

APPENDIX A

MODULE NO. B1-90: INITIAL INTEGRATION OF REMOTELY PILOTED AIRCRAFT (RPA) INTO NON-SEGREGATED AIRSPACE

Summary	Implementation of basic procedures for operating remotely piloted aircraft (RPA) in non-segregated airspace including detect and avoid.	
Main performance impact as per Doc 9854	KPA-01 – Access and equity, KPA-10 – Safety.	
Operating environment/ Phases of flight	En-route, oceanic, terminal (arrival and departure), aerodrome (taxi, take-off and landing)	
Applicability considerations	Applies to all RPA operating in non-segregated airspace and at aerodromes. Requires good synchronization of airborne and ground deployment to generate significant benefits, in particular to those able to meet minimum certification and equipment requirements.	
Global concept component(s) as per Doc 9854	AOM – airspace organization and management AUO – airspace user operations CM – conflict management	
Global plan initiatives (GPI)	GPI-6: Air traffic flow management GPI-9: Situational awareness GPI-12 Functional integration of ground systems with airborne systems GPI-17: Data link applications	
Main dependencies	Nil	
Global readiness checklists		Status
	Standards readiness	Est. 2018
	Avionics availability	Est. 2018
	Ground systems availability	Est. 2018
	Procedures available	Est. 2018
	Operations approvals	Est. 2018

1. NARRATIVE

1.1 General

1.1.1 This module will discuss the baseline on which the further improvements discussed will be based. The aim is to move from initial accommodation of remotely piloted aircraft (RPA), to integration into traffic within non-segregated airspace, and finally to full transparent operation within the airspace. Block 1 is the first step in this process. The Block 1 improvements are:

- a) streamlined process to access non-segregated airspace;
- b) airworthiness certification for RPA;
- c) operator certification;
- d) remote pilot licensing requirements;

- e) detect and avoid technology performance requirements; and
- f) communication performance requirements.

1.1.2 Below is a list of definitions that are used in this module.

Command and control (C2) link. 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.

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

Detect and avoid. The capability to see, sense or detect conflicting traffic or other hazards and take the appropriate action.

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

Note.— In the context of remotely piloted aircraft, an aircraft operation includes the remotely piloted aircraft system.

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 station (RPS). 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 which 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 approved 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.

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

1.2 Baseline

1.2.1 The baseline for this module is a situation where RPA are only used in segregated airspace.

1.3 Change brought by the module

1.3.1 The module provides for the implementation of basic procedures for operating RPA in non-segregated airspace including detect and avoid. This includes the following actions:

- a) **Streamline process to access non-segregated airspace:** State authorities will need to consider if current national/regional processes are adequate for enabling the level of airspace access necessary to accomplish all missions proposed or envisioned for RPA flights. While international RPAS Standards and Recommended Practices (SARPs) are being developed, national and/or regional authorization processes will be used to access airspace. Methods for improving and streamlining these processes will be worked on during this time frame. Approval to use existing technologies, such as ground-based detect and avoid systems, may support access to airspace through enhanced collision avoidance capability. This will allow authorities to streamline the process to grant authorization for airspace access.
- b) **Defining airworthiness certification for RPA:** Standards committees (such as RTCA SC-203, ASTM F 38, EUROCAE WG 73, and others) will continue their work in the Block 1 time frame, developing minimum aviation system performance standards (MASPS). Certification takes into account system configuration, usage, environment, and the hardware and software of the entire system (e.g. aircraft, remote pilot stations, C2 links). It also considers design characteristics, production processes, reliability, and in-service maintenance procedures that adequately mitigate risk of injury/damage to people, property or other aircraft. EASA's rulemaking directorate has issued policy statement E. Y013-01 for airworthiness certification of RPAS that outlines procedures for type certification of civil RPA once standards have been established. Technical standards might be used to certify specific components of the RPAS. The certificate of airworthiness will be issued to the aircraft while considering the entire system. The C2 links will have to meet identified performance requirements. Certification standards and procedures will need to be worked out during this time frame.
- c) **Define operator certification:** The operator has responsibility for operational control and configuration management of the RPAS. In order to obtain an Operator Certificate, processes and procedures must be established that ensure laws, regulations and procedures of those States in which operations are conducted are complied with. Operators must have programmes in place related to personnel training, continuing airworthiness, maintenance and safety management.
- d) **Define communication performance requirements:** Requirements to support command and control (C2) and ATC communications commensurate with the level of airspace access will be needed. These performance-based requirements will be developed and certified to support the RPAS operational improvements. The technology needs to support all aspects of removing the pilot from the aircraft such as the ability to manage the trajectory of the RPA and display of the on-board avionics. The security of the C2 links must be assured for all operations beyond line-of-sight. Likewise performance requirements related to reliability, availability and latency will need to be developed.
- e) **Define remote pilot licensing requirements:** Requirements for the remote pilot licence will have many similarities to those of pilots, however new factors such as

ratings for both the remote pilot station (RPS) and RPA will be included. Medical provisions will be addressed concurrently and will focus on the unique environment presented by RPAS.

