EUROPEAN ORGANISATION
FOR THE SAFETY OF AIR NAVIGATION

EUROCONTROL

EUROCONTROL SPECIFICATIONS FOR THE USE OF MILITARY REMOTELY PILOTED AIRCRAFT[1] AS OPERATIONAL AIR TRAFFIC OUTSIDE SEGREGATED AIRSPACE

DOCUMENT IDENTIFIER: EUROCONTROL-SPEC-0102

[1] formerly called 'unmanned aerial vehicles' - UAV. The term has been changed throughout the document except where reference is made to working arrangements or documents that existed before the change of terminology.

Edition Number *Help*	**:**	**2.0**
Edition Date *Help*	**:**	**1 February 2012**
Status	**:**	**Released Issue**
Intended for	**:**	**General Public**
Category	**:**	**EUROCONTROL Specification**

DOCUMENT IDENTIFICATION SHEET

TITLE		
EUROCONTROL Specifications for the Use of Military Remotely Piloted Aircraft as Operational Air Traffic Outside Segregated Airspace		
	Reference*Help*:	MIL/MILT/UAV/06-2116
Document Identifier*Help*	**Edition Number:**	2.0
EUROCONTROL-SPEC-0102	**Edition Date:**	01 Feb 2012

Abstract*Help*

These high-level, generic specifications have been drafted by the UAV-OAT TF. They require that RPA operations should not increase the risk to other airspace users; that ATM procedures should mirror those applicable to manned aircraft; and that the provision of air traffic services to RPAs should be transparent to ATC controllers. Moreover, they are not constrained by limitations in current RPA capability. The specifications have been subjected to a safety assurance process and, subsequently, to endorsement by the Military Team, formal consultation via the EUROCONTROL Notice of Proposed Rule-Making process, and acceptance by the Civil/Military Interface Committee.

Keywords*Help*

RPA Specifications
OAT
Segregated Airspace

Contact Person(s)	Tel	Unit
Mr Edgar REUBER	++ 32 2 729 4784	DSS/CM

DOCUMENT STATUS AND TYPE					
Status		**Intended for**		**Category*Help***	
Working Draft	☐	General Public	☑	EUROCONTROL Rule	☐
Draft	☐	Restricted EUROCONTROL	☐	EUROCONTROL Specification	☑
Proposed Issue	☐			EUROCONTROL Guideline	☐
Released Issue	☑				

ELECTRONIC SOURCE *Help*		
Path:		
Host System	Software	Size
Windows_NT	Microsoft Word 12.0	423 Kb

DOCUMENT APPROVAL

The following table identifies all management authorities who have successively approved the present issue of this document.

AUTHORITY	NAME AND SIGNATURE	DATE
Chairman UAV-OAT TF	Wg Cdr Mike STRONG	11/09/07
Head of Regulatory Unit	Mr Jean-Luc GARNIER	01/10/07
Director DCMAC	Mr Jean-Robert CAZARRE	18/09/07
Director General	Mr Victor AGUADO	02/10/07

DOCUMENT CHANGE RECORD

The following table records the complete history of the successive editions of the present document.

EDITION NUMBER	EDITION DATE	INFOCENTRE REFERENCE	REASON FOR CHANGE	PAGES AFFECTED
0.1	07/06/04		Initial draft	All
0.2	17/08/04		UAV-OAT TF consultation	All
0.3	15/09/04		For discussion at UAV-OAT TF/3	All
0.4	28/10/04		UAV-OAT TF consultation	All
0.5	02/12/04		For discussion at MILT/3	All
0.6	24/08/05		For discussion at UAV-OAT TF/4	All
0.7	13/09/05		For discussion at MILT/5	All
0.8	05/12/05		For discussion at CMIC/25	All
0.9	25/04/06		For ENPRM circulation	All
0.10	15/12/06		UAV-OAT TF Review	All
0.11	26/01/07		For CMIC/28 approval	All
0.12	31/03/07		For VISA by RU	All
1.0	26/07/07		Formal Release	All
2.0	01/02/12		replacement of UAV with RPA, biennial review	All

TABLE OF CONTENTS

<u>Annexes</u>

EXECUTIVE SUMMARY

As the result of a need articulated at the European AIRCHIEF Conference in 2003, and a request made subsequently through the Civil/Military Interface Standing Committee (CMIC), EUROCONTROL formed the UAV-OAT Task Force (TF) to draft air traffic management (ATM) specifications for the use of military remotely piloted aircraft (RPAs) flying as Operational Air Traffic (OAT) outside segregated airspace. Membership of the TF comprised EUROCONTROL civil and military staff, national military experts and representatives from other interested organisations.

Specifications were chosen as the most appropriate category from the EUROCONTROL Regulatory and Advisory Framework because their voluntary status would leave individual states free to decide whether or not to incorporate them into their own national regulations. This was also the rationale for keeping the specifications high-level and generic.

The TF sought to identify best practice and to build upon existing material. However, practically, there were no extant national procedures that were suitable for adaptation into EUROCONTROL specifications. Instead, the TF started with a virtually clean sheet of paper.

The consequent specifications follow three basic principles. Firstly, RPA operations should not increase the risk to other airspace users; secondly, ATM procedures should mirror those applicable to manned aircraft; and, thirdly, the provision of air traffic services to RPAs should be transparent to ATC controllers. The specifications are also innovative insofar as they are not constrained by limitations in current RPA capability such as sense-and-avoid. The specifications will therefore only be practicable once Industry develops this and other necessary technology.

The specifications have been subjected to a safety assurance process by an external contractor, intended to support the argument that, *by application of the draft specifications, military RPA OAT operations in non-segregated airspace will be acceptably safe.* The approach taken was to demonstrate that the risks to other airspace users from RPA operations would be no greater than for manned military OAT in non-segregated airspace and would be reduced as far as possible. Recommendations arising from this process were then incorporated into the specification document.

Inter alia, the specifications envisage a primary mode of operation that entails oversight by a pilot-in-command, and a back-up mode that enables an RPA to revert to autonomous flight in the event of loss of control data-link. A similar hierarchy is followed with regard to traffic avoidance and collision avoidance. Thus, where ATC is not available to separate an RPA from other airspace users, the pilot-in-command will assume this responsibility using available surveillance information and technical assistance in the form of a sense-and-avoid system. The latter will also initiate last-ditch collision avoidance should circumstances warrant.

Other specifications are similarly pragmatic. Thus, the air traffic services provided to RPAs should accord with those provided to manned aircraft, and RPAs should carry similar functionality for flight, navigation and communication as required for manned aircraft. In effect, if RPAs are to integrate with other airspace users, they must fit in with those other users and with current procedures, rather than existing ATM being required to adjust to accommodate RPAs.

Because these specifications focus only on ATM, they are just one part of the bigger jig-saw that must fit together before military RPAs will be allowed to fly routinely outside segregated airspace. Other agencies working on airworthiness and certification, system security, operator training and other such aspects must all perforce play their part. It is also important to note that the specifications do not address the question of military RPAs flying as General Air Traffic or the operation of civil RPAs.

These specifications have been subject to stakeholder consultation via the EUROCONTROL Notice of Proposed Rule-Making mechanism, and comment from the consultation has been incorporated into a subsequent draft. This was accepted on 12 Mar 07 by CMIC, which commended the specification document to the Director General (DG) EUROCONTROL for approval and subsequent notification to the EUROCONTROL Provisional Council (PC).

The specifications will be subject to biennial review by the EUROCONTROL Civil-Military ATM Co-ordination Division (DSS/CM) to ensure they remain abreast of evolving RPA and ATM technology.

1 INTRODUCTION

1.1 Background

1.1.1 There is a pressing operational requirement to migrate military Remotely Piloted Aircraft (RPAs) outside the confines of segregated airspace. This resulted in a suggestion from the autumn 2003 session of the European AIRCHIEF Conference to the Military Harmonization Group (MILHAG) that it should examine the possibility of drafting harmonized ATC procedures for the use of military RPAs outside segregated airspace in peacetime. Conscious of the focus on Air Traffic Management (ATM), and because of EUROCONTROL's pre-eminence with regard to the harmonization of ATM in Europe, MILHAG chose to invite the Agency to undertake the work required. The Civil/Military Interface Standing Committee (CMIC) endorsed[2] this position and formally requested EUROCONTROL to develop specifications for the use of military RPAs as Operational Air Traffic (OAT) outside segregated airspace.

1.1.2 As a result, a UAV-OAT Task Force (TF) was established, comprising EUROCONTROL civil and military staff, national military experts and representatives from other interested organisations. This membership was intended to provide RPA expertise rather than national positions.

1.1.3 Wherever possible, the TF identified best practice and built upon existing material, rather than creating from scratch. *Inter alia*, sources were national UAV/RPA documentation, the Joint JAA/EUROCONTROL UAV TF, the EC and Industry. Close liaison was undertaken with the NATO UAS FINAS (Flight in Non-Segregated Airspace) Military WG.

1.1.4 The TF recognised that there was an interest in operating military RPAs as General Air Traffic (GAT) and in the operation of civil RPAs. There was also a case for harmonising the operation of RPAs in segregated airspace in Europe. However, the TF concentrated its effort on RPAs as OAT in non-segregated airspace as something that was achievable in the near-term. Other RPA operations could be considered in the longer term.

1.1.5 EUROCONTROL Specifications (entailing use of the executive word *should*) were considered to be the most appropriate category from the EUROCONTROL Regulatory and Advisory Framework (ERAF), rather than Rules (which would be binding) or Guidelines. Specifications have voluntary status and may be developed by other organisations than EUROCONTROL. Individual states would therefore be free to decide whether or not to incorporate the EUROCONTROL RPA Specifications into their own national regulations, which was also the rationale for keeping the specifications high-level and generic.

1.2 Terms of Reference

1.2.1 The Terms of Reference (TORs) for the UAV-OAT TF, as approved by the EUROCONTROL Military Team, are at Annex A.

[2] CMIC/19 Minutes (CMIC/19/04/12 dated 17 May 04)

1.3 Objective

1.3.1 The objective of this Paper is to formulate EUROCONTROL Specifications for the use of military RPAs as OAT outside segregated airspace in a form suitable for states to incorporate into their national regulations as required.

1.3.2 The specifications are set in the context of current ATM, but do not preclude future developments. Indeed, in approving the specifications, CMIC asked that EUROCONTROL should maintain the specifications and update them as required.

1.3.3 Although the Paper considers non-related ATM matters in brief, it does not seek to address aspects of RPA operations that are outside the EUROCONTROL orbit, eg airworthiness, certification, system security, licensing of personnel, etc.

1.4 Glossary of Terms

1.4.1 A glossary of terms is provided at Annex B.

1.5 Abbreviations

1.5.1 Abbreviations are listed at Annex C.

1.6 Document Structure

1.6.1 After an introduction, this Paper addresses aspects of military RPA ATM, dealing briefly with extant regulations that impact upon the RPA specifications and then explaining the nature of RPA airspace requirements. Thereafter, it summarises a number of national RPA ATM regulations, albeit none were suitable for adaptation into EUROCONTROL specifications. With regard to the specifications themselves, these are presented individually in the form of discussion followed by specification. Every effort has been made to keep the specifications short and straightforward to assist with incorporation into national regulations. The Paper closes with passing mention of several related non-ATM issues. Where appropriate, supporting information and detail is provided in the form of annexes.

