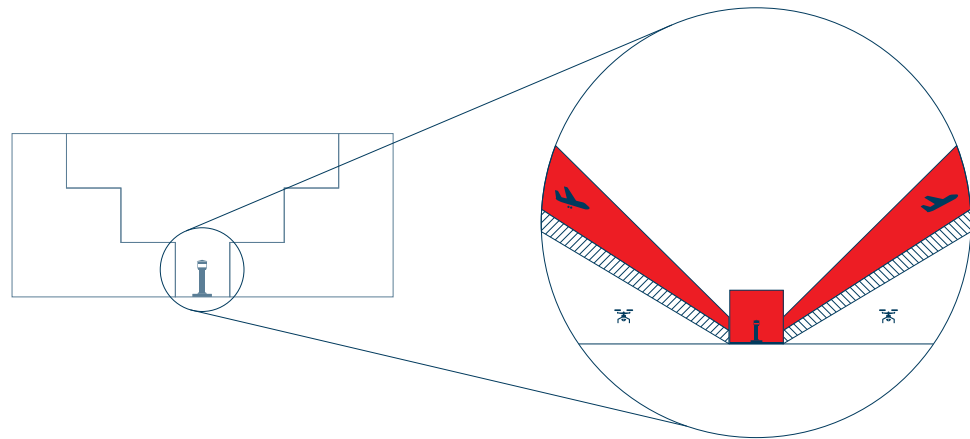
RPAS operations that are planned over a movement area, runway or approach/departure path of a controlled aerodrome but in close proximity to and beneath the height of a nearby terrain feature or man-made obstacle may be “shielded” from other airspace users by virtue of the terrain or obstacle.

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4.4. Coordinated Operations

Coordinated Operations refer to RPAS operations where interaction with ATC is required as determined through assessment of the characteristics of the location and equipment levels and capability of the RPAS.

Fig 8: Coordinated RPAS Operations



Coordinated Operations form the majority of requests received by Airservices and require the greatest consideration and development of procedures.¹⁰ At present, the majority of applications for these operations are within 3NM of a controlled aerodrome but the number of requests for operations above 400 feet AGL is increasing and is expected to expand into more frequent Beyond Visual Line of Sight (BVLOS) operations over time. Coordinated Operations require the application of RPAS Buffers: This refers to the development of a number of standard buffers for the segregation of aircraft and promulgation of these buffers in the National ATS Procedures Manual (NAPM). These buffers are similar in nature to separation standards applied between manned aircraft. Each RPAS operation is individually assessed in a similar manner to a manned aircraft request for the same operating area. For RPAS operations in low level airspace surrounding a controlled tower, Coordinated Operations will typically occur in the Amber RPAS Fly Zone.

¹⁰ Note: no segregation is provided between multiple RPAS operations unless compliant with CASR Part 172 Manual of Standards 10.11.5

Airservices RPAS Buffers

The development of standard buffers is being progressed to provide ATC with a series of tactical options to segregate RPAS operations from other airspace users. It is envisaged that as this work evolves and as RPAS operators and ATC become more familiar with the buffers and processes, RPAS operators will be able to contact ATC directly on the day of operations, similar to other airspace users such as survey flights and parachute operations. This will reduce the work involved in the assessment process and the operation may be accommodated subject to normal traffic considerations. This work is ongoing and further buffers will be published once assessed through the safety management system processes. As experience with RPAS operations in controlled airspace expands it is expected that the buffers constructed in the initial stages will be reviewed and refined.

Individual Assessments

For the foreseeable future, there will be a number of RPAS operations that will require Individual assessment due to the nature of the operation or the location. The assessment process is discussed in further detail in Para 5. It is envisaged that as the number of Individual Assessments will decrease over time as RPAS buffers are further developed and Green RPAS Fly Zones are promulgated.

4.5 Integrated Operations

Integrated Operations refer to RPAS operations where the equipment levels and capability of the RPAS are highly reflective of conventionally piloted aircraft. They can be largely managed through pre-existent systems and processes.