- f) **Define detect and avoid technology performance requirements:** These performance-based requirements will be developed and certified to support the RPAS operational improvements as discussed above. The technology will be developed in conjunction with other risk mitigation efforts to gain incremental access to the airspace. Initial capabilities may include ground-based detect and avoid systems consisting of any combination of policy, procedures, and technology derived from ground-based sensors intended to facilitate safe airspace access over land or water. Surveillance (radar, automatic dependent surveillance – broadcast (ADS-B)) initiatives will help gather, test, and verify data, along with the appropriate modeling and simulation activities, to establish requirements and build an overall safety case for detect and avoid. The detect and avoid technology will be used by the remote pilot to meet collision and hazard avoidance responsibility and provide situational awareness.

2. INTENDED PERFORMANCE OPERATIONAL IMPROVEMENT

2.1 Metrics to determine the success of the module are proposed in the *Manual on Global Performance of the Air Navigation System* (Doc 9883).

<i>Access and Equity</i>	Limited access to airspace by a new category of users.
<i>Safety</i>	Increased situational awareness; controlled use of aircraft.
<i>Cost Benefit Analysis</i>	The business case is directly related to the economic value of the aviation applications supported by RPAS.

3. NECESSARY PROCEDURES (AIR AND GROUND)

3.1 It is anticipated that as the improvements take shape in this block, air traffic services and procedures will have to change to accommodate these new airspace users. RPAS procedures such as C2 link failure will need to be standardized and may include a specific transponder code or ADS-B emergency mode. Additional procedures may include separation standards; ATC phraseology; and voice/data communications means between remote pilot and ATC.

4. NECESSARY SYSTEM CAPABILITY

4.1 Avionics

4.1.1 The RPA must have the equipment and avionics which collect the data necessary for the remote pilot in the RPS to control the flight path of the aircraft and carry out any required procedural manoeuvres. The implications of the remote pilot being external to the aircraft will require a review of the data required to observe the operating limitations of the aircraft in the expected operating conditions. New indicators may be needed in the RPS to depict the additional types of data (system health monitoring, environmental conditions, etc) being provided by the on-board avionics.

4.1.2 Technology is being developed to demonstrate an airborne detect and avoid system (ABDAA) for RPA which must be able to fulfil the requirements for mid-air collision avoidance in non-segregated airspace for both cooperative and non-cooperative targets. This technology is not yet addressing other hazards or ground manoeuvring support tools.

4.2 Ground systems

4.2.1 Ground-based detect and avoid (GBDAA) is the technology in this time frame envisioned to afford the greatest return on investment to allow better access to non-segregated airspace. This technology will improve the “detect and avoid” situational awareness for the remote pilot within the specific coverage areas defined by the systems and has the potential to be the near/midterm solution to the detect and avoid problem plaguing the RPAS community. This approach is currently utilized on a limited basis and may become a global approach in this time frame.

5. HUMAN PERFORMANCE

5.1 Human factors considerations

5.1.1 The controller-pilot relationship is changing and will need to be investigated. Specific training for controllers, remote pilots and pilots (manned aircraft) will be required, in particular with respect to the new detect and avoid situations.

5.1.2 The identification of Human Factors considerations is an important enabler in identifying processes and procedures for this module. In particular, the human-machine interface for the automation aspects of this performance improvement will need to be considered and where necessary accompanied by risk mitigation strategies such as training, education and redundancy.

5.2 Training and qualification requirements

5.2.1 Training in the operational standards and procedures will be identified along with SARPs necessary for this module to be implemented. Likewise the qualifications requirements will be identified and included in the regulatory readiness aspects of this module when they become available.

5.2.2 Medical qualifications will need to be identified and may include psychological components.

6. REGULATORY/STANDARDIZATION NEEDS AND APPROVAL PLAN (AIR AND GROUND)

- Regulatory/standardization: new or updated requirements for RPAS operations are needed that include baseline standards and guidance material.
- Approval plans: to be determined, based upon State or regional applications.