2 MILITARY RPA ATM ASPECTS

2.1 Regulatory Context

2.1.1 Article 8 of the Convention on International Civil Aviation (hereinafter the Chicago Convention[3]) addresses the notion of RPAs insofar that it states that: *No aircraft capable of being flown without a pilot shall be flown without a pilot over the territory of a contracting State without special authorization by that State and in accordance with the terms of such authorization. Each contracting State undertakes to insure* [sic] *that the flight of such aircraft without a pilot in regions open to civil aircraft shall be so controlled as to obviate danger to civil aircraft.*

The *Global Air Traffic Management Operational Concept* (Doc 9854) states, *An unmanned aerial vehicle is a pilotless aircraft, in the sense of Article 8 of the Convention on International Civil Aviation, which is flown without a pilot-in-command on-board and is either remotely and fully controlled from another place (ground, another aircraft, space) or programmed and fully autonomous.* This understanding of RPAs was endorsed by the 35th Session of the ICAO Assembly.

2.1.2 Notwithstanding, Article 3 of the Chicago Convention recognises that military aircraft are state aircraft, which are therefore exempted from civil regulations. Article 3 also stipulates that national regulations for state aircraft must *have due regard for the safety of navigation of civil aircraft*. Thus, although military RPAs are not bound by the Chicago Convention because they are state aircraft, it would be untenable to operate military RPAs outside segregated airspace without ensuring they did not pose an undue threat to other airspace users.

2.1.3 It was therefore considered that the Specifications for military RPAs should follow ICAO international standards and recommended practices for manned aircraft with regard to ATM wherever practicable.

2.1.4 Moreover, RPAs should be operated in accordance with the OAT rules governing the flights of manned aircraft as specified by the appropriate authority. RPAs should also be able to show an equivalent level of compliance with ATM and CNS requirements applicable to the airspace within which they were intended to operate.

In this context, ICAO Circular 328 specifies,

2.8 The principal objective of the aviation regulatory framework is to achieve and maintain the highest possible and uniform level of safety. In the case of UAS, this means ensuring the safety of any other airspace user as well as the safety of persons and property on the ground.

2.9 Identifying the commonalities and differences between manned and unmanned aircraft is the first step toward developing a regulatory framework that will provide, at a minimum, an equivalent level of safety for the integration of UAS into non-segregated airspace and at aerodromes. Technical specifications to support airworthiness, command and control (C2), detect and avoid and other functionalities are being addressed by various industry standards-development organizations (SDO) around the world. ICAO's focus will remain on the higher-level performance-

[3] ICAO Doc 7300/8 (Eighth Edition)

based standards, e.g. specifying minimum performance requirements for communications links, rather than how to achieve said requirements, along with harmonizing terms and definitions needed to support this activity.

2.10 Development of the complete regulatory framework for UAS will be a lengthy effort, lasting many years. As individual subjects and technologies reach maturity, the pertinent SARPs will be adopted. It is envisioned that this will be an evolutionary process, with SARPs being added gradually. Non-binding guidance material will often be provided in advance of the SARPs for use by States that face early operation of UAS. Therefore close adherence to the guidance material will facilitate later adoption of SARPs and will ensure harmonization across national and regional boundaries during this development phase. It is to be noted that elements of the regulatory framework for UAS certainly already exist inasmuch as UA are aircraft and as such major portions of the regulatory framework applicable to manned aircraft are directly applicable.

2.11 Data collection is critical to the development of SARPs. This process requires time and inherently serves as a prelude to a robust understanding of the unique characteristics presented by UAS. Therefore, every effort should be made amongst Contracting States to collect data in a coordinated manner and share it openly to expedite the development of international civil aviation standards.

2.1.5 The EUROCONTROL Harmonisation of OAT and GAT/OAT Interface (HOGI) Task Force was engaged in work to harmonise OAT in Europe and its interface with GAT. The outcome, reflected in the EUROAT document, is relevant to RPAs operating as OAT, and states will therefore need to factor this into their subsequent use of these RPA Specifications.

2.2 Airspace Requirements

2.2.1 At present, most military RPAs in Europe are restricted to airspace that is segregated for the purpose from other aircraft or they are flown over the sea using special arrangements (eg UK ‘clear range’ procedure whereby the RPA operating authority is responsible for ensuring that no threat is posed to other airspace users). Where operations are permitted outside segregated airspace, numerous restrictions to ensure the safety of other airspace users normally apply. This is extremely limiting. To exploit fully the unique operational capabilities of current and future RPA platforms, and to undertake training necessary for the safe conduct of RPA operations, European military authorities require RPAs to be able to access all classes of airspace and to be able to operate across national borders and FIR/UIR boundaries.

2.2.2 Notwithstanding, it is broadly accepted by European military authorities that RPA operations outside segregated airspace should be conducted at a level of safety equivalent to that for manned aircraft. Similarly, RPA operations should not increase the risk to other airspace users and should not deny the airspace to them. Moreover, ATM regulations and procedures for RPAs should mirror as closely as possible those applicable to manned aircraft. RPA-specific ATM procedures should therefore only be implemented where the absence of an on-board pilot – particularly in combination with loss of control data-link – generates a need for special arrangements. Otherwise, the provision of an air traffic service to an RPA should be transparent to the ATC controller and other airspace users.

2.3 Small RPAs

2.3.1 In ATM terms, small RPAs – for example, comparable in size to model aircraft – are regarded as equating to such model aircraft and, accordingly, are unlikely to require integration with other airspace users. Indeed, similar constraints to those which presently govern flight by model aircraft may apply also to small RPAs, eg height, visual line-of-sight, proximity to aerodromes, etc, but such consideration falls outwith these specifications. Instead, RPA operations are categorized only by reference to flight rules (see para 3.1).

2.4 Existing National UAV/RPA ATM Regulations

2.4.1 Details of existing UAV/RPA ATM regulations for France, Sweden, UK and USA are summarized at Annex D, albeit circa early-2004, when the specifications were first drafted.

3 PROPOSED EUROCONTROL SPECIFICATIONS

3.1 ATM Categorization of RPA Operations

3.1.1 There are numerous ways of categorizing RPAs, eg weight, role, type, etc. Although each may be valid in context, it is flight rules that are most relevant to the operation of RPAs outside segregated airspace, since these govern the ATM rules and regulations that apply to manned aircraft. Where necessary for these Specifications, therefore, it is logical that the operation of RPAs should be categorized according to whether the sortie is flown under IFR or VFR as applied to OAT.

Specification RPA1. For ATM purposes, where it becomes necessary to categorize RPA operations, this should be done on the basis of flight rules, namely IFR or VFR as applied to OAT.

3.2 Mode of Operation

3.2.1 Notwithstanding any pre-programmed mission autonomy, the primary mode of operation of an RPA for the purposes of ATM should entail oversight by the pilot-in-command, who should at all times be able to intervene in the management of its flight. However, in the event of total loss of control data-link between the pilot-in-command and the RPA, a back-up mode of operation should enable the RPA to revert to autonomous flight that is designed to ensure the safety of other airspace users.

Specification RPA2. For ATM purposes, the primary mode of operation of an RPA should entail oversight by the pilot-in command, who should at all times be able to intervene in the management of the flight. A back-up mode of operation should enable the RPA to revert to autonomous flight in the event of total loss of control data-link between the pilot-in-command and the RPA. This back-up mode of operation should ensure the safety of other airspace users.

3.3 Flight Rules

3.3.1 In essence, the rules for manned aircraft require that VFR flights shall be conducted so that the aircraft is flown in conditions of visibility and distance from clouds not less than those specified, while the rules for IFR flight require that the aircraft is equipped with suitable instruments and with navigation equipment appropriate to the route to be flown and with the required provisions when operated in controlled airspace. Outside controlled airspace, an IFR flight is required to fly at a cruising level appropriate to its track.

3.3.2 Compliance with IFR should be relatively straightforward for an RPA since this relates to the carriage of equipment that is already available to manned aircraft. However, the rules for VFR flight pose a problem for an RPA insofar as it may be difficult for the RPA pilot-in command to assess whether the visibility and distance from cloud equate to VMC. If an RPA is unable to establish that it is VMC, it could fly IFR if properly equipped, although this would constrain its freedom of operation. It is therefore in the interest of RPA operators that RPAs should be designed to a level which allows full alignment and transparency with manned aircraft for all flight rules, including the ability to assess in-flight conditions.

Specification RPA3. RPAs should comply with VFR and IFR as they affect manned aircraft flying OAT. For VFR flight, the RPA pilot-in-command should have the ability to assess in-flight meteorological conditions.

3.4 Traffic Avoidance and Collision Avoidance

3.4.1 It is a requirement for manned aircraft that they shall not be operated in such proximity to other aircraft as to create a collision hazard, and it seems axiomatic that the same requirement should apply to RPAs. Notwithstanding, effective traffic avoidance and collision avoidance probably represent the greatest technical challenge confronting the routine operation of RPAs outside segregated airspace.

3.4.2 The hierarchy for the application of traffic avoidance and collision avoidance for an RPA should be:

a. ATC - traffic avoidance.

b. Pilot-in-command - traffic avoidance and collision avoidance.

c. Autonomous operation – collision avoidance.

3.4.3 Use of chase aircraft would help resolve some of the problems associated with collision avoidance by RPAs. However, this is impracticable in the long term, given the anticipated scale of future RPA operations, and would remove many of the advantages of using RPAs in place of manned aircraft. These specifications therefore presume the absence of accompanying chase aircraft.

3.4.4 Right-of-Way

3.4.4.1 Most if not all nations apply the right-of-way as prescribed by ICAO (Rules of the Air, Annex 2), and there is no reason to exempt RPAs. Likewise, the rule on converging aircraft should apply according to whether the RPA is power-driven and heavier-than-air or is an airship or a glider or a balloon, in the same way it applies to manned aircraft.

Specification RPA4. RPAs should comply with the right-of-way rules as they apply to other airspace users.

3.4.5 Separation from Other Airspace Users - IFR

3.4.5.1 Within controlled airspace, separation from other airspace users is normally achieved as part of the provision of an air traffic service, although this does not permit the pilot to relax his vigilance for the purpose of detecting potential collisions. For an RPA operating in controlled airspace, it is therefore reasonable to argue that the primary means of achieving separation should be compliance with ATC instructions. However, ATC will only provide separation as a function of the airspace classification, and there is therefore a requirement for the RPA to be able to react to possible conflict with unknown traffic in the same way as a manned aircraft, ie by first detecting the confliction and then manoeuvring to avoid it.

<u>Specification RPA5</u>. For IFR OAT flight by RPAs in controlled airspace, the primary means of achieving separation from other airspace users should be by compliance with ATC instructions. However, additional provision should be made for collision avoidance against unknown aircraft.

3.4.6 <u>Separation from Other Airspace Users - VFR</u>

3.4.6.1 It is implicit when flying VFR that the pilot is ultimately responsible for maintaining safe separation from other airspace users which, in a manned aircraft, he will achieve by remaining VMC and by maintaining an active visual scan and taking avoiding action as required. The RPA must achieve the same result and do so with an equivalent level of safety to a manned aircraft.

3.4.6.2 The RPA pilot-in-command may have surveillance information available to him to assist him with traffic avoidance and collision avoidance, and such sources should be utilised wherever practicable. However, in addition, he will require technical assistance to detect and avoid conflicting traffic with the same degree of assurance as a manned aircraft flying VFR. Thus provided for, he could then be responsible for the safe conduct of a flight, unless loss of control data-link made it impracticable, at which point an automatic system would take over to ensure collision avoidance. The technical assistance – embracing the concept of Sense and Avoid – should therefore:

a. Enable the RPA pilot-in-command to maintain VMC when operating VFR.

b. Detect conflicting traffic.

c. Enable the RPA pilot-in-command to interact with conflicting traffic in accordance with the right-of way rules.

d. Ensure automatic collision avoidance in the event of failure of traffic avoidance for whatever reason.