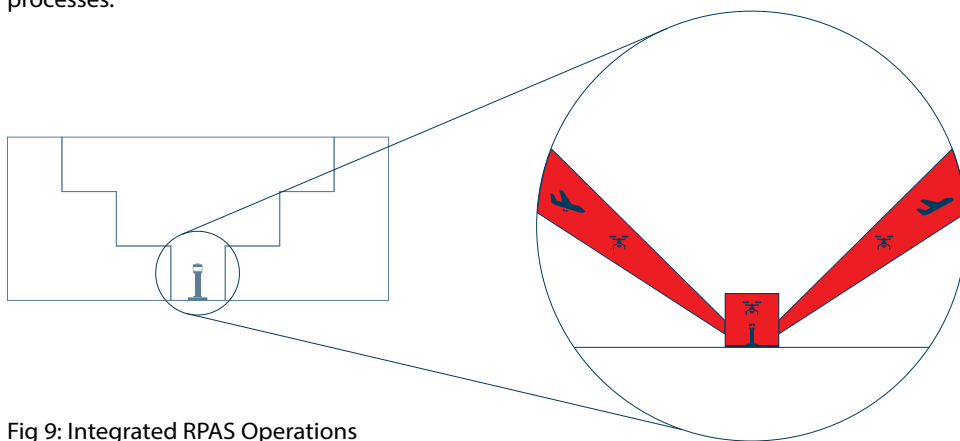


Fig 9: Integrated RPAS Operations

Integrated Operations typically meet the requirements of CASR Part 172, are capable of presenting real time navigational information using approved navigation systems and maintain continuous two way communications with ATC. Separation standards as per the Manual of Air Traffic Services are applied and the RPAS is effectively managed as an IFR aircraft.

Where elements of RPAS performance characteristics are subtly different to conventional aircraft, standards may have to be reviewed and amended as necessary. For example; in planning for the Global Hawk operation in Australian administered airspace in 2015, it was identified that the aircraft has a limited angle of bank when changing track. This resulted in the radar separation standard being increased for its operation.

Integrated Operations will not typically be associated with the low level airspace surrounding controlled aerodromes and RPAS Fly Zones will not typically be relevant to Integrated Operations.

5

RPAS Controlled Airspace Access Request Process

Specific RPAS operations within controlled airspace above 400 feet AGL or within 3NM of a controlled aerodrome are required to submit an application to CASA. Airservices is responsible for assessing these applications in order to facilitate access into the controlled airspace.

The function of assessing applications is managed by Operations Standards and Assurance. The application is examined and categorised according to;

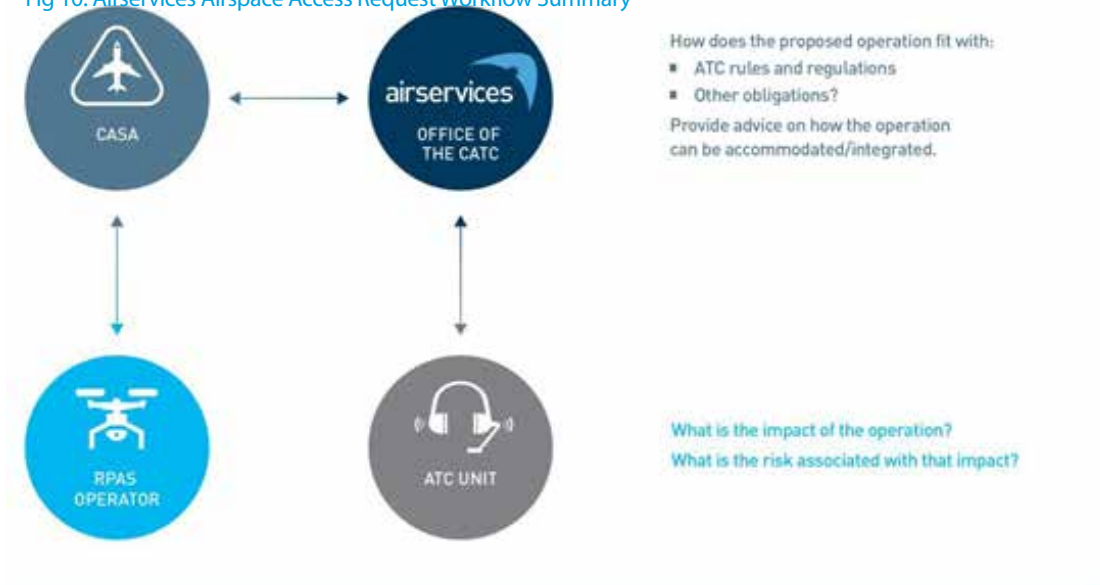
- ✓ RPAS equipment levels and capability;
- ✓ Location and height of the requested operation;
- ✓ The availability of terrain, obstacles or RPAS Safety Buffers which may be relevant to the operation;
- ✓ Conditions placed on the RPAS operators certificate; and
- ✓ Any other information relevant.