7. **IMPLEMENTATION AND DEMONSTRATION ACTIVITIES (AS KNOWN AT TIME OF WRITING)**

7.1 **Current use**

- The United States specifically the FAA, is in the review process for defining “small UAS” procedures: once small UAS procedures are approved, small UAS operations in the U.S. outside of military operating areas may be permitted, first in unpopulated, then sparsely populated areas. Small UAS policy will be based on the successive expansions of their use and the rules and procedures that are established. These small UAS procedures will continue to be developed to allow small UAS to operate in more types of airspace. Visual line-of-sight (VLOS) will be used to provide detect and avoid mitigation for these UAS. This is a US-focused approach that currently may not apply for other States.
- Some States are looking at localized ground-based detect and avoid (GBDAA) technology to support the detect and avoid requirements.
- **Europe:** EUROCONTROL is in the process of integrating an RPA in Class C and D airspace under IFR and VFR. Detect and avoid is mitigated through GBDAA and scanning through the on-board camera system. This will enable further integration.
- The MIDCAS consortium is developing a detect and avoid test bed that should be available for testing beginning in 2012.
- In regard to VLOS, the Netherlands will certify an RPAS this year (civil certified).
- Euro Hawk is flying in controlled airspace as “operational air traffic”.
- EUROCAE has finalized its work on a guidance document for VLOS.
- A strategy document outlining EC policy on UAS is in preparation through an EC UAS panel, addressing industry and market issues, UAS insertion and spectrum, safety, societal dimensions and R&D.
- Legal framework for the development of AMC is in place. EASA will only deal with UAS with a mass greater than 150 kg.

7.2 **Planned or ongoing trials**

- In the United States and Europe, several civil applications, initially VLOS and more integration of civil IFR/VFR operations in this time frame are expected based on full certification and special authorization.
- **United States:** Demonstrating enhanced voice communications through a digital network radio system, the use of surveillance information on a CDTI in 2012.
- Requirements for frequency spectrum for RPAS will be established in this time frame.
- SESAR addresses UAS within WPs 9, 11 and 15.

- The European Defence Agency has launched the MIDCAS project. It is addressing detect and avoid from both military and civil perspectives. The budget is 50 million Euros and it is expected to produce a working prototype for detect and avoid application by the end of 2013.
- Mercator, an ultra-light UAS that is solar/battery powered for long duration flights at around FL450 is being tested in Belgian airspace to demonstrate a UAS flight in a busy ATM environment.

8. REFERENCE DOCUMENTS

8.1 Standards

- ICAO Annex 1 — *Personnel Licensing*
- ICAO Annex 2 — *Rules of the Air*
- ICAO Annex 6 — *Operation of Aircraft*
- ICAO Annex 7 — *Aircraft Nationality and Registration Marks*
- ICAO Annex 8 — *Airworthiness of Aircraft*
- ICAO Annex 10 — *Aeronautical Telecommunications, Volume II — Communication Procedures including those with PANS status*
- ICAO Annex 13 — *Aircraft Accident and Incident Investigation*
- U.S. Department of Transportation FAA, Air Traffic Organization Policy N JO 7210.766
- NATO STANAG 4586, *Standard Interfaces of UAV Control System (UCS) for NATO UAV Interoperability*

8.2 Guidance material

- ICAO Circ 328, *Unmanned Aircraft Systems (UAS)*
- ICAO RPAS Guidance Manual (under development)

8.3 Approval documents

- EUROCAE Documents (under development)
- RTCA Documents (under development)
- New guidance material needed for type certification, certificate of airworthiness, operator certificate, remote pilot licence, frequency spectrum, communications, and detect and avoid

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APPENDIX B

MODULE NO. B2-90: REMOTELY PILOTED AIRCRAFT (RPA) INTEGRATION IN TRAFFIC

Summary	Continuing to improve the remotely piloted aircraft (RPA) access to non-segregated airspace; continuing to improve the remotely piloted aircraft systems (RPAS) approval/certification processes; continuing to define and refine the RPAS operational procedures; continuing to refine communication performance requirements; standardizing the command and control (C2) link failure procedures and agreeing on a unique squawk code for C2 link failure; and working on detect and avoid technologies, to include automatic dependent surveillance – broadcast (ADS-B) and algorithm development to integrate RPA into the airspace.	
Main performance impact as per Doc 9854	KPA-01 – Access and equity, KPA-10 – Safety.	
Operating environment/ Phases of flight	All phases of flight including taxi	
Applicability considerations	Applies to all RPA operating in non-segregated airspace and at aerodromes. Requires good synchronization of airborne and ground deployment to generate significant benefits, in particular to those able to meet minimum certification and equipment requirements.	
Global concept component(s) as per Doc 9854	AOM – airspace organization and management CM – conflict management AUO – airspace user operations	
Global plan initiatives (GPI)	GPI-9: Situational awareness GPI-12: Functional integration of ground systems with airborne systems GPI-17: Data link applications	
Main dependencies	B1-90	
Global readiness checklist		Status (indicate ready with a tick or input date)
	Standards readiness	Est. 2023
	Avionics availability	Est. 2023
	Ground systems availability	Est. 2023
	Procedures available	Est. 2023
	Operations approvals	Est. 2023