3.4.6.3 This technical assistance would also supplement the air traffic service being provided when an RPA is flying VFR in controlled airspace, and would significantly enhance safety where national regulations permit IFR flight outside controlled airspace.

<u>Specification RPA6</u>. For VFR OAT flight by RPAs, the RPA pilot-in command should utilize available surveillance information to assist with traffic avoidance and collision avoidance. In addition, technical assistance should be available to the pilot-in-command to enable him to maintain VMC and to detect and avoid conflicting traffic. An automatic system should provide collision avoidance in the event of failure of traffic avoidance.

3.5 Sense and Avoid

3.5.1 Sense and Avoid (S&A) is a generic expression employed to reflect a technical capability commensurate with a pilot's ability to see and avoid other air traffic.

3.5.2 A S&A system comprises those components which enable an RPA to sense and avoid other airspace users in real-time; it may be on-board, or ground-based involving the pilot-in-command, or a combination of both.

3.5.3 The primary purpose of an S&A system is to enable the RPA pilot-in-command to perform the dual functions of traffic avoidance and collision avoidance normally undertaken by the pilot of a manned aircraft. Its secondary purpose is to undertake collision avoidance autonomously if traffic avoidance fails, for example in the event of loss of control data-link. S&A is therefore essential to the safe operation of RPAs outside segregated airspace. Moreover, it must achieve an equivalent level of safety to a manned aircraft.

Specification RPA7. An RPA S&A system should enable an RPA pilot-in-command to perform those traffic avoidance and collision avoidance functions normally undertaken by a pilot in a manned aircraft, and it should perform a collision avoidance function autonomously if traffic avoidance has failed for whatever reason. The S&A system should achieve an equivalent level of safety to a manned aircraft.

3.5.4 In essence, a S&A system should provide the ability to detect conflicting traffic in time to perform an avoidance manoeuvre. The system would then notify the RPA pilot-in command of the conflict and propose a course of action to pass well clear. In the subsequent event of inaction or absence of override by the RPA pilot-in-command, the S&A system would manoeuvre the RPA autonomously to miss the conflicting traffic.

Specification RPA8. An RPA S&A system should notify the RPA pilot-in command when another aircraft in flight is projected to pass within a specified minimum distance. Moreover, it should do so in sufficient time for the RPA pilot-in command to manoeuvre the RPA to avoid the conflicting traffic by at least that distance or, exceptionally, for the onboard system to manoeuvre the RPA autonomously to miss the conflicting traffic.

3.5.5 Notwithstanding the above involvement of S&A in both traffic avoidance and collision avoidance, implementation of these functions should as far as is reasonably practicable be independent of each other. Their functionality should also minimize situations where collision avoidance might override or compromise traffic avoidance.

Specification RPA9. Implementation of traffic avoidance and collision avoidance functions in an S&A system should as far as is reasonably practicable be independent of each other. In execution, they should avoid compromising each other.

3.5.6 Source material theorizes on possible parameters to provide a safe and effective S&A capability, eg detection range and the search volume defined by azimuth and elevation that sensors need to scan. However, such assessments should be left to Industry as part of its work on producing a technological solution to S&A, especially since such parameters will vary according to RPA performance (including manoeuvrability). For this, Industry needed guidance on the minimum separation to be achieved between RPAs and other airspace users. Industry should then be able to calculate the necessary parameters to achieve this minimum separation and engineer S&A systems accordingly. However, more than one minimum separation distance was required, and a ‘layered’ application (eg like an onion skin) may be more appropriate.

3.6 Separation Minima – Where Separation is Provided by ATC

3.6.1 Where separation is provided by ATC within controlled airspace, and in accord with the principle that ATM regulations and procedures for RPAs should as closely as possible mirror those for manned aircraft, the separation minima between RPAs operating IFR and other traffic in receipt of a separation service should be the same as for manned aircraft flying OAT in the same class of airspace.

<u>Specification RPA10</u>. Within controlled airspace where separation is provided by ATC, the separation minima between RPAs operating IFR and other traffic in receipt of a separation service should be the same as for manned aircraft flying OAT in the same class of airspace.

3.7 Separation Minima/Miss Distance – Where Responsibility Rests with the UAS

3.7.1 A 2-tier system is envisaged in circumstances where responsibility for traffic avoidance/collision avoidance rests with the UAS (in the same way that it would for a manned aircraft). The first level would involve the RPA pilot-in-command and the second would utilize autonomous collision avoidance. However, the required miss distance for the latter should be less stringent than the minimum separation which an RPA pilot-in-command was required to achieve, since it was seen as a last-ditch tool akin to TCAS II.

3.7.2 <u>RPA Pilot-in-Command</u>

3.7.2.1 There are no prescribed ICAO separation minima for manned aircraft where responsibility for separation rested with the onboard pilot. Instead, it is only necessary that aircraft should not be operated in such proximity to other aircraft as to create a collision hazard[4]. However, Industry required something less vague. As a consequence, a practical minimum separation to be achieved by an RPA pilot-in-command is proposed.

3.7.2.2 Several authoritative organizations quote or imply that 500ft is an appropriate and acceptable miss distance for RPAs. In the USA, the FAA[5] view of 'well clear' (ie so as to not represent a collision hazard) is a minimum separation of 500ft between aircraft. To a considerable degree, this figure is accepted by the Joint JAA/EUROCONTROL RPA TF[6] as the basis for recommending work to identify Minimum Performance Standards (MPS) for future S&A systems. Industry[7] itself regards 500ft as a minimum 'worst-case separation' distance for S&A. Finally, in the context of manoeuvring between aircraft to achieve safe separation, NATO[8] defines 500ft as 'well clear'.

3.7.2.3 Thus, arguably, 500ft represents an adequate minimum distance that an RPA pilot-in-command should be required to achieve against other airspace users. However, while use of 500ft vertical separation is routine between manned aircraft and should not therefore cause undue concern to other airspace users, the application of 500ft

[4] ICAO Annex 2 - Rules of the Air, § 3.2.1
[5] FAA Order 8700.1, Change 3, Chapter 169, § 5A
[6] Joint JAA/EUROCONTROL UAV TF Final Report dated 11 May 04
[7] UAVS Draft Paper 'Guideline Parameters for an Integrated Sense and Avoid System for UAVs'
[8] NATO AGS3 'UAV ATC Study for AGS' dated 16 Dec 03

horizontal separation could generate a heightened sense of collision risk. An increase in horizontal separation to 0.5nm would reduce this perception and also the collision risk itself, and is therefore preferable. These minima would only apply away from aerodromes.

Specification RPA11. Where an RPA pilot-in-command is responsible for separation, he should, except for aerodrome operations, maintain a minimum distance of 0.5nm horizontally or 500ft vertically between his RPA and other airspace users, regardless of how the conflicting traffic was detected and irrespective of whether or not he was prompted by a S&A system.

3.7.3 Autonomous Collision Avoidance

3.7.3.1 Where an UAS initiates collision avoidance autonomously, this is considered analogous to the role performed by airborne collision avoidance systems (ACAS) developed for manned aircraft, as currently manifest in TCAS II. However, since TCAS II is a co-operative[9] system, it does not provide a near-term solution to S&A. This may become feasible if the carriage and operation of SSR (providing altitude information) is ever mandated on all airspace users, but not before.

3.7.3.2 TCAS uses time-to-go to Closest Point of Approach rather than minimum separation distance, although distance and altitude difference are taken into account where closure rates are low. In addition, the size of the protected volume surrounding each TCAS-equipped aircraft is dependant upon the speed and heading of the aircraft involved in the encounter. Some idea of miss distances may be gleaned from the prescribed alarm thresholds required to generate a TCAS II Resolution Advisory in the case of low closure rate; these vary according to altitude but are set between 0.2-1.1nm laterally and 300-700ft vertically[10].

3.7.3.3 In the case of autonomous collision avoidance, it is considered logical to require the UAS to achieve miss distances similar to those designed into ACAS. The system should be compatible with (and not compromise the operation of) ACAS.

Specification RPA12. Where an UAS initiates collision avoidance autonomously, it should achieve miss distances similar to those designed into ACAS. The system should be compatible with ACAS.

3.8 Aerodrome Operations

3.8.1 Extant national procedures for the aerodrome operation of RPAs are surprisingly sparse. Nonetheless, principles similar to those for RPA flight as OAT should apply. Thus, RPA operations at aerodromes should interface with the aerodrome control service as near as possible in the same way as manned aircraft.

Specification RPA13. RPA operations at aerodromes should interface with the aerodrome control service as near as possible in the same way as manned aircraft.

[9] Requires common fitment of equipment.
[10] FAA Introduction to TCAS II Version 7 dated Nov 00

3.8.2 Although RPAs may be launched and recovered in a variety of ways (eg by hand, catapult, etc), these specifications assume a requirement to use taxiways and runways.

3.8.3 Ground Operation

3.8.3.1 In this context, Ground Operation covers the movement of an RPA from parking position to lift-off and from touchdown to parking position, and includes integration with manned aircraft and vehicles using the manoeuvring areas and the avoidance of runway incursions.

3.8.3.2 In the absence of technical assistance to enable an RPA to navigate its way around an airfield, to see and obey visual signs and signals, and to avoid collisions, the RPA should be provided with ground-based observation to assist with taxiing. This may involve the RPA following a manned ground vehicle by optical or other (non-mechanical) coupling or being towed to the take-off position. These ground-based observers should be in communication with the aerodrome control service and with the RPA pilot-in-command. A similar procedure should apply to return the RPA to its parking position.

Specification RPA14. When taxiing, and in the absence of adequate technical assistance, an RPA should be monitored by ground-based observers, who should be in communication with the aerodrome control service and with the RPA pilot-in-command.

3.8.4 Runway and Aerodrome Visual Circuit

3.8.4.1 Take-off and landing and flight in an aerodrome visual circuit should accord with national procedures, and the RPA should follow aerodrome control service instructions.

3.8.4.2 Irrespective of flight conditions, the RPA pilot-in-command should remain responsible for ensuring his flight path is clear of obstructions and should therefore maintain situational awareness with regard to the runway and the aerodrome visual circuit. This does not preclude RPAs from executing autonomous take-offs and landings, but is intended to enable the RPA pilot-in-command to intervene in response to aerodrome control service instructions - which may include integration with other traffic flying in the aerodrome visual circuit - and to assume responsibility for collision avoidance.

Specification RPA15. For take-off and landing and flight in an aerodrome visual circuit, the RPA pilot-in-command should be able to maintain situational awareness to fulfil his responsibility for collision avoidance, and he should comply with aerodrome control service instructions.

3.8.4.3 Where safe integration is impracticable, consideration should be given to excluding other aircraft from the airspace in the immediate vicinity of an aerodrome during the launch and recovery of RPAs.

Specification RPA16. Where safe integration is impracticable, consideration should be given to excluding other aircraft from the airspace in the immediate vicinity of an aerodrome during the launch and recovery of RPAs.

3.9 Emergency Procedures

3.9.1 With regard to ATM, the TF considered it to be outside its scope to identify and address the multifarious emergencies that might befall a military RPA. This Paper therefore deals with these only in general terms.