If the initial assessment determines that the RPAS operation may be feasible, Operations Standards and Assurance relays the application with the results of the initial assessment to the relevant operational ATC unit.

Line management in the ATC unit, in consultation with Operations Standards and Assurance, will examine the application with consideration of:

- ✓ Outcomes of the initial assessment;
- ✓ The compatibility of the RPAS operation with other planned operations and the impact of the RPAS operation on the overall operation; and
- ✓ The risk associated with the RPAS operation.

Fig 10: Airservices Airspace Access Request Workflow Summary



The assessment process will determine under what conditions the RPAS operation can be approved. The result of the assessment is provided to CASA by Operations Standards and Assurance. Airservices meets its permission requirements, as detailed in CASR Part 101, through this process. In essence, CASA acts as an agent for Airservices in respect of the CASR Part 101 Regulatory requirements for authorising operations.

As the regulations mature and as RPAS operators and ATC systems develop it is likely that requests for access to controlled airspace will be directed to the ATC unit responsible for the airspace in the first instance.. This process has been introduced for Emergency Services operations and may be expanded to cover commercial RPAS operators for regular or routine operations.

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RPAS Operations under 'Standard Operating Conditions' (SOC)

Standard Operating Conditions is a set of conditions under which very small RPAS weighing less than 2kg may be operated with minimal risk to manned aircraft and do not require direct ATC consideration or CASA authorisation. RPAS operated under the Standard Operating Conditions are not permitted within 3NM of a controlled aerodrome.



Regulatory Requirements

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National policy or regulatory position for surveillance, navigation or communication equipment for RPAS is in its infancy. At present, there is no standardised approach or framework which supports:

- ✓ The equipment level and capability required for RPAS integration;
- ✓ The minimum specifications for RPAS equipment in any airspace category; or
- ✓ Certification standards

This issue is compounded by the emerging development of low cost, often uncertified technology solutions. As one example there are several low power units in design based upon ADS-B technology. In many cases the traditional pathway for equipment certification is financially prohibitive to a point of creating an unviable environment for RPAS operators. This challenge is recognised globally and there are initiatives under way in various forums to address the issue.

8

Concept of Cost Recovery

Airservices is authorised under the Airservices Act to recover costs through the provision of charges for services and facilities. The conventional model for recovery is by way of air navigation charges described in the *Contract for the Provision of Aviation Facilities and Services*¹¹. The nature of RPAS and their operations do not suit this method nor would the extant process accurately represent the costs incurred by Airservices in accommodating RPAS operations.

The current authorisation processes involves the RPAS operator submitting the application to CASA, who in turn refer the application to Airservices with the final determination relayed back to the operator through CASA. Airservices interface with the RPAS operator is through CASA and it is proposed that Airservices cost recovery will leverage the existing process by having CASA recover Airservices costs from an RPAS operator with a periodic reconciliation to occur between CASA and Airservices. This process would be managed and overseen under authority of an agreement between the CASA and Airservices finance teams.

Future changes to the access process may result in a direct fee to operators or may result in an aviation charge through current pricing mechanisms for RPAS operations where the equipment levels and capability of the RPAS are highly reflective of conventionally piloted aircraft.

¹¹ <http://www.airservicesaustralia.com/services/charges-and-costing/customer-pricing-information/>

RPAS Safety Performance Management

9

A number of initiatives have been implemented to enhance Airservices Safety Performance Management capability for RPAS. This has included upgrades to the CIRRRIS system reporting module, changes to internal safety event review processes and the development of RPAS specific content for Executive and Board Safety Reporting purposes.