1. NARRATIVE

1.1 General

1.1.1 Based on Block 1, Initial integration of remotely piloted aircraft (RPA) in non-segregated airspace, Block 2 includes the procedures and technology that are possible in the Block 2 timeframe.

1.2 Baseline

1.2.1 The baseline is the initial accommodation of RPA in non-segregated airspace provided by module B1-90.

1.3 Changes brought by the module

1.3.1 This module brings a number of improvements in procedures and uses the experience accumulated with B1-90 as well as developments in technology to enable the further integration of RPA in traffic, thereby expanding the RPA applications while maintaining levels of safety. The projected changes related to this module include:

- **Access to most airspace for select airframes without specific airspace constraints:** As aircraft certification (based on an established safety case for a particular RPA system – airframe, C2 link, and remote pilot station (RPS)) is developed and procedures are defined, airspace constraints will gradually be lifted and specific RPA will be permitted to fly in more situations. In the Block 2 timeframe, this will start with a very small number of RPA, but will be permitted to grow as RPA prove they can meet standards, and certification and procedures are developed. This access will be based on the improvements to the RPAS, the developed technology, (ground-based detect and avoid (GBDAA), ADS-B, and specific C2 link failure code) and improved ATM procedures.
- **RPA certification procedures:** Using minimal aircraft system performance specification (MASPS) developed by standards committees or adopted by ICAO, material solutions will be developed for integration into RPAS. As these solutions are integrated into selected RPAS, the RPA will go through the process of being certified airworthy. Airworthiness and certification are based on well-established airworthiness design standards. Therefore the following related issues will have to be addressed:
 - Standards and Recommended Practices (SARPs) and Procedures for agreed RPA classes
 - SARPs and procedures for remote pilot stations (RPS)
 - Provisions for C2 links
 - Possible rule changes to set forth a type standard for various RPA
 - Modification of type design (or restricted category) standards to account for unique RPA features (e.g. removal of windscreens, crashworthiness standards, piloting handover from one RPS to another, etc.)
- **RPA procedures defined:** Procedures outlined below will be developed to permit selected RPA (proven airworthy) to fly in non-segregated airspace with manned aircraft. Training for remote pilots, pilots and ATC personnel must be developed to accommodate these RPA:
 - **Standardized C2 link failure procedures**
 - **New special purpose transponder code for C2 link failure:** A new transponder code will be developed so that the ATC automation can differentiate RPA C2 link failure from two-way radio communication failures. Because transponder codes cannot be received over the high seas, RPA will broadcast position to nearby aircraft via ADS-B. If ADS-C is mandated for high seas RPA, C2 link failure position may be tracked by ATC if that electronic link remains intact.
 - **Revised separation criteria and/or handling procedures (i.e. moving airspace)**

- **ADS-B on most RPA classes:** It is envisioned that ADS-B will be included on most new RPA being built during this time period and a retrofit program should be established for older aircraft.
- **Communication performance requirements** to support command and control (C2) and ATC communications will be refined. Security, reliability, availability and latency requirements will be increased to match the greater level of airspace access granted to RPA.
- **Detect and avoid technologies** will be improved and certified to support RPA and operational improvements. Ground-based detect and avoid (GBDAA) will be certified and approved for more pieces of airspace. Other approaches to consider include an on-board (airborne) detect and avoid solution (ABDAA). ABDAA efforts are currently focused on developing the capability to perform both airborne separation and collision avoidance on board the aircraft that ensure an appropriate level of safety even in the event of command and control link failure. The initial capability will provide an ability to collect and analyze valuable data for developing a robust airborne DAA system.
- **Protected spectrum and security**¹ this necessitates the use of designated frequency bands, i.e. those reserved for aeronautical safety and regularity of flight under aeronautical mobile (route) service (AM(R)S), aeronautical mobile satellite (route) service (AMS(R)S), aeronautical radio navigation service (ARNS) and aeronautical radio navigation satellite service (ARNSS) allocations as defined in the ITU radio regulations. It is essential that any communications between the RPS and RPA for C2 meet the performance requirement applicable for that airspace and/or operation, as determined by the appropriate authority. SATCOM links may require a backup.

