Guidelines

ACCOMMODATION OF MILITARY IFR MALE TYPE RPAS UNDER GAT AIRSPACE CLASSES A-C

CONTENTS

1. Executive summary

The use of unmanned aircraft systems (UAS) of different types and performance by the military is not new. Several armed forces from different Member States such as France, Italy and the UK have been operating MALE RPAS within their national airspace since several years.

These RPAS have been initially operated over areas of operations or in segregated or reserved airspace and, while the core mission of military RPAS is still conducted in segregated or reserved airspace, there is an increased need to have access to non-segregated airspace particularly to transit from home base to the mission area. In addition, the use of RPAS by the military is increasing and several Member States have planned to either acquire this capability or to expand their fleets to new RPAS types.

To support European Member States with the military RPAS transit flight as GAT, EASA Executive Director and EDA Chief Executive agreed to cooperate and to develop jointly these guidelines for the operation of military RPAS in non-segregated airspace. These guidelines propose a basis for the Member States and their civil ANSPs[1] to conduct their own safety assessment and to develop their operational procedures and processes in compliance with European ATM/ANS Regulation[2], allowing these operations in a more regular basis.

The expected potential benefits of these guidelines are to:

- Further foster mutual civil and military knowledge on this topic;
- Enhance civil – military coordination with standard procedures thus reducing the time required to plan MALE RPAS flights;
- Increase the harmonisation of procedures in case of cross border operations;
- Reduce the segregated airspace volume to the minimum by enabling en-route flight in non-segregated airspace thus minimizing the impact on the ATM system;
- Maintain overall safety and ATM performance while gradually increasing the number of RPAS operations;
- Share Military expertise and best practices with EASA in view of the development of the upcoming EASA regulation as regards certified operations.

The main purpose of these guidelines is to describe the best practises currently existing allowing RPAS flights in non-segregated Airspace over Europe as well as the outcomes of EDA's accommodation study[3] **; on this basis, this document proposes high level guidance for the accommodation of military IFR RPAS under GAT – Airspace classes A-C – outside segregated airspace aiming at facilitating such RPAS transit flights in a short-term.** To this end, the document contains descriptions of existing operations, practises and give performance of some existing platform currently used by the military operators of those EU Member States. It includes a description of existing operation and the existing operational environment and its potential evolution in the near future.

[1] Military ANSPs could also use it.
[2] https://www.easa.europa.eu/regulations#regulations-atmans----air-traffic-management air-navigation-services
[3] 17.CPS.OP.017 Safety case study — accommodation of MALE-type RPAS

Then, based on these descriptions, potential use cases and operational scenarios are detailed for which an analysis on the potential impacts on safety is made.

It is worth to recall that RPAS accommodation is defined by ICAO as "the condition when an RPAS can operate along with some level of adaptation or support that compensates for its inability to comply within existing operational constructs". The "existing operational constructs" are not adapted to RPAS operation and until new operational constructs are in place (regulatory framework and required technology) all RPAS operations in European airspace will have a certain degree of segregation (through dedicated airspace, route, flight level, timeslot…). **Given that the accommodation phase will concern <u>a very limited number of MALE RPAS flights</u>,** RPAS operations involving civil air traffic control could however be enabled following a safety assessment that identify the operational limitations or specific arrangements to be implemented in order to compensate the ground risks and air risks linked to non-compliance with operational requirements that exist for manned aircraft. This is the objective of this document.

Moreover, the accommodation phase in envisaged within 2020-2025 timeframe or until new operational constructs are in place, including a civil harmonised certification of the UAS, a civil harmonise RPL, a civil harmonised operator certification or civil harmonised maintenance requirements. This document applies to the accommodation phase.

This document is not a regulation and is not binding. It should be seen as supporting information and intends to provide guidance on a possible approach to military RPAS accommodation in European airspace. **<u>However, it needs to be recognised that it is ultimately the responsibility of the Member States to ensure safe operations in their airspace under their sovereignty through a close coordination with all actors involved, including the ATCOs concerned by such flights</u>**.

Finally, this document is in line with the regulation applicable to State aircraft, manned and unmanned:

- The Military RPAS is certified by a national Military Aviation Authority in terms of airworthiness against national and/or international military certification specifications, supported when deemed relevant by civil certification specifications and standards;
- The Remote Pilot in Command is licensed by a national Military Aviation Authority.
- The military operators are certified by a national Military Aviation Authority according to criteria/requirements set to be comparable to those applied for a military operator operating manned aircraft in the same class of airspace.

From the information provided in these guidelines the following conclusions can be made:

- Today there are operations of military MALE RPAS in some European Member States but operations are limited and cross border operations are done on a case by case basis through bilateral agreements.
- The existing military MALE RPAS have been certified by the national military authorities following military certification standards.