It is envisaged that there will be further enhancements to RPAS safety reporting and performance management systems in line with the operational enhancements discussed within this document. Discussions with the Australian Transport Safety Bureau (ATSB) and CASA have commenced to progress this initiative.



10

Conclusion

This RPAS concept document is designed to articulate, where Airservices have responsibility, the facilitation and integration of RPAS operations utilising known regulations and technology. The document also articulates the strategic direction and work in progress at Airservices to further enhance the integration of RPAS operations. As research, collaborations, regulatory and technology changes develop the concept will be revised to keep pace with those changes.

Appendix A

Regulatory and international framework (RPAS)

A.1 ICAO

The purpose of ICAO RPAS documentation is to:

- a. Apprise States of the emerging ICAO perspective on the integration of RPAS into non-segregated airspace and at aerodromes;
- b. Consider the fundamental differences from conventionally piloted aviation that such integration will involve; and
- c. Encourage States to help with the development of ICAO policy on RPAS by providing information on their own experiences associated with these aircraft.¹²

ICAO has made several UAS-related amendments to the Annexes since 2010. These include:

- ✓ Amendment 13 to Annex 13: Defining accident to include reference to unmanned aircraft (March 2010)
- ✓ Amendment 6 to Annex 7: Registration and identification requirements for remotely piloted aircraft (April 2012)
- ✓ Amendment 43 to Annex 2: High level requirements relating to remotely piloted aircraft systems (April 2012).
- ✓ Amendment 175 to the International Standards and Recommended Practices, Personnel Licensing (Annex 1 to the Convention on International Civil Aviation) was adopted by the Council on 7 March 2018. The amendment relates to the introduction of a regulatory structure for the issuance of remote pilot licences and the provision of a global framework for the regulation of RPAS licensing to support international flights operating under international instrument flight rules (IFR).

In 2015 ICAO also published Doc 10019 – Manual on Remotely Piloted Aircraft Systems (RPAS)

¹² Advisory Circular 328 AN/190 – Unmanned Aircraft Systems (UAS)

A.2 CASA

Regulation of RPAS within Australian administered airspace is contained in Part 101 of the Civil Aviation Safety Regulations 1988 (CASR). CASR Part 101 was enacted in July 2002 and considers all modes of unmanned aerial operation such as aircraft, rockets and balloons.

Part 101 includes the following Subparts:

- ✓ Subpart 101.B that imposes a general prohibition on the hazardous operation of unmanned aircraft
- ✓ Subpart 101.C that imposes a range of obligations in relation to the operation of unmanned aircraft generally
- ✓ Subpart 101.D that comprises specific provisions for the regulation of tethered balloons and kites
- ✓ Subpart 101.E that comprises specific provisions for the regulation of unmanned free balloons
- ✓ Subpart 101.F that comprises specific provisions for the regulation of remotely piloted aircraft (RPA)
- ✓ Subpart 101.G that comprises specific provisions for the regulation of model aircraft
- ✓ RPAS¹³ are addressed specifically under Sub-part F

A significant element of Part 101 is the exemption extended to aircraft regulated under the part from other major components of Civil Aviation Regulations.

101.020 Exemption from certain other provisions of CAR 1988

Parts 4, 4A, 4B, 4C, 5, 7, 9, 10, 11, 12, 13 and 14 of CAR 1988 do not apply to an aircraft to which this Part applies, nor to a micro UAV.¹⁴

Of particular relevance to Airservices are the consequences which arise from the exemption of RPAS operations from the provisions of the following CAR's:

- ✓ Part 4, Airworthiness Requirements,
- ✓ Part 10, Air Traffic Services and other Services
- ✓ Part 11, Conditions of Flight
- ✓ Part 12, Rules of the Air.

A significant amendment to CASR Part 101 and corresponding AC 101-10 took effect on the 29th Sep 2016 facilitating operation of excluded RPA. Excluded RPA operating in accordance with 'Standard operating Conditions' (SOC) do not require specific authorisation from CASA.