1.3.2 This might lead to a utilization scheme, still to be discussed and validated, as follows:

Block 2	Class B and C	Class A Airspace (other than High Seas)	High Seas (Class A Airspace)	Class D, E, F, and G
Authorization	Strict compliance with the provisions of the authorization is required			Operations not permitted, unless by waiver or authorization
C2 Link Failure Procedures	Will follow standardized procedures. A special purpose transponder code will be established.		Will follow standardized procedures.	
ATC Communications	Continuous two-way communications as required for the airspace. RPA will squawk 7600 in case of communication failure with ATC.		Continuous two-way communications will be maintained directly or via a service provider (e.g. ARINC or SITA) depending on location and operation.	
Separation Minima	New separation minima may be required		Separation criteria will be analyzed and special separation criteria might be	

¹ ICAO Cir 328, *Unmanned Aircraft Systems (UAS)*

		developed.	
ATC Instructions	RPAS will comply with ATC instructions as required		
RPA Observers	As required for the operation		
Medical	Remote pilots shall have an appropriate medical certificate		
Presence of Other Aircraft	RPAS shall not increase safety risk to the air navigation system		
Visual Separation	Visual separation may be permitted.	TBD	
Responsibility of Remote Pilot	Remote pilot is responsible for compliance with the rules of the air and adherence with the authorization		
Populated Areas	Restrictions to be determined by the State.	Not applicable	
ATC Services	Consistent with Annex 11,		
Flight Plan	RPAS operations, except VLOS, shall be conducted in accordance with IFR. Flight plans shall be filed.		
Meteorological Conditions	Restrictions to be determined by the State		
Transponder	Shall have and use an operating mode C/S transponder		
Safety	Identify the hazards and mitigate the safety risks; adhere to the authorization		
NOTAMs	NOTAM requirements, if any, to be determined by the State		
Certification	TBD		

2. INTENDED PERFORMANCE OPERATIONAL IMPROVEMENT

2.1 Metrics to determine the success of the module are proposed in the *Manual on Global Performance of the Air Navigation System* (Doc 9883).

<i>Access and Equity</i>	Access to airspace by a new category of users.
<i>Safety</i>	Increased situational awareness; controlled use of aircraft
<i>Cost Benefit Analysis</i>	The business case is directly related to the economic value of the aviation applications supported by RPAS.

3. NECESSARY PROCEDURES (AIR AND GROUND)

3.1 Improved air traffic management (ATM) procedures will need to be in place to allow the access of RPA into non-segregated airspace. Specifically:

- a) ATM provisions need to be amended to accommodate RPA taking into account the unique operational characteristics of each RPA type as well as their automation and non-traditional IFR/VFR capabilities;
- b) air navigation service providers will need to review emergency and contingency procedures to take account of unique RPA failure modes such as C2 link failure, to include standardized procedures, and a new special purpose transponder code. Consideration will also be needed of procedures that may be necessary if the RPA is using an alternate C2 link that results in excessive delay in responding to RPA pilot inputs;

- c) terminal areas may need to modify their procedures to allow for the increased volume of RPA activity; and
- d) ground operations may need to be modified to accommodate the increased activity of RPA as well.

3.2 Improved RPA certification procedures will need to be developed, as well as standardized C2 link failure procedures. As ABDAA algorithms are developed, associated RPA operations procedures will need to be developed.

4. NECESSARY SYSTEM CAPABILITY

4.1 Avionics

- ADS-B OUT on most RPA as well as manned aircraft
- Preliminary development and testing of airborne detect and avoid technologies

4.2 Ground systems

- GBDAAs where applicable
- ATC automation will need to be able to respond to the new C2 link failure code
- Automatic position reporting to ATC capability for C2 link failure over high seas

5. HUMAN PERFORMANCE

5.1 Human factors considerations

5.1.1 The controller-pilot relationship is changing and will need to be investigated. Specific training for controllers, remote pilots and pilots will be required, in particular with respect to the new detect and avoid situations.

5.1.2 This module is still in the research and development phase so the Human Factors considerations are still in the process of being identified through modelling and beta testing. Future iterations of this document will become more specific about the processes and procedures necessary to take the Human Factors considerations into account. There will be a particular emphasis on identifying the human-machine interface issues if there are any and providing the high risk mitigation strategies to account for them.

5.2 Training and qualification requirements

5.2.1 This module will eventually contain a number of personnel training requirements. As and when they are developed, they will be included in the documentation supporting this module and their importance highlighted. Likewise, any qualifications requirements that are recommended will become part of the regulatory needs prior to implementation of this performance improvement.