3.9.2 RPA emergency procedures should mirror those for manned aircraft wherever possible. Nevertheless, the absence of a pilot in the cockpit and the unique nature of some RPA emergencies will require additional provisions. These may include use of an Emergency Recovery Procedure or a Flight Termination System, either autonomously or managed by the RPA pilot-in-command. Such pre-programmed emergency flight profiles should be designed to ensure the safety of other airspace users and people on the ground, and they should be coordinated with ATC as appropriate.

Specification RPA17. RPA emergency procedures should mirror those for manned aircraft as far as practicable. Where different, they should be designed to ensure the safety of other airspace users and people on the ground, and they should be coordinated with ATC as appropriate.

3.9.3 Loss of Control-Link Between RPA and Pilot-in-Command

3.9.3.1 The potential for loss of control-link between an RPA and its pilot-in-command requires that the craft be pre-programmed with an appropriate contingency plan.

Specification RPA18. RPAs should be pre-programmed with an appropriate contingency plan in the event that the pilot-in-command is no longer in control of the RPA.

3.9.3.2 Given that one of the more likely causes of loss of control of an RPA by its pilot-in-command is loss of data-link, the UAS should provide the pilot-in-command with a prompt indication of any such loss of control data-link.

Specification RPA19. An UAS should provide a prompt indication to its pilot-in-command in the event of loss of control data-link.

3.9.3.3 It is important that ATC be made aware if an RPA flying in its airspace is no longer under the control of its pilot-in-command. This should be accomplished both by the pilot-in-command informing ATC as soon as possible and by the UAS itself providing an indication to ATC, possibly by operation of a specific squawk. The pilot-in-command should also advise ATC of the contingency plan which the RPA will be executing.

Specification RPA20. When an RPA is not operating under the control of its pilot-in-command, the latter should inform the relevant ATC authority as soon as possible, including details of the contingency plan which the RPA will be executing. In addition, the UAS should indicate such loss of control to ATC.

3.10 Airspace Management

3.10.1 Flexible Use of Airspace (FUA) is a key component of present and future European airspace management and, as such, provides a means of accommodating portions of an RPA sortie where operating requirements or technical or functional shortcomings render it incompatible with other air traffic. Thus, where an UAS cannot meet all the requirements of a complex airspace structure, processes associated with airspace management should be utilized to reserve airspace for the express purpose of enabling the RPA to transit the airspace in question.

Specification RPA21. Where an UAS cannot meet the technical and/or functional requirements for operation as OAT, that portion of the sortie should be accommodated within temporary reserved airspace to provide segregation from other airspace users.

3.11 Interface with ATC

3.11.1 In general, RPA operations should interface with ATC in the same way as manned aircraft. Ergo, the air traffic service routinely provided to an RPA should require no special action or consideration on the part on an ATC controller.

3.11.2 Communications

3.11.2.1 While in receipt of an air traffic service, the RPA pilot-in command should maintain 2-way communications with the appropriate ATC authorities, and should make all position and other reports as required.

3.11.2.2 Extant ATC phraseology is adequate for the provision of an air traffic service to RPAs except that a controller may find it helpful to be aware that he was providing an air traffic service to an RPA. The word ‘unmanned’ should therefore be included on first contact with an ATC unit. However, it was not felt necessary to alert other airspace users to the presence of an RPA on frequency by repeating the word on every transmission.

Specification RPA22. While in receipt of an air traffic service, the RPA pilot-in command should maintain 2-way communications with ATC, using standard phraseology when communicating via RTF. The word ‘unmanned’ should be included on first contact with an ATC unit.

3.11.3 Air Traffic Service

3.11.3.1 The air traffic service provided to RPAs should accord with that provided to manned aircraft, including separation criteria. Thus, the RPA pilot-in command will be required to comply with any ATC instruction or request for information made by an air traffic unit in the same way and within the same timeframe as the pilot of a manned aircraft. Where this is not possible, eg because it is not technically feasible, then the RPA pilot-in command must make a clear statement to ATC to this effect, eg ‘Negative, unable to comply’.

Specification RPA23. The air traffic service provided to RPAs should accord with that provided to manned aircraft.

3.11.4 Flight Planning

3.11.4.1 Where flight by manned aircraft requires the submission of a flight plan to ATC, the same should apply to flight by RPAs.

3.11.4.2 The flight plan should indicate that it relates to an unmanned aircraft.

3.11.4.3 Due to the typical nature of RPA operations, it is anticipated that requirements may occur for en-route holding (ie orbits). Accordingly, the RPA flight plan should include any requirements for en-route delays, defining holding area orientation, leg lengths, altitudes and holding times.

Specification RPA24. Where flight by manned aircraft requires the submission of a flight plan to ATC, the same should apply to flight by RPAs. The RPA flight plan should indicate that it relates to an unmanned aircraft, and should include details of any requirement for en-route holding.

3.11.5 Flight Deviations

3.11.5.1 While in receipt of an air traffic service, RPAs should be monitored continuously by the RPA pilot-in command for adherence to the approved flight plan. All requests for flight deviations should be made by using established procedures to the appropriate ATC authorities.

Specification RPA25. While in receipt of air traffic service, RPAs should be monitored continuously by the RPA pilot-in command for adherence to the approved flight plan.

3.11.6 RPA Performance Characteristics

3.11.6.1 The performance characteristics of individual RPAs will vary. Pilots-in-command should have detailed knowledge of their particular vehicle. However, the knowledge requirement for ATC controllers will perforce be more general, in the same way it is for the various types of manned aircraft they routinely control. They should therefore be familiar with RPA performance characteristics insofar as they relate to integration with other traffic under their control, eg airspeed, rate of climb/descent, turn radius, etc.

Specification RPA26. Pilots-in-command should have detailed knowledge of the performance characteristics of their particular vehicle. ATC controllers should be familiar with RPA performance characteristics insofar as they relate to integration with other traffic under their control.

3.12 Meteorology

3.12.1 Similar to manned aircraft, weather minima for RPA flight will be determined by the equipment and capabilities of each UAS, the qualifications of the RPA pilot-in command, the flight rules being flown and the class(es) of airspace in which the flight is conducted.

Specification RPA27. The weather minima for RPA flight should be determined by the equipment and capabilities of each UAS, the qualifications of the RPA pilot-in command, the flight rules being flown and the class of airspace in which the flight is conducted.

3.13 Flight Across International Borders and Across Flight and Upper Information Region (FIR/UIR) Boundaries

3.13.1 As state aircraft, RPAs are theoretically exempt the requirement of Article 8 of the Chicago Convention for special authorization for unmanned aircraft to fly over the territory of another state. However, Article 3 precludes state aircraft from flying over the territory of another state without authorization by special agreement. Conscious of the potential sensitivity of flight across international borders, the TF took the view that Article 3 applied to state RPAs, and that they should therefore be the subject of authorization by special agreement.

3.13.2 International borders do not necessarily coincide with FIR/UIR boundaries. To reduce the potential for misunderstanding in such circumstances, and to enhance flight safety by ensuring that air navigation service providers (ANSPs) are made aware of RPA activity within airspace for which they have responsibility, the TF felt that, where it was planned for an RPA flight to enter another FIR/UIR or the sovereign airspace of another state, then details of the flight should be pre-notified to the relevant airspace authority. This should normally be accomplished by the submission of a flight plan.

3.13.3 Where an air traffic service is being provided to an RPA by ATC and transfer is required to an ATC unit in an adjacent state, this should be conducted in the same manner as for manned aircraft.

<u>Specification RPA28</u>. With regard to cross-border operations, state RPAs should be bound by the same international conventions as manned state aircraft. In addition, flights by state RPAs into other FIR/UIRs or into the sovereign airspace of other states should be pre-notified to the relevant airspace authorities, normally by submission of a flight plan. ATC transfers between adjacent states should accord with those for manned aircraft.

3.14 OAT CNS Functionality Requirements

3.14.1 When flying outside segregated airspace, RPA CNS functionality and performance should be equivalent to that required for manned aircraft, and appropriate to the airspace in which the RPA is flying and to any air traffic service provided to the RPA. This is in addition to functionality related to possible communication relay and control data-linking, and to the S&A system(s) previously discussed.

3.14.2 Depending on the sortie, an RPA may be required to carry some or all of the following CNS functionality:

a. Radio Communications. Capable of forming part of the architecture that enables the RPA pilot-in-command to communicate with ATC on regular ATC frequencies.

b. Navigation Systems. Capable of providing data in a format that will enable the RPA pilot-in-command to report in accordance with ATC requirements.

c. Transponder. An operable SSR transponder that will allow the RPA pilot-in-command to respond to ATC requests to alter settings, squawk ident, etc.

3.14.3 Notwithstanding the above, where, for technical or operational reasons, compliance with specific CNS functionality requirements is not possible or is not warranted, the exemption policy[11] applicable to manned state aircraft should extend to RPAs.

3.14.4 Although ACAS may seem ideally suited for installation in RPAs, it was developed for manned aircraft, and further research is required before any system employing ACAS technology could be considered for use on RPAs.

Specification RPA29. RPAs should carry similar functionality for flight, navigation and communication to that required for manned aircraft. The exemption policy for manned state aircraft with regard to specific equipage requirements should also apply to state RPAs.

3.14.5 In accord with the principle that the provision of an air traffic service to an RPA should be transparent to an ATC controller, there is no requirement for a continuous ground link between ATC and the RPA pilot-in-command to supplement communications conducted via the RPA itself. Nevertheless, it would be prudent for the RPA pilot-in-command to have some other means of communicating with ATC in case of loss of linkage via the RPA.

Specification RPA30. The RPA pilot-in-command should be provided with an independent means of communication with ATC in case of loss of normal communications linkage, for example via telephone.

3.14.6 When in receipt of an ATS, it is clearly important that there should be minimal delay in the ability of a pilot-in-command to respond to ATC instructions, particularly when these relate to traffic avoidance. The pilot-in-command should therefore be able to provide a prompt response to traffic avoidance instructions similar to that by a pilot of a manned aircraft.

Specification RPA31. A pilot-in-command should be able to provide a prompt response to traffic avoidance instructions similar to that by a pilot of a manned aircraft.

[11] CMIC Policy Guidance for the Exemption of State Aircraft from Compliance with Specific Aircraft Equipage Requirements dated 4 Mar 03

4 SAFETY MANAGEMENT

4.1 A mature edition (0.5 dated 2 Dec 04) of these specifications has been subject to an independent safety assurance process, as summarized at Annex E. The recommendations arising from this process have been incorporated subsequently into the specification document.

4.2 The related Summary Report stated a requirement for guidance material in support of the specifications to assist states with incorporation of the specifications into their national regulations. This guidance material been since been developed, and is incorporated into the specification document at Annex F.

4.3 Subsequent to the safety assurance process, input has been accepted from the NATO UAS FINAS WG in order for the proposed incorporation of the specifications into any future NATO STANAG detailing ATM for military RPAs. In addition, comment received following ENPRM consultation has prompted a number of other minor changes. None are regarded as affecting the findings of the safety assurance process, but are recorded for tracking purposes at Annex G.

5 IMPACT ASSESSMENT

5.1 An Impact Assessment has been conducted on these specifications. The related document is at Annex H.

6 RELATED NON-ATM ISSUES

6.1 Context

6.1.2 The UAV-OAT TF focused upon ATM. However, other important issues will need to be addressed before the operation of military RPAs as OAT outside segregated airspace can become routine. Although these lie outside the scope of the work and expertise of the TF, several are considered below, albeit in brief.