AC 101-10 Remotely piloted aircraft systems - operation of excluded RPA

<https://www.casa.gov.au/files/ac10110pdf>

Following a public consultation process CASA issued Instrument 96/17 on the 17th Oct 2017 clarifying the application of Part 101 and strengthening content where it was deemed deficient.

Direction – Operation of certain unmanned aircraft (CASA ruling on changes to CASR 101)

<https://www.legislation.gov.au/Details/F2017L01370/Download>

It is recognised by CASA that the current regulatory construct for RPAS requires modernisation to keep pace with RPAS segment developments. This has been addressed by CASA through the generation of several regulatory projects.

CASA will ultimately modernise CASR Part 101 into CASR Part 102.

¹³ Referred to in the Regulations as Unmanned Aerial Vehicles (UAV)

¹⁴ Civil Aviation Safety Regulations 1988, s101.020

Appendix B

Remotely Piloted Aircraft Systems: Overview

Any aircraft intended to operate without a pilot aboard may be categorised generally as an RPAS. The operation of an unmanned aerial vehicle while retaining a level of manual intervention and control relies on a network of human and technical systems working together.

B.1 System components

B.1.1 Remotely piloted aircraft (RPA)

Remotely piloted aircraft are an unmanned aircraft which are controlled by a remote pilot through a remote pilot station located external to the aircraft.

Some functions of the RPAS may be automated but in normal operation there always remains an element of manual intervention and control present.

B.1.2 Remote pilot (RP)

The remote pilot (RP) is located external to the aircraft and maintains control of the RPA through a remote pilot station. Remote pilots may be assisted by other crew members but it is the RP who has direct responsibility for the safe conduct of the aircraft throughout its flight.

It is the presence of a remote pilot within the system which distinguishes RPAS operations from other unmanned aerial systems.

B.1.3 Remote pilot station (RPS)

Any device through which the RP controls an RPA is considered a Remote Pilot Station (RPS). These vary in sophistication from smart phones to complex control suites, sometimes with multiple displays intentionally designed to replicate an aircraft flight deck¹⁵.

B.1.4 Command and Control (C2) Link

The data link between the RPS and the RPA, over which the flight is managed, is the Command and Control (C2) link. The C2 link may be direct between the RPS and RPA or relayed through an intermediate vehicle such as a satellite. The C2 link may perform four basic functions:

- ✓ Relay of the remote pilot's instructions to the aircraft over the telecommand or uplink
- ✓ RPA response, status and health reporting over the telemetry or downlink
- ✓ Communication, carrying air-ground or air-air communications between the RP and ATC or other aircraft
- ✓ Payload command and control; uplink, downlink and communications functions specific to the operation of the payload carried by the RPA.

No certification standards have yet been established for C2 and various media are used from 3G mobile signals to satellite communications.

The robustness of the C2 link, particularly the telecommand and telemetry components is an important consideration for the integration of RPAS into ATM operations. This is discussed below under 'Lost Link'.

15 ICAO Doc 10019, Manual on Remotely Piloted Aircraft Systems (RPAS), s1.5.2(c)

B.1.5 Payload

Equipment or objects carried by the RPA but which are not essential to flight are Payload.

Physical payload is an element of the system and while it may influence the nature and demands of the mission or the performance of the RPA it is not an element that directly concerns ATM.

B.1.5.1 Launch and Recovery Equipment

Many, particularly smaller, RPA are capable of take-off and landing without needing a conventional runway or helipad. Utilising launch and recovery equipment like catapult, arrestor net or parachute recovery systems smaller RPAS may be capable of operating to and from almost anywhere.

B.1.5.2 Flight Termination System

A Flight Termination System allows for the deliberate, safe and controlled termination of flight in the event of an emergency. The system may be initiated by the remote pilot or automatically based on a programmed series of failures or events. A primary consideration in determining the appropriate mode of termination will be to minimise the possibility of harm to other persons, property or aircraft on the ground or in the air.

B.2 Operational characteristics

The nature of RPAS and their operational characteristics introduce several concepts which are either new to the ATM domain or sufficiently different from conventionally piloted aircraft operations to warrant further consideration.