6. REGULATORY/STANDARDIZATION NEEDS AND APPROVAL PLAN (AIR AND GROUND)

- Regulatory/standardization: new or updated requirements and standards are needed that include:
 - C2 link failure standards and procedures;
 - specific special purpose transponder code for C2 link failure;
 - updated ATM procedures to allow for the integration of RPA into en-route and terminal airspace; and
 - updated airworthiness standards and procedures
- Approval plans: to be determined.

7. IMPLEMENTATION AND DEMONSTRATION ACTIVITIES (AS KNOWN AT TIME OF WRITING)

7.1 Planned or ongoing trials

- **Europe:** So far all strategies are aimed at full integration within the timeframe of Block 2. SESAR will address this. ADS-B and SATCOM are on the agenda. RPA and manned operations will be integrated at airports. The Separation and Airspace Safety Panel (SASP) will determine the separation minima.
- **United States:** Demonstrating the capability to integrate RPA into the NAS using ADS-B and addressable voice over IP communications.

8. REFERENCE DOCUMENTS

8.1 Standards

- ICAO Annex 1 — *Personnel Licensing*
- ICAO Annex 2 — *Rules of the Air*
- ICAO Annex 3 — *Meteorological Service for International Air Navigation*
- ICAO Annex 4 — *Aeronautical Charts*
- ICAO Annex 6 — *Operation of Aircraft*
- ICAO Annex 7 — *Aircraft Nationality and Registration Marks*
- ICAO Annex 8 — *Airworthiness of Aircraft*
- ICAO Annex 10 — *Aeronautical Telecommunications, Volume II — Communication Procedures including those with PANS status*
- ICAO Annex 10 — *Aeronautical Telecommunications, Volume IV — Surveillance and Collision Avoidance Systems*
- ICAO Annex 11 — *Air Traffic Services*
- ICAO Annex 12 — *Search and Rescue*
- ICAO Annex 13 — *Aircraft Accident and Incident Investigation*
- ICAO Annex 15 — *Aeronautical Information Services*
- ICAO Annex 17 — *Security — Safeguarding International Civil Aviation against Acts of Unlawful Interference*

- U.S. Department of Transportation FAA, Air Traffic Organization Policy N JO 7210.766
- NATO STANAG 4586, *Standard Interfaces of UAV Control System (UCS) for NATO UAV Interoperability*

8.2 **Guidance material**

- ICAO RPAS Guidance Manual

8.3 **Approval documents**

- EUROCAE Documents
- RTCA Documents

APPENDIX C

MODULE NO. B3-90: REMOTELY PILOTED AIRCRAFT (RPA) TRANSPARENT MANAGEMENT

Summary	Continuing to improve the certification process for remotely piloted aircraft (RPA) in all classes of airspace, working on developing a reliable C2 link, developing and certifying airborne detect and avoid (ABDAA) algorithms for collision avoidance, and integration of RPA into aerodrome procedures.	
Main performance impact as per Doc 9854	KPA-01 – Access and Equity, KPA-02 – Capacity, KPA-05 – Environment, KPA-09 – Predictability, KPA-10 – Safety.	
Operating environment/ Phases of flight	En-route, oceanic, terminal (arrival and departure), aerodrome (taxi, take-off and landing)	
Applicability considerations	Applies to all RPA operating in non-segregated airspace and at aerodromes. Requires good synchronization of airborne and ground deployment to generate significant benefits, in particular to those able to meet minimum certification and equipment requirements.	
Global concept component(s) as per Doc 9854	AOM – airspace organization and management CM – conflict management AUO – airspace user operations	
Global plan initiatives (GPI)	GPI-6: Air traffic flow management GPI-9: Situational awareness GPI-12: Functional integration of ground systems with airborne systems	
Main dependencies	B2-90	
Global readiness checklist		Status (indicate ready with a tick or input date)
	Standards readiness	Est. 2028
	Avionics availability	Est. 2028
	Ground systems availability	Est. 2028
	Procedures available	Est. 2028
	Operations approvals	Est. 2028

1. NARRATIVE

1.1 Baseline

1.1.1 The baseline contains procedures that accommodate and allow for the integration of RPA into the airspace. This includes the improvements addressed in Block 2-90, which are:

- a) access to most airspace for select airframes without specific authorization or experimental aircraft waiver;
- b) RPA certification procedures;
- c) RPAS approval procedures;
- d) standardized C2 link failure procedures;

- e) new special purpose transponder code for C2 link failure;
- f) revised separation criteria and/or handling procedures (i.e. moving airspace);
- g) ADS-B on most RPA classes;
- h) detect and avoid technology improvements; and
- i) automatic position reporting to ATC capability for C2 link failure over high seas.