6.2 Airworthiness and Certification

6.2.1 Individual nations have well-established airworthiness and certification processes for manned military aircraft, and it is probable that these will be mirrored as near as possible for military RPAs. Moreover, for flight outside segregated airspace, RPA standards of airworthiness cannot vary widely from those for manned aircraft without raising public and regulatory concern. Further, it is self-evident that the RPA airworthiness requirements for one nation should be acceptable by others to facilitate cross-border operations and flight across FIR/UIR boundaries.

6.2.2 The NATO Joint Capability Group on RPAs has established the UAS FINAS Military WG to recommend and document NATO-wide guidelines to allow the cross-border operation of military RPAs in non-segregated airspace, with such guidance to include system airworthiness and certification. The WG, which first met in April 2004, has been directed to proceed on a philosophy based on manned aircraft regulation, and envisages a 5-year programme of work.

6.2.3 The EU had previously launched the European Capabilities Action Plan (ECAP), which was intended to support the deployment of a rapid reaction force, and which included the establishment of a UAV Project Group to develop EU UAV operational capability. The ECAP has now been absorbed within the European Defence Agency.

6.2.4 Six nations (France, Germany, Italy, Spain, Sweden and UK) are participating in the European Technologies Acquisition Programme (ETAP) to produce standard regulation for the certification of military RPAs in line with that for manned aircraft.

6.2.5 Although military RPAs currently predominate, sundry bodies are also progressing the future regulation of civil RPAs. For example, the Joint JAA/EUROCONTROL UAV TF completed its report[12] in May 04 on a concept for European regulations for civil RPAs, which includes consideration of airworthiness, operational approval and licensing. The EC has been similarly engaged via its sponsorship of the USICO (UAV Safety Issues for Civil Operations) Project which investigated the integration of civil RPAs outside segregated airspace. More recently, the European Organisation for Civil Aviation Equipment (EUROCAE) has established Working Group 73 to develop recommendations and establish technical standards for UASs

[12] Joint JAA/EUROCONTROL UAV TF Final Report dated 11 May 04

6.3 System Security

6.3.1 Concern about UAS security is common to the operation of both military and civil RPAs. Three important areas are:

a. The susceptibility of the control data-link to malicious interference.

b. The vulnerability of an RPA ground station to unlawful seizure.

c. The potential for malevolent misuse of an RPA.

6.3.2 Security measures need to be incorporated into an UAS to provide assurance that the RPA will be used only for its intended and authorized purpose. Thus, the security risks themselves need to be evaluated and mitigated as appropriate.

6.3.3 The Joint JAA/EUROCONTROL UAV TF report provides an overview that includes discussion on physical security, data-link security and integrity, encryption, data network security and software security. On behalf of NATO, the UAS FINAS Military WG intends to include UAS security in its eventual guidelines.

6.4 Training and Licensing

6.4.1 It follows that training for an RPA pilot-in-command will depend primarily upon the capability of an RPA and its mission profile. From an ATM viewpoint, this should include the provision of competence appropriate to the airspace to be flown in and to the air traffic services available within that airspace. Moreover, as with RPA airworthiness, the licensing of RPA pilots-in-command should fulfil certain minimum criteria that allow them to operate RPAs in the airspace of other countries.

6.4.2 The topic is discussed in the Joint JAA/EUROCONTROL UAV TF report, and features in the work of the UAS FINAS Military WG. Training and medical requirements for RPA pilots-in-command have previously been considered by the NATO Air Traffic Management Committee (NATMC) ATM Group[13] and, more currently, the NATO Standardisation Agency (NSA) Air Operations Support Working Group (AOSpWG) is addressing medical requirements for RPA operators.

[13] AC/92(ATM)WP(2001)1 dated 6 Jul 01

7 CURRENT STATUS OF SPECIFICATION DOCUMENT

7.1 Edition 0.5 (dated 2 Dec 04) of the specification document was subjected to a safety assurance process (see Annex E) and the consequent recommendations were incorporated into Edition 0.7 (dated 13 Sep 05), which was endorsed by the Military Team in Nov 05. A reformatted Edition 0.8 (dated 5 Dec 05) was then given initial approval by CMIC in Mar 06, and Edition 0.9 (dated 24 Apr 06) was circulated for stakeholder consultation via the ENPRM mechanism. Edition 0.11 (dated 26 Jan 07) was accepted by CMIC/28 in Mar 07. This Edition 1.0 (dated 26 Jul 07) is prepared for public release after approval by DG EUROCONTROL.

7.2 In accord with the request by CMIC for EUROCONTROL to maintain and update the specifications as required, this document will be subject to biennial review by EUROCONTROL (DSS/CM).

8 CONCLUSION

8.1 On the basis of these EUROCONTROL Specifications, RPA operations will neither increase the risk to other airspace users nor deny airspace to them. Moreover, ATM procedures will mirror those applicable to manned aircraft, and the provision of an air traffic service to an RPA will be transparent to ATC controllers.

8.2 The EUROCONTROL Specifications seek to address various aspects of RPA operations within the context of ATM. In doing so, they envisage a primary mode of operation that entails oversight by a pilot-in-command, and a back-up mode that enables an RPA to revert to autonomous flight in the event of loss of data-link. A similar hierarchy is followed with regard to traffic avoidance and collision avoidance. Thus, where ATC is not available to separate an RPA from other airspace users, the pilot-in-command will assume this responsibility using available surveillance information and technical assistance in the form of a S&A system. The latter will also initiate last-ditch autonomous collision avoidance should circumstances warrant.

8.3 At aerodromes, RPA operations will interface with the aerodrome control service akin to manned aircraft. Whilst taxiing, RPAs should be monitored by ground-based observers.

8.4 RPA emergency procedures are discussed in general terms but should mirror those for manned aircraft wherever possible. Likewise, weather minima for RPAs should be determined by factors similar to those that govern flight by manned aircraft. Moreover, for cross-border operations, state RPAs should be bound by the same international conventions as manned state aircraft. On the other hand, where RPA operations are not compatible with other air traffic, they should be accommodated within temporary reserved airspace. Finally, RPAs should carry similar CNS functionality to that required for manned aircraft, though the exemption policy for manned state aircraft should also apply to state RPAs.

8.5 The individual specifications are repeated at Annex I.

Annex A - UAV-OAT TF Terms of Reference[14]

1 Mission

1.1 The UAV-OAT TF is tasked to develop EUROCONTROL Specifications for the use of UAVs as OAT outside Segregated Airspace. The work will consider existing civil and military national documentation and the Task Force will consult with external bodies as required. At a later stage the deliverables could be used in the development of civil regulations for UAV by appropriate bodies.

2 Authority

2.2 The Task Force will report to the MIL Team.

3 Participation

3.3 The Task Force participants will be national military experts who have already been involved in addressing the ATM practicalities of UAV operations outside segregated airspace. It is anticipated that all participants will assist with the provision of already developed material and will contribute in the development of deliverables from the Task Force.

- Agency Staff: SD/MIL and DAS/AFN, DAS/CSM, SRU and RU as appropriate.
- Other: NATO, USAF, EU.

4 Tasks

4.1 The UAV-OAT TF is tasked to develop EUROCONTROL Specifications for the use of UAVs as OAT outside Segregated Airspace, consulting with external bodies as required. To fulfil this task the Task Force shall:

- Review military UAV ATM requirements;
- Review and make use of existing international and national civil/military UAV ATM regulations, procedures and guidelines;
- Review the work required, mainly within the ATM domain, and recommend a Work Programme;
- Monitor the developments within the industry and military UAV community eg requirements, technology, procedures;
- Take due note of emerging civil UAV ATM regulations;
- Adapt work to EUROCONTROL Notice of Proposed Rule-Making (ENPRM) process if possible;
- Deliver a harmonised set of proposed EUROCONTROL Specifications which can be used by the Member States for implementation of UAVs as OAT in non-segregated airspace including cross-border operations.
- Progress the harmonization of ATM specifications for the operation of UAVs within segregated airspace in Europe based upon EUROCONTROL Specifications developed by the TF for the use of UAVs as OAT outside segregated airspace.

5 Occurrence of This Task Force Per Year

[14] The term ‘UAV’ has not been replaced with ‘RPA’ in this Annex as the Task Force was disbanded in 2010. The Annex is kept for ‘historical’ reasons.

5.1 The Task Force will meet as required. It is anticipated that a significant amount of work can be undertaken by correspondence and virtual meetings.

Annex B - Glossary of Terms

All terms are defined within the context of Air Traffic Management.

Collision Avoidance	Avoidance of collision with other airspace users.
Controlled Airspace	An airspace of defined dimensions within which air traffic control service is provided in accordance with the airspace classification.
General Air Traffic	GAT flights are all movements of civil aircraft, as well as all movements of State aircraft, when these movements are carried out in accordance with the procedures of ICAO.
Instrument Flight Rules	A set of procedures prescribed by the appropriate controlling authority for conducting flight operations under conditions not meeting the requirements for visual flight or in certain types of airspace.
Operational Air Traffic	OAT flights are all flights which do not comply with the provisions stated for GAT and for which rules and procedures have been specified by appropriate national authorities[15].
Remotely Piloted Aircraft	An aircraft where the flying pilot is not on-board the aircraft.*
Sense & Avoid System	A Sense & Avoid System comprises those components which enable a RPA to sense and avoid other airspace users in real-time; it may be on-board, or ground-based involving the pilot-in-command, or a combination of both.
Segregated Airspace	Airspace that is segregated for exclusive use and into which other traffic is not permitted.
Traffic Avoidance	The maintenance of prescribed separation minima from other traffic.
UAV Pilot-in-Command	The person in direct control of the UAV.
UAV System	A UAV System is the UAV and its flight control and operating system, including any ground station and data links and any dedicated processes for communication with ATC.
Unmanned Aerial Vehicle	An aircraft which is designed to operate with no human pilot onboard. Within this Paper, the reference will be to a military UAV unless stated otherwise. As of edition 2.0 of this document, UAVs are generally referred to as RPA - Remotely Piloted Aircraft.
Unmanned Aircraft System	An aircraft and its associated elements which is operated with no pilot on-board.*

[15] PC16 took account of the conclusion reached by all CMIC members, other than those representing Turkey, that there was no requirement to amend the current definitions of OAT and GAT as agreed by the EUROCONTROL Commission

* Definitions from ICAO Circular 328/2010.

Visual Flight Rules	A set of procedures prescribed by the appropriate controlling authority for conducting flight operations under conditions meeting the requirements for visual flight or in certain types of airspace.