B.2.1 Visual Line of Sight (VLOS)

A visual line of sight operation is one in which the remote pilot maintains direct visual contact with the aircraft to manage its flight and meet separation and collision avoidance responsibilities. This is the basis for the majority of operations currently being approved by CASA.

The requirement to maintain visual contact with the RPA allows the delegation of collision avoidance accountability to the remote pilot.

CASA are currently facilitating discussions to enable extension of RPAS operations beyond the line of sight of the remote pilot in cases where a trained observer is able to maintain visual line of sight with the RPA and direct communication with the RP. This mode of operation is currently referred to as Extended Visual Line of Sight (EVLOS).

Operations which cannot be conducted as VLOS or EVLOS are classified as Beyond Visual Line of Sight (BVLOS).

B.2.2 Detect and Avoid

At the time of writing academic research and technology developments for RPAS operations are primarily focused on enabling BVLOS operations through the development of what is termed Detect and Avoid (DAA) technology.

This technology once established is cited as the key enabler for RPAS operations especially those outside segregated airspace.

Detect and avoid is defined in Annex 2 as “the capability to see, sense or detect conflicting traffic or other hazards and take the appropriate action”. This capability aims to ensure the safe execution of an RPA flight and to enable full integration in all airspace classes with all airspace users⁹.

B.2.3 Lost Link

The loss of command and control link contact with the RPA such that the remote pilot can no longer manage the aircraft’s flight is a key consideration for all RPAS operations. Lost link procedures are assessed during CASA’s process for issuing operational permissions.

Common procedures for RPAS who experience a lost link are return to the point of origin, loiter to establish C2 link or flight termination at or close to current position.

When there is a loss of C2 link the RP cannot intervene in an RPAS flight trajectory and the RPAS may be limited to performing automated actions. It is possible in extreme circumstances that an RPAS may experience what is termed a flyaway, characterised by a fully unrestrained operation.

A loss of C2 link should not be equated to a failure of voice communication with ATC.

B.2.4 First Person View (FPV)

First Person View (FPV) refers to a device which generates and transmits a video image from a remotely piloted aircraft to a ground station providing the remote pilot the illusion of an onboard pilot’s perspective.

While FPV may be a useful aid to navigation in BVLOS applications, limitations of field of view, depth perception, downlink bandwidth and signal reliability mean it cannot yet be considered as the basis of an acceptable DAA capability.

B.2.5 ATC Communications Paths

RPAS communication with ATC should be equivalent to manned aircraft capability for the relevant airspace or operation. However, as the RP is not on board the aircraft and equivalent communication performance may be difficult to achieve a range of alternative communication architectures may be used. These may include:

- ✓ Retransmission through the RPA
- ✓ Hand held VHF transceiver
- ✓ The use of alternate frequencies
- ✓ The use of a mobile phone or Potable Electronic Device (PED) as a contingency or backup solution only.

Note: The use of a mobile phone/PED as a primary means of communication with ATC is

generally not acceptable. In very rare circumstances where a mobile phone/PED is the only achievable means of communication a safety assessment may be considered.

A range of contemporary communication solutions for the RPAS industry are in development and it is likely that the range of alternate options will expand over time.

B.2.6 Handover

Responsibility for the control of a remotely piloted aircraft may be handed over in-flight between pilots using the same RPS, between different stations at the same site, or between RPS located distant from each other. In some circumstances handover is achieved by the use of deliberate temporary C2 link disruption.

Long range, long endurance operations may use a local RP/RPS for take-off and landing with handover to RP/RPS in distant locations for control of the balance of the mission. Handover capability may be particularly useful in the case of an RPS failure or maintenance issue, allowing the flight to continue without losing control of the RPA.

Appendix C Referenced Documents

Title	Identification
Manual of Standards Part 172 – Air Traffic Services	MOS Part 172
Civil Aviation Safety Regulations 1998	CASR 1998
Civil Aviation Regulations 1998	CAR 1998
Manual on Remotely Piloted Aircraft Systems (RPAS)	ICAO Doc 10019
Unmanned Aircraft Systems (UAS)	ICAO Cir 328
Manual of Air Traffic Services (MATS)	MATS