1.2 Changes brought by the module

- **Certification for RPA flying in all classes of airspace:** here the RPA operates in non-segregated airspace just like any other aircraft. Certification has been defined based on standards, and the safety case has been proven for each aircraft type. The air traffic management (ATM) procedures (identification of aircraft type, separation minima, and communication failure procedures) are well defined in Block 3 to allow for this type of operation.
- **Communication:** performance requirements to support command and control (C2) and ATC communications will be fully vetted and certified during this block. Security, reliability, availability and latency requirements will be increased to support full airspace access by RPA.
- **Certified pre-set automatic response:** The ability to respond automatically to provide collision avoidance manoeuvres. This is needed to ensure safety even during a C2 link failure event. The remote pilot shall have the ability to override the automatic actions whenever the C2 link is operational.
- **Certified airborne detect and avoid (ABDAA) algorithms:** During this block the procedures and standards for avoidance manoeuvres, based on an ABDAA solution and algorithm set, will be developed and certified.
- **Aerodrome procedures:** During this block, RPA will be integrated into aerodrome operations. Consideration may have to be given to the creation of airports that would support RPA operations only. The unique characteristics of RPA need to be considered, some of the areas to be considered are:
 - o Applicability of aerodrome signs and markings
 - o Integration of RPA with manned aircraft operations on the manoeuvring area of an aerodrome
 - o Issues surrounding the ability of RPA to avoid collisions while manoeuvring
 - o Issues surrounding the ability of RPA to follow ATC instructions in the air or on the manoeuvring area (e.g. “follow green Cessna 172” or “cross behind the Air France A320”)
 - o Applicability of instrument approach minima to RPA operations
 - o Necessity of RPA observers at aerodromes to assist the remote pilot with collision avoidance requirements
 - o Implications for aerodrome requirements of RPA infrastructure, such as approach aids, ground handling vehicles, landing aids, launch/recovery aids, etc.
 - o Rescue and fire fighting requirements for RPA (and remote pilot station, if applicable)

- o RPA launch/recovery at sites other than aerodromes
- o Integration of RPA with manned aircraft in the vicinity of an aerodrome
- o Aerodrome implications for RPAS-specific equipment (e.g. remote pilot stations)

1.2.1 This might lead to a utilization scheme, still to be discussed and validated, as follows:

Block 3	Fully Controlled Terminal Airspace (Class B, C)	En Route Class A Airspace	High Seas Class A Airspace	Uncontrolled and Partially Controlled Airspace (Class D, E, F, and G)
Authorization	Strict compliance with standard regulations is required.			
C2 Link Failure Procedures	Shall follow standardized procedures. A special purpose transponder code will be established.		Shall follow standardized procedures. Must broadcast or contract position reports to ATC	RPA must be equipped for airborne detect and avoid in case a C2 link failure is experienced during flight
ATC Communications	Continuous two-way communications as required for the airspace. RPA will squawk 7600 in case of communications failure with ATC.		Primary communications are via terrestrial data link; for communications failure RPA pilot will use telephonic communications RPA will be capable of air-to-air communications	N/A
Separation Minima	New separation minima may be required.		Separation criteria will be analyzed and special separation criteria might be developed.	RPA is responsible for maintaining safe distance
ATC Instructions	RPA will comply with ATC instructions as required			
RPA Observers	Not required if RPAS is equipped for GBDAA flight in a GBDAA approved area, or is equipped for ABDAA	Not required		N/A
Medical	Remote pilots shall have an appropriate medical certificate			

Presence of Other Aircraft	RPA shall not increase safety risk to the air navigation system		
Visual Separation	Visual separation will be permitted if RPAS is equipped for GBDAA flight in a GBDAA approved area, or is equipped for ABDAA	TBD	RPA will use GBDAA or ABDAA for visual separation
Responsibility of Remote Pilot	Remote pilot is responsible for compliance with the rules of the air and adherence with the authorization		
Populated Areas	Restrictions to be determined by the State.	Not applicable	Restrictions to be determined by the State.
ATC Services	Consistent with Annex 11, Appendix 4		
Flight Plan	RPA operations will be conducted on an IFR or VFR flight plan. VFR flight plans will only be conducted if the RPAS is equipped for GBDAA flight in a GBDAA approved area, or is equipped for ABDAA.		
Meteorological Conditions	Restrictions to be determined by the State		
Transponder	Shall have and use ADS-B		TBD
Safety	Identify the hazards and mitigate the safety risks; adhere to the authorization		
NOTAMs	NOTAM requirements, if any, to be determined by the State		
Certification	To be determined		

2. INTENDED PERFORMANCE OPERATIONAL IMPROVEMENT

2.1 Metrics to determine the success of the module are proposed in the *Manual on Global Performance of the Air Navigation System* (Doc 9883).