Annex C - RPA-OAT Abbreviations

ACAS	Airborne Collision Avoidance System
ANSP	Air Navigation Service Provider
AOSp	Air Operations Support (NATO WG)
ATC	Air Traffic Control
ATM	Air Traffic Management
CMIC	Civil/Military Interface Standing Committee
CNS	Communications, Navigation and Surveillance
COA	Certificate of Authorization (US)
EATMP	European Air Traffic Management Programme
EC	European Community
ECAP	European Capabilities Action Plan
ERP	Emergency Recovery Procedure
ESARR	Eurocontrol Safety Regulatory Requirement
ETAP	European Technologies Acquisition Programme
EUROCAE	European Organisation for Civil Aviation Equipment
FHA	Functional Hazard Analysis
FINAS	Flight in Non-Segregated Airspace (NATO WG)
FIR	Flight Information Region
FTS	Flight Termination System
FUA	Flexible Use of Airspace
GAT	General Air Traffic
HOGI	Harmonisation of OAT and GAT/OAT Interface (TF)
ICAO	International Civil Aviation Organisation
IFR*	Instrument Flight Rules
IMC*	Instrument Meteorological Conditions
JAA	Joint Aviation Authority
MILT	Military Team
MPS	Minimum Performance Standards
NATMC	NATO Air Traffic Management Committee
NATO	North Atlantic Treaty Organisation
NSA	NATO Standardisation Agency
OAT	Operational Air Traffic
PSSA	Preliminary System Safety Analysis

ROA	Remotely Operated Aircraft (US designation for UAVs)
RPA	Remotely Piloted Aircraft
RTF	Radiotelephony
S&A	Sense and Avoid
SM	Safety Management
SSR	Secondary Surveillance Radar
STANAG	NATO Standardisation Agreement
TCAS	Traffic alert and Collision Avoidance System
TF	Task Force
TORs	Terms of Reference
UAS	Unmanned Aircraft System
UAV	Unmanned Aerial Vehicle
UIR	Upper Information Region
USICO	UAV Safety Issues for Civil Operations
VFR*	Visual Flight Rules
VMC*	Visual Meteorological Conditions

* Where the terms IFR, VFR, IMC and VMC are used in these Specifications, they refer to the flight rules and the minima of the meteorological conditions specified by ICAO Annex 2 as transposed to the flight rules and the minima of the metrological conditions required for operations as OAT. Such terms do not infer operations as GAT.

Annex D – Existing National UAV/RPA ATM Regulations

1. Czech Republic

Czech UAS Regulatioin

2 France

2.1 DIRCAM Instruction No 2250 (dated 5 Jan 04) prescribes the rules for UAV flights as part of military air traffic over France.

2.2 The Instruction requires that UAVs are segregated from other airspace users in time and/or space. This entails the use of restricted areas, temporary restricted zones, prohibited areas, temporary segregated areas, cross border areas, and control zones and control areas with an ATS airspace classification of A to D. The UAV is required to remain within the specified airspace, which can include work areas and launch/recovery sites. However, to allow the UAV to transit from one work area to another, it must use a corridor, which is negotiated with civil air traffic authorities to segregate the UAV from other traffic types.

3 Sweden

3.1 UAV-Policy Issue 2 (dated 8 Apr 03), issued by the Swedish Armed Forces Military Flight Safety Inspectorate, governs military UAV operations in Sweden.

3.2 All aspects of the Policy are governed by the requirement that UAVs should pose no greater threat than manned aircraft. Accordingly, for Class 2 and Class 3 UAV systems, flight is only allowed in segregated airspace. However, the policy for Class 4 UAV systems theorizes that it should be possible to fly such a UAV in airspace that is open to civil aviation provided the ATS requirements for the various airspace classifications are met. Thus, the UAV system must contain all the system safety levels and functional characteristics that are valid for a similar manned aircraft in a similar airspace.

4 United Kingdom

4.1 CAP 722 (dated 29 May 02), issued by CAA DAP, provides evolving guidance for UAV operations in the UK.

4.2 As with Sweden, CAA policy is that UAVs operating in the UK must meet the same or better safety and operational standards as manned aircraft. At present, this means that military UAVs may normally only be flown within danger areas. Exceptionally, flight outside danger areas may be accommodated subject to extensive and extended preplanning and the exclusive use of temporary segregated airspace.

4.3 The document provides guidance to Industry on how to progress Sense and Avoid (S&A) criteria as part of the requirement for aerial collision avoidance, but reserves judgment on the parameters governing the performance of such a S&A system.

5 United States of America

5.1 Current DoD guidance originates from FAA Order 7610.4 – Special Military Operations. In support, AFI 11-202 Vol 3 (General Flight Rules) prescribes general flight rules governing the operation of (US) Air Force aircraft (manned and remotely-operated) flown by (US) Air Force pilots.

5.2 Both FAA and USAF consider UAVs (referred to as Remotely Operated Aircraft [ROAs] in US terminology) to be aircraft. As such, they must meet civil standards to fly outside segregated airspace.

5.3 Without the capability to sense and avoid other aircraft, UAVs are restricted to flight within segregated airspace. For state-owned aircraft, operators must obtain a Certificate of Authorization or Waiver (COA) to conduct operations outside segregated airspace. A 'Special Airworthiness Certificate (Experimental)' is required for non-state-owned aircraft operations. When DSA (detect, sense and avoid) is solved and allied to other systems that meet the same airspace-specific operating requirements as manned aircraft, a UAV should be able to fly in the National Airspace System (ie outside segregated airspace) with the same operational flexibility as manned aircraft, commonly referred to as *file and fly.*

Annex E – Ebeni-Stasys Safety Assurance Process[16]

1 Background

1.1 Ebeni-Stasys were contracted to conduct an independent safety assurance process of Edition 0.5 (dated 2 Dec 04) of the EUROCONTROL draft UAV specifications - to support the argument that, *by application of the draft specifications, military UAV operations in non-segregated airspace will be acceptably safe*. The process took the form of a Functional Hazard Analysis (FHA)/Preliminary System Safety Analysis (PSSA), and was conducted in accord with the requirements of EUROCONTROL Safety Regulatory Requirement (ESARR) 4 on Risk Assessment and Mitigation in ATM.

2 FHA/PSSA

2.1 Starting with the premise that present operations by manned military aircraft flying OAT outside segregated airspace are safe, the contractor defined a series of models and scoping assumptions for this situation and also for a future situation involving the operation of military UAVs outside segregated airspace. These were then compared and validated at a Workshop held in Brussels on 1/2 Jun 05, attended by a representative cross-section of military and civilian stakeholders. Comment received during the Workshop thereafter formed the basis of work by the contractor to assess risk mitigations, derive safety requirements to achieve these risk mitigations, and rationalize the subsequent safety requirements and the draft specifications.

2.2 The FHA/PSSA and its conclusions are the subject of a Summary Report[17].

3 Summary Report

3.1 The Summary Report details how the safety assurance activity identified 9 hazards that fell within the defined scope of the safety analysis. A causal and consequence analysis was undertaken for each of these, which gave rise to 53 safety requirements (at Appendix 1), comprising 26 Functional Safety Requirements, 10 Mitigating Safety Requirements and 17 Safety Integrity Requirements. Eight of the safety requirements were not addressed by the draft specifications. However, the overarching safety analysis showed that - subject to the inclusion of these 8 safety requirements - the draft specifications would adequately address the safety recommendations derived from the independent safety assurance activity.

<u>Appendix</u>:

1. Safety Requirements – Traceability to Specifications.

[16] As the report dates from 2006, the term UAV has not been replaced with RPA.
[17] Ebeni-Stasys Summary Report – Safety Assurance of the Draft Specifications for the Use of Military UAVs as OAT Outside Segregated Airspace (Edition Number 1.0 dated 29 Mar 06)

Appendix 1 to Annex E – Safety Requirements – Traceability to Specifications[18]

ID	Requirement [1]	Specifications	
		Edition 0.5 Annex E paragraph	**Edition 2.0 Annex I**
Functional Safety Requirements			
FSR-01	*The air traffic service provided to RPAs should accord with that provided to manned aircraft*	9.1, 11.1 and 12.2	RPA13 RPA22 RPA23
FSR-02	When ATC are responsible for traffic avoidance, the separation minima between RPAs and other traffic should be the same as for manned aircraft flying OAT in the same class of airspace	7.2 and 8.1	RPA8 RPA10
FSR-03	The Pilot-in-command is responsible for ensuring that the RPA trajectory is compliant with any ATC clearance	6.1	RPA5
FSR-04	*While in receipt of an air traffic service, RPAs should be monitored continuously by the RPA Pilot-in-command for adherence to the approved flight plan*	3.1 and 12.4	RPA2 RPA25
FSR-05	*The weather minima for RPA flight should be determined by the equipment and capabilities of each UAS*	13.1	RPA27
FSR-06	RPAs shall be pre-programmed with an appropriate contingency plan in the event that the Pilot-in-command is no longer in control of the RPA	Not covered within draft specificat-ions	RPA18
FSR-07	Following the above event, RPAs should continue flight autonomously and in accordance with the pre-programmed contingency plan	3.1	RPA2
FSR-08	RPAs flying in controlled airspace shall notify ATC of contingency plans for emergency operations prior to operations	12.3	RPA24
FSR-09	*Where a RPA Pilot-in-command has primary responsibility for traffic avoidance, he should maintain a minimum distance of 500ft between his RPA and other airspace users, regardless of how the conflicting traffic was detected and irrespective of whether or not he was prompted by a collision avoidance system*	8.2	RPA11
FSR-10	RPA collision avoidance systems should enable a RPA Pilot-in-command to perform collision avoidance functions as least as well as, and preferably better, than a pilot in a manned aircraft	6.1, 6.2, 7.1, 9.2, 9.3 and 9.4	RPA5 RPA6 RPA7 RPA14 RPA15

[18] For reasons of readability, the term UAV has been replaced with RPA throughout this table although the reference in the original document is to UAV.

FSR-11	Autonomous RPA collision avoidance systems should have equivalent efficacy to a pilot performing threat detection and collision avoidance actions	8.3	RPA12
FSR-12	RPA equipment carriage shall render it compatible with mandated collision avoidance systems fitted to other aircraft	8.3	RPA12
FSR-13	RPAs should have limited alerting systems equivalent to those on a manned aircraft, to minimise the potential alerts that can interrupt compliance with traffic avoidance instructions	Not covered within draft specificat-ions	RPA6 RPA9
FSR-14	Pilots in Command of RPAs and ATC shall be familiar with individual RPA performance characteristics	Not covered within draft specificat-ions	RPA26
FSR-15	*RPAs should carry similar equipment for flight, navigation and communication as required for manned aircraft, as mandated for the airspace in which the RPA is operating, with the exception of ACAS*	15.1	RPA29
FSR-16	RPAs should carry appropriate equipment to ensure RPA Pilots in Command are provided with an accurate situational indication equivalent to that provided to a pilot of a manned aircraft	6.2 and 9.3	RPA6 RPA15
FSR-17	*While in receipt of an air traffic service, the RPA Pilot-in-command should maintain two-way communications with ATC, using standard phraseology when communicating via RTF. The word "unmanned" should be included on first contact with an ATC agency*	9.2 and 12.1	RPA15 RPA22
FSR-18	*Where RPA emergency procedures necessarily differ from those for manned aircraft eg RPA control link hijacking, security breaches etc., they should be designed to ensure the safety of other airspace users and people on the ground, and they should be coordinated with ATC as appropriate*	10.1	RPA17
FSR-19	RPA Pilots in Command shall be able to provide a timely response to traffic avoidance instructions similar to a pilot of a manned aircraft[19]	Not covered within draft specificat-ions	RPA31
FSR-20	*With regard to cross-border operations, state RPAs should be bound by the same international conventions as manned state aircraft. In addition, flights by state RPAs into the FIR/UIR of other states should be pre-notified to the relevant FIR/UIR authorities, normally by submission of a contingency plan. ATC transfers between adjacent states should accord with those for manned aircraft*	14.1	RPA28
FSR-21	RPAs Pilots in Command shall have equivalent piloting skills to pilots of conventional aircraft, enabling them to monitor, control and operate the air vehicle in a manner comparable to manned aircraft	13.1	RPA27

[19] FSR-19 is in addition to FSR-21 and relates to the efficacy of the Pilot-in-Command to RPA interface. However, where an RPA takes longer than a manned air vehicle to respond to a pilot command (eg due to control link latency) then this delay must be incorporated within the performance characteristics of the RPA as defined in FSR-14.

FSR-22	UASs shall provide an indication to Pilots in Command when the RPA Control Link has been lost and the RPAs is operating autonomously	Not covered within draft specificat-ions	RPA19
FSR-23	Autonomous RPA traffic avoidance systems should have equivalent efficacy to a pilot performing traffic avoidance actions	3.1, 6.2 and 9.4	RPA2 RPA6
FSR-24	Where a RPA is unable to continue to comply with any of the requirements for operations in non-segregated airspace then the RPA should be segregated from all other airspace users as soon as practicable.	9.5 and 11.1	RPA16 RPA21
FSR-25	When the RPA Control Link has been lost Pilots in Command shall inform ATC as soon as possible	Not covered within draft specificat-ions	RPA20
FSR-26	UASs shall provide an indication to ATC when the RPA is operating autonomously	Not covered within draft specificat-ions	RPA20
Mitigating Safety Functions			
MSF-01	Pilot-in-command must inform ATC when unable to comply with any ATC instruction	4.1 and 12.2	RPA3 RPA23
MSF-02	RPAs shall be fitted with suitable conspicuity devices to aid visual acquisition by other airspace users.	6.2	RPA6
MSF-03	Whilst for manned and unmanned operations the Pilot-in-command is a common factor to both the Traffic avoidance and Collision Avoidance functions, to reduce the risk to AFARP then implementation of these functions should be as independent as far as is reasonably practicable	Not covered within draft specificat-ions	RPA9
MSF-04	Following failure of the RPA Collision Avoidance System, the RPA flight should be terminated as soon as safely practicable	10.1	RPA17
MSF-05	Pilot-in-command must inform ATC as soon as he becomes aware that the RPA is responding incorrectly to any ATC instruction	4.1 and 12.2	RPA3 RPA23
MSF-06	Pilot-in-command must inform ATC of any intentional deviation from an ATC instruction	4.1 and 12.2	RPA3 RPA23
MSF-07	Pilot-in-command must inform ATC of any delayed response to an ATC instruction	4.1 and 12.2	RPA3 RPA23
MSF-08	In the event of loss of communications with ATC the Pilot-in-command shall attempt to contact ATC, if the attempt fails the Pilot-in-command should follow lost communications procedures as per manned operations	10.1 and 12.1	RPA17 RPA22
MSF-09	*RPAs should comply with VFR and IFR as they affect manned aircraft flying OAT*	4.1	RPA3
MSF-10	*RPAs should comply with the right-of-way rules as they apply to other airspace users*	5.1	RPA4

Safety Integrity Requirements (no trace to Specifications)	
SIR-01	The probability that a Pilot-in-command of a RPA does not inform ATC of an inability to comply with ATC instructions shall be equivalent, and preferably lower, than for manned operations
SIR-02	The probability of failure of RPA visual conspicuity devices shall be equivalent to those used on manned AV
SIR-03	The probability that the RPA Collision Avoidance system (with or without Pilot-in-command) fails to avoid a collision shall be equivalent to an aircraft with a pilot on board
SIR-04	The probability that a Pilot-in-command of a RPA does not inform ATC of a recognised incorrect response to an ATC instruction shall be equivalent to manned operations
SIR-05	The probability that a Pilot-in-command of a RPA does not inform ATC of an intentional deviation from an ATC instruction shall be equivalent, and preferably lower, than for manned operations
SIR-06	The probability that a Pilot-in-command of a RPA does not inform ATC of a delayed response to an ATC instruction shall be equivalent, and preferably lower, than for manned operations
SIR-07	The probability that a Pilot-in-command of a RPA fails to notice loss of Traffic avoidance and contact ATC shall be equivalent, and preferably lower, than manned operations[20]
SIR-08	The probability that a Pilot-in-command of a RPA fails to follow lost communications procedures in the event of loss of Traffic avoidance from ATC shall be equivalent to manned operations
SIR-09	The frequency of occurrence of RPAs being unable to implement a traffic avoidance instruction due to a UAS failure shall be equivalent to that of manned aircraft
SIR-10	The frequency of occurrence with which a RPA pre-programmed flight path plan is corrupted or incorrect shall be equivalent to that of a Pilot-in-command of a manned aircraft being unable or incorrectly responding to a traffic avoidance instruction
SIR-11	The frequency of occurrence with which a RPA Pilot-in-command looses situational awareness shall be equivalent, and preferably lower, to that of manned aircraft
SIR-12	The frequency of occurrence with which an Autonomous RPA fails to implement its pre-programmed contingency plan shall be equivalent, and preferably lower, to that of a Pilot-in-command being unable to comply with a traffic avoidance instruction
SIR-13	The frequency of occurrence with which a RPA Pilot-in-command does not recognise a missed co-ordination and transfer shall be equivalent, and preferably lower, than that for a pilot of a manned aircraft
SIR-14	The probability of a RPA false collision avoidance or other false alerts shall be equivalent to that for manned aircraft
SIR-15	The frequency of occurrence of a RPA flight control error shall be equivalent to that for manned aircraft
SIR-16	The frequency of occurrence of a RPA Pilot-in-command human error shall be equivalent to that for a Pilot of a manned aircraft
SIR-17	The frequency of occurrence of corruption of RPA flight control commands shall be equivalent to that of manned aircraft

[20] Consideration should be given to provision of independent means of communication with ATC such as telephone etc.

Note:

1. The safety requirements are as presented in the Ebeni-Stasys Summary Report. Use of *italics* indicates that the draft specifications explicitly address the safety recommendations derived from the independent safety assurance activity, whereas normal font reflects implicit application unless stated otherwise for Edition 0.5.

Annex F – Guidance Material to States to Assist with Incorporation of the Specifications into National Regulations

1. Although these EUROCONTROL specifications have been subject to a safety assurance process (see Annex F), states should apply their own safety management systems when incorporating the specifications into national regulations.

2. In applying such safety management systems, states should take into account the caveats (ie Scope, Assumptions, Limitations and Safety Issues) recorded in the Ebeni-Stasys Summary Report (available from EUROCONTROL DSS/CM).

3. These EUROCONTROL specifications are voluntary and employ the executive word *should*. When incorporating the specifications into national regulations, states should employ an imperative appropriate to the status of their regulations.

4. At paragraph 2.1.5 in the main document, reference is made to the work of the HOGI Task Force, which is seeking to harmonise the rules for OAT, develop an OAT transit system and establish a strategy for the pan-European use of military training areas. As OAT, RPAs will be affected by the work of the HOGI Task Force, and states should take this into account when incorporating these EUROCONTROL specifications into national regulations.

5. When incorporating these EUROCONTROL specifications into national regulations, states should put into place a programme of safety monitoring to ensure that military RPA operations in non-segregated airspace remain acceptably safe.

Annex G – Changes to Specifications Subsequent to Safety Process

1. A previous specification regarding RPA operations involving the use of a chase plane has been deleted *in toto.* There was no basis for claiming the same right-of-way status for a formation flight comprising a RPA and its chase plane as aircraft engaged in airborne refuelling or towing.

2. Wording of RPA2 has been amended by the addition of *'....who should at all times be able to intervene in the management of the flight'*. This mirrors the extant preceding explanatory text.

3. In RPA6, the final sentence has been amended from *'....loss of control data-link.'* to *'….failure of traffic avoidance'.* This change clarifies that the automatic system should provide collision avoidance in the event of failure of traffic avoidance (ie for whatever reason) rather than specifically in the case of loss of control data-link.

4. Wording at RPA7 has been amended from *'....in the event of loss of control data-link'* to *'....if traffic avoidance has failed for whatever reason'* to align with the change to RPA6. In addition, the last sentence has been amended from *'….an aircraft with a pilot onboard.'* to *'….a manned aircraft'.* to accord with other references to manned aviation.

5. RPA9 has been added in response to a recommendation from the safety process.

6. Wording in RPA10 has been amended from *'….other IFR traffic….'* to *'….other traffic in receipt of a separation service….'* This change reflects the fact that, in some classes of controlled airspace, separation is also provided against VFR traffic where the latter is in receipt of a separation service.

7. Wording at RPA11 has been amended from *'…..he should maintain a minimum distance of 500ft…..'* to *'…..he should, except for aerodrome operations, maintain a minimum distance of 0.5nm horizontally or 500ft vertically…..'*. This change represents an increase in horizontal separation from 500ft to 0.5nm, and reflects previous unease expressed about 500ft horizontal separation within the RPA-OAT TF, and subsequent discussion with the UAS FINAS Military WG. It also clarifies that the specification does not relate to aerodrome operations.

8. Both in the section title and in all the specifications relating to Aerodrome Operations, references to a*irfield* have been amended to *aerodrome* and references to *ATC* have been amended to *aerodrome control service* to accord with ICAO Annex 11.

9. In RPA14, *'accompanied'* has been amended to *'monitored'* to allow for other arrangements.

10. RPA15 is an amalgam of two previous specifications which dealt separately with VFR and IFR operations since the requirements are the same. In addition, reference to *'….should be able to view the runway and the airfield circuit….'* has been amended to *'….should be able to maintain situational awareness….*' to clarify the nature of the requirement.

11. The start of RPA17 has been amended from *'Where RPA emergency procedures necessarily differ from those for manned aircraft, they should be designed….*' to *'RPA emergency procedures should mirror those for manned aircraft as far as practicable. Where different, they should be designed….'*. This change provides a positive

statement that every effort should be made to align emergency procedures for RPAs with those for manned aircraft.

12. RPA18, RPA19 and RPA20 have been added in response to recommendations from the safety process.

13. In RPA22, reference to '*ATC agency'* has been amended to *'ATC unit'* to accord with ICAO Annex 11.

14. RPA26 has been added in response to a recommendation from the safety process.

15. In RPA 27, *'the flight rules being flown'* has been added to the factors determining the weather minima for RPA flight. This had previously been missed.

16. Both in the preceding section title and in RPA29, reference to *equipment* has been amended to *functionality* to clarify the nature of the requirement and not relate it specifically to the carriage of equipment.

17. RPA30 and RPA31 have been added in response to recommendations from the safety process.

Annex H – Impact Assessment

1 Introduction

1.1 This document is intended to provide a high-level impact assessment commensurate with the generic nature of the specifications. It is made on the basis of available information and knowledge. Notwithstanding, a degree of conjecture is necessary because of the innovative nature of the specifications and the current absence of some supporting technology.

1.2 It is anticipated that individual states will conduct their own, more detailed, impact assessments as part of the process of incorporating the specifications into national regulations.

2 Current Situation

2.1 At present, most military RPAs in Europe are restricted to airspace that is segregated for the purpose from other aircraft or they are flown over the sea using special arrangements. Where operations are permitted outside segregated airspace, numerous restrictions to ensure the safety of other airspace users normally apply. This is extremely limiting. To exploit fully the unique operational capabilities of current and future RPA platforms, and to undertake training necessary for the safe conduct of RPA operations, European military authorities require RPAs to be able to access all classes of airspace and to be able to operate across national borders. This will entail their migration outside segregated airspace.

3 Nature of Specifications

3.1 The EUROCONTROL specifications relate only to the air traffic management (ATM) aspects of military RPAs flying as Operational Air Traffic (OAT) outside segregated airspace.