<i>Capacity</i>	Could be negatively impacted due to larger separation standards being applied for safety reasons between RPA and manned traffic.
<i>Access and Equity</i>	Transparent access to airspace by RPA
<i>Environment</i>	The uniform application of the module increases global interoperability by allowing pilots and remote pilots to be faced with understandable situations when flying in different States.
<i>Predictability</i>	Increased predictability of RPA through global interoperability of communications and situational awareness.
<i>Safety</i>	Increased situational awareness; controlled use of aircraft.
<i>Cost Benefit Analysis</i>	The business case is directly related to the economic value of the aviation applications supported by RPAS.

3. NECESSARY PROCEDURES (AIR AND GROUND)

- ATM procedures for RPA to operate in all classes of airspace
- Procedures that allow for multiple RPA in the same airspace at the same time
- Procedures that allow RPA to operate out of all classes of airports

- Procedures that allow pre-set automatic responses in specific situations
- Ground and air procedures that ensure harmonized operations where RPA are operating alongside manned aircraft.

4. NECESSARY SYSTEM CAPABILITY

4.1 Avionics

- Certified ABDAA algorithms
- Reliable C2 links
- Equipage of all aircraft, with proven detect and avoid technology
- Equipage of RPAS with necessary equipment to work within existing aerodrome parameters to the greatest extent practicable

4.2 Ground systems

- GBDA to supplement where applicable
- Certified automatic algorithms

5. HUMAN PERFORMANCE

5.1 Human factors considerations

5.1.1 This module is in the research and development phase so the Human Factors considerations are still in the process of being identified through modelling and beta testing. Future iterations of this document will become more specific about the processes and procedures necessary to take the Human Factors considerations into account. There will be a particular emphasis on identifying the human-machine interface issue if there are any and providing the high risk mitigation strategies to account for them.

5.2 Training and qualification requirements

5.2.1 This module will eventually contain a number of personnel training requirements. As and when they are developed, they will be included in the documentation supporting this module and their importance highlighted. Likewise, any qualifications requirements that are recommended will become part of the regulatory needs prior to implementation of this performance improvement.

6. REGULATORY/STANDARDIZATION NEEDS AND APPROVAL PLAN (AIR AND GROUND)

- Regulatory/standardization: to be determined
- Approval plans: to be determined

7. **IMPLEMENTATION AND DEMONSTRATION ACTIVITIES (AS KNOWN AT TIME OF WRITING)**

7.1 None.

8. **REFERENCE DOCUMENTS**

8.1 **Standards**

- ICAO Annex 1 — *Personnel Licensing*
- ICAO Annex 2 — *Rules of the Air*
- ICAO Annex 3 — *Meteorological Service for International Air Navigation*
- ICAO Annex 4 — *Aeronautical Charts*
- ICAO Annex 6 — *Operation of Aircraft*
- ICAO Annex 7 — *Aircraft Nationality and Registration Marks*
- ICAO Annex 8 — *Airworthiness of Aircraft*
- ICAO Annex 9 — *Facilitation*
- ICAO Annex 10 — *Aeronautical Telecommunications, Volume II — Communication Procedures including those with PANS status*
- ICAO Annex 10 — *Aeronautical Telecommunications, Volume IV — Surveillance and Collision Avoidance Systems*
- ICAO Annex 11 — *Air Traffic Services*
- ICAO Annex 12 — *Search and Rescue*
- ICAO Annex 13 — *Aircraft Accident and Incident Investigation*
- ICAO Annex 14 — *Aerodromes*
- ICAO Annex 15 — *Aeronautical Information Services*
- ICAO Annex 16 — *Environmental Protection*
- ICAO Annex 17 — *Security — Safeguarding International Civil Aviation against Acts of Unlawful Interference*
- ICAO Annex 18 — *The Safe Transport of Dangerous Goods by Air*
- U.S. Department of Transportation FAA, Air Traffic Organization Policy N JO 7210.766
- NATO STANAG 4586, *Standard Interfaces of UAV Control System (UCS) for NATO UAV Interoperability*

8.2 **Guidance material**

- TBD

8.3 **Approval documents**

- EUROCAE Documents (under development)
- RTCA Documents (under development)