3.2 In accord with the EUROCONTROL Regulatory and Advisory Framework (ERAF), these RPA specifications are not mandatory. Instead, states will be free to decide to what extent they wish to incorporate them into their own national regulations. As written, the specifications are high-level, generic and standalone, so they can be understood without supporting detail and thereby be more amenable to such incorporation. Where appropriate, they embrace considered wisdom from other work on RPAs.

3.3 Relevant guidance material will be issued with the specifications.

4 Stakeholders Affected

4.1 Stakeholders expected to be affected by the specifications include:

- Civil/Military Aviation Authorities
- Civil/Military ANSPs
- Civil/Military Airspace Users
- RPA operators
- Aviation Industry

5 Regulatory Assessment

5.1 There are no extant pan-European regulations for the operation of military RPAs outside segregated airspace. Moreover, those regulations that exist at national level are not conducive to routine flying activity.

5.2 Widespread adoption and implementation of the EUROCONTROL specifications will facilitate the integration of RPAs with other airspace users and will enhance the ability to operate RPAs across national borders. Moreover, in the light of keen interest shown, and an apparent lack of anything similar elsewhere in the world, countries outside Europe could decide to adopt the specifications. The specifications may also form a basis of future ATM for civil RPAs.

5.3 Notwithstanding, because the specifications relate only to ATM, they are just one part of the bigger jigsaw that must fit together to enable military RPAs to fly routinely outside segregated airspace. Other aspects outwith the remit of EUROCONTROL - such as airworthiness, certification, system security, training and licensing of personnel, etc – will need to be addressed by the appropriate bodies.

6 Economic Assessment

6.1 <u>Technology</u>

6.1.1 Unsurprisingly, the cost of implementation to the stakeholders listed at § 4.1 is difficult to gauge, as much as anything because the specifications demand the use of technology that Industry has yet to develop, and set requirements which are genuinely challenging. Without this new technology, however, RPAs will not be capable of integrating safely with other airspace users.

6.1.2 Although there may be some R&D funding, most development costs will fall on Industry and will therefore be passed on eventually to RPA operators. Sense and avoid is likely to be a major expense.

6.1.3 The developing technology extends to all elements of the UAS, in the air and on the ground. Data-linking and its associated need for spectrum are other considerations that will entail significant cost, albeit it is again not possible to estimate how much.

6.2 <u>Training</u>

6.2.1 Although the pilot-in-command of a RPA flying in non-segregated airspace may not need to be qualified as a crewmember of a manned aircraft, he will require sufficient training to enable him to interact with ATC and with other airspace users. For IFR flight, for example, this will include an instrument rating. The training cost should therefore be less than that required for the pilot of a manned aircraft but more than that required for a basic RPA operator.

6.2.2 Because the specifications require that the air traffic services provided to RPAs should accord with that provided to manned aircraft, only limited additional training for controllers should be necessary, mainly related to emergency procedures that are unique to RPAs. Controllers will also be required to become familiar with RPA performance characteristics insofar as they relate to integration with other traffic under their control. The cost of controller training should therefore be comparatively insignificant.

7 Safety Impact

7.1 The safety assurance process (summarized at Annex E) conducted on the draft RPA specifications confirmed that, by application of the specifications, military RPA operations in non-segregated airspace would be acceptably safe.

8 Efficiency Impact

8.1 The specifications require RPAs to comply with the VFR and IFR as they affect manned aircraft flying OAT. They also stipulate that ATM procedures should mirror those applicable to manned aircraft. In addition, no priority is sought for flight by RPAs. Finally, the very argument for the use of RPAs is predicated in part on the fact that they are more efficient than manned aircraft in a number of roles, benefiting from lower fuel-consumption and their suitability for extended or repetitious tasks. The overall impact on the efficient use of airspace by RPAs flown in accord with these specifications should therefore be positive.

9 Benefits of Implementation

9.1 The benefit of pan-European implementation on these specifications will be to significantly harmonize national ATM regulations for the operation of military RPAs as OAT outside segregated airspace. Notwithstanding the other elements that must fall into place, their implementation will also represent a major step towards the future routine integration of RPAs with other airspace users. Furthermore, as the first of their kind, the specifications could form a template for non-European countries. Finally, the specifications will allow operators to begin to exploit the full potential of military RPAs, and may well pave the way for flight by civil RPAs.

9.2 Conversely, failure to implement the specifications could inhibit the continuing development of military RPAs, with consequent adverse impact upon a number of national and multi-national programmes intended to replace manned combat aircraft with RPAs. This would damage European industry and could risk leaving its armed forces with inferior combat equipment. In addition, individual nations would in all probability develop their own disparate regulations, and the opportunity to achieve early pan-European harmonization would thereby be lost.

Annex I - RPA-OAT EUROCONTROL Specifications

ATM CATEGORIZATION OF RPA OPERATIONS

RPA1. For ATM purposes, where it becomes necessary to categorize RPA operations, this should be done on the basis of flight rules, namely IFR or VFR as applied to OAT.

MODE OF OPERATION

RPA2. For ATM purposes, the primary mode of operation of a RPA should entail oversight by the pilot-in command, who should at all times be able to intervene in the management of the flight. A back-up mode of operation should enable the RPA to revert to autonomous flight in the event of total loss of control data-link between the pilot-in-command and the RPA. This back-up mode of operation should ensure the safety of other airspace users.

FLIGHT RULES

RPA3. RPAs should comply with VFR and IFR as they affect manned aircraft flying OAT. For VFR flight, the RPA pilot-in-command should have the ability to assess in-flight meteorological conditions.

RIGHT-OF-WAY

RPA4 RPAs should comply with the right-of-way rules as they apply to other airspace users.

SEPARATION FROM OTHER AIRSPACE USERS

RPA5. For IFR OAT flight by RPAs in controlled airspace, the primary means of achieving separation from other airspace users should be by compliance with ATC instructions. However, additional provision should be made for collision avoidance against unknown aircraft.

RPA6. For VFR OAT flight by RPAs, the RPA pilot-in command should utilize available surveillance information to assist with traffic avoidance and collision avoidance. In addition, technical assistance should be available to the pilot-in-command to enable him to maintain VMC and to detect and avoid conflicting traffic. An automatic system should provide collision avoidance in the event of failure of traffic avoidance.

SENSE AND AVOID

RPA7. A RPA S&A system should enable a RPA pilot-in-command to perform those traffic avoidance and collision avoidance functions normally undertaken by a pilot in a manned aircraft, and it should perform a collision avoidance function autonomously if traffic avoidance has failed for whatever reason. The S&A system should achieve an equivalent level of safety to a manned aircraft.

RPA8. A RPA S&A system should notify the RPA pilot-in command when another aircraft in flight is projected to pass within a specified minimum distance. Moreover, it should do so in sufficient time for the RPA pilot-in command to manoeuvre the RPA to avoid the conflicting traffic by at least that distance or, exceptionally, for the onboard system to manoeuvre the RPA autonomously to miss the conflicting traffic.

RPA9. Implementation of traffic avoidance and collision avoidance functions in an S&A system should as far as is reasonably practicable be independent of each other. In execution, they should avoid compromising each other.

SEPARATION MINIMA/MISS DISTANCES

RPA10. Within controlled airspace where separation is provided by ATC, the separation minima between RPAs operating IFR and other traffic in receipt of a separation service should be the same as for manned aircraft flying OAT in the same class of airspace.

RPA11. Where a RPA pilot-in-command is responsible for separation, he should, except for aerodrome operations, maintain a minimum distance of 0.5nm horizontally or 500ft vertically between his RPA and other airspace users, regardless of how the conflicting traffic was detected and irrespective of whether or not he was prompted by a S&A system.

RPA12. Where a UAS initiates collision avoidance autonomously, it should achieve miss distances similar to those designed into ACAS. The system should be compatible with ACAS.

AERODROME OPERATIONS

RPA13. RPA operations at aerodromes should interface with the aerodrome control service as near as possible in the same way as manned aircraft.

RPA14. When taxiing, and in the absence of adequate technical assistance, a RPA should be monitored by ground-based observers, who should be in communication with the aerodrome control service and with the RPA pilot-in-command.

RPA15. For take-off and landing and flight in an aerodrome visual circuit, the RPA pilot-in-command should be able to maintain situational awareness to fulfil his responsibility for collision avoidance, and he should comply with aerodrome control service instructions.

RPA16. Where safe integration is impracticable, consideration should be given to excluding other aircraft from the airspace in the immediate vicinity of an aerodrome during the launch and recovery of RPAs.

EMERGENCY PROCEDURES

RPA17. RPA emergency procedures should mirror those for manned aircraft as far as practicable. Where different, they should be designed to ensure the safety of other airspace users and people on the ground, and they should be coordinated with ATC as appropriate.

RPA18. RPAs should be pre-programmed with an appropriate contingency plan in the event that the pilot-in-command is no longer in control of the RPA.

RPA19. A UAS should provide a prompt indication to its pilot-in-command in the event of loss of control data-link.

RPA20. When a RPA is not operating under the control of its pilot-in-command, the latter should inform the relevant ATC authority as soon as possible, including details of the contingency plan which the RPA will be executing. In addition, the UAS should indicate such loss of control to ATC.

AIRSPACE MANAGEMENT

RPA21. Where a UAS cannot meet the technical and/or functional requirements for operation as OAT, that portion of the sortie should be accommodated within temporary reserved airspace to provide segregation from other airspace users.

INTERFACE WITH ATC

RPA22. While in receipt of an air traffic service, the RPA pilot-in command should maintain 2-way communications with ATC, using standard phraseology when communicating via RTF. The word ‘unmanned’ should be included on first contact with an ATC unit.

RPA23. The air traffic service provided to RPAs should accord with that provided to manned aircraft.

RPA24. Where flight by manned aircraft requires the submission of a flight plan to ATC, the same should apply to flight by RPAs. The RPA flight plan should indicate that it relates to an unmanned aircraft, and should include details of any requirement for en-route holding.

RPA25. While in receipt of air traffic service, RPAs should be monitored continuously by the RPA pilot-in command for adherence to the approved flight plan.

RPA26. Pilots-in-command should have detailed knowledge of the performance characteristics of their particular vehicle. ATC controllers should be familiar with RPA performance characteristics insofar as they relate to integration with other traffic under their control.

METEOROLOGY

RPA27. The weather minima for RPA flight should be determined by the equipment and capabilities of each UAS, the qualifications of the RPA pilot-in command, the flight rules being flown and the class of airspace in which the flight is conducted.

FLIGHT ACROSS INTERNATIONAL BORDERS AND ACROSS FLIGHT AND UPPER INFORMATION REGION (FIR/UIR) BOUNDARIES

RPA28. With regard to cross-border operations, state RPAs should be bound by the same international conventions as manned state aircraft. In addition, flights by state RPAs into other FIR/UIRs or into the sovereign airspace of other states should be pre-notified to the relevant airspace authorities, normally by submission of a flight plan. ATC transfers between adjacent states should accord with those for manned aircraft.

OAT CNS FUNCTIONALITY REQUIREMENTS

RPA29. RPAs should carry similar functionality for flight, navigation and communication to that required for manned aircraft. The exemption policy for manned state aircraft with regard to specific equipage requirements should also apply to state RPAs.

RPA30. The RPA pilot-in-command should be provided with an independent means of communication with ATC in case of loss of normal communications linkage, for example via telephone.

RPA31. A pilot-in-command should be able to provide a prompt response to traffic avoidance instructions similar to that by a pilot of a manned aircraft.