- To accommodate these new airspace users on a regular basis, the military operators of the military RPAS Male type will need to describe the operational concept in the accommodation phase and carry out a safety assessment of these operations to be approved by the military competent authorities.
- In addition, the European civil ANSPs, will be required to develop a safety assessment of the new or amended procedures and/or technical systems within their functional system. The national supervisory authorities or competent authorities will need to approve the relevant safety assessment prior to implementation.
- Due to the lack of harmonised civil certification standards regarding MALE-type RPAS operations in non-segregated airspace, EASA considers, in the framework of this document, that it is more appropriate to integrate them in the airspace following the specific operational risk assessment method as per the 'specific category' of EASA concept of operations for UAS. However, since this document is not a regulation and is not binding, it does not force any party to use SORA as the methodology for operational risk assessment.
- It is ultimately the responsibility of the Member States to ensure safe operations in their airspace under their sovereignty. Military RPAS operators and the competent authorities can agree at national level to deviate from the abovementioned process or to assess the safety of these operations on the basis of other national or international standards and regulations.
- Provided that the military MALE RPAS operator mitigates all the identified operational risks, they are approved by the military competent authorities and the civil ANSPs has put in place the approved operational procedures defined in the safety cases, this document describes a two-step approach for accommodation of military RPAS in airspace classes A-C:
  - First phase (Use Case 1) in which strategic mitigation measures used are more conservative than Use Case 2 but still using dynamic corridors, greater separation minima, more conservative time-based separation and other ATC procedures to ensure safety is maintained and to allow ATCOs to gain confidence with the performance of these platforms;
  - Second phase (Use Case 2) in which, building upon the previous experience and provided that all the risks are properly mitigated, the strategic mitigation measures can be reduced gradually without introducing new tactical mitigations.
- Considering the above, the following recommendations can be made:
  - It is recommended that military MALE RPAS operators, civil ANSPs and relevant competent authorities may consider the information provided in these guidelines when performing their respective safety assessments and approving them prior to start operations.
  - In terms of tactical mitigation procedures and due to the lack of DAA standards validated in the European ATM Network and recognised by civil and military authorities, it is recommended that at least the RPA is equipped with required CNS equipment by the European interoperability regulations or by the European airspace users requirements or with CNS which have equivalent performance to those required today by the EU regulations:
    - For Communications: radio communication or datalink (if flying above FL285) with similar reliability;
    - For Surveillance: mode S transponder. Otherwise at least Mode C transponder. Mode A is considered not suitable for TCAS detection;
    - For Navigation: RNP/RNAV based on ground or GNSS aids or inertial which demonstrate to maintain the necessary navigation performance;

- If claimed that they are equipped with TCAS II 7.1 version, it shall be demonstrated that the RPA is able to have the necessary performance to comply with RA indicated. If used on TA mode only, which is a degraded mode, this shall be used only as a temporary measure and should not be the final solution. Other DAA claims should to be demonstrated to the competent authority for the performance[4].
- For the C2 link, performance need to be demonstrated suitable for the operations being performed in the European airspace. If the RPAS would not comply with ICAO communication loss procedures in case of Lost C2 Link, the operator shall define in coordination with the competent authority a suitable contingency procedure.
- The different contingency procedures shall be compliant as much as possible with those included in the ICAO SARPs.
- The different contingency procedures, if different from previous points, shall demonstrate that their effect is minimised, and they don't affect safety and efficiency of European ATM system.
- EASA recommends its involvement in future RPAS projects as essential step to ensure the safety objectives of the EASA Basic Regulation are achieved.

[4] It is important to note that any DAA capabilities supporting RPAS operations in non-segregated airspace would need to be developed and validated in the relevant European Airspace and be endorsed by EASA for the entire European airspace. The validation exercise can be done under R&D programme such as SESAR Joint Undertaking research programmes or the EDA RPAS Air Traffic Integration R&D activities.

2. Introduction and scope

2.1 Background information and purpose

The use of unmanned aircraft systems (UAS) of different types and performance by the military is not new. Several armed forces of different Member States such as France, Italy and the UK are also operating MALE RPAS within their national airspace since years (e.g. Reaper in France and Italy or SkyGuardian in UK). These RPAS are used for different mission such as intelligence, surveillance, target acquisition, and reconnaissance (ISTAR and have been initially operated over areas of operations or in segregated or reserved airspace.

The use of RPAS by the military is increasing and several Member States have planned to either acquire this capability or to expand their fleets to new RPAS types and, while the core mission of military RPAS is still conducted in segregated or reserved airspace, there is an increased need to have access to non-segregated airspace notably to transit from home base to the mission area.

The main purpose of these guidelines is to describe the best practises currently existing allowing RPAS flights in non-segregated Airspace over Europe and, on this basis, to propose a guidance for the accommodation of military IFR RPAS under GAT – Airspace classes A-C – outside segregated area. This aims at facilitating such RPAS transit flights in a short-term. Military operators indeed underlined the need to have more flexibility and efficiency by enabling the en-route /transit part of the flight outside segregated area.

Over the past three years, a substantial effort has been made to develop a framework allowing UAS operations in the 'open' and 'specific' categories. This work was initiated at JARUS and has led EASA to the publication of the Agency Opinion 01/2018 for these types of operations. There are also many on-going initiatives aiming at developing the Unmanned Traffic Management (UTM or U-space for the European version).

Regarding larger RPAS operations that would normally fall into the certified operations category, various initiatives are in progress. ICAO RPAS Panel is working on developing the related SARPs. JARUS is also working on the certification requirements. The cooperation between the European Commission (EC), the European Aviation Safety Agency (EASA), the European Defence Agency (EDA) and the SESAR Joint Undertaking (SJU) has led SJU to elaborate an ambitious roadmap for drones (Roadmap for the safe integration of drones into all classes of airspace). Considering national defence and security objectives and plans, military requirements have been integrated in this roadmap which is underlining 2030 as the targeted date for the full integration of military Medium-Altitude Long-Endurance (MALE) drones in non-segregated airspace in IFR and VFR in classes A-G. Moreover, there have been R&D and demonstration activities, some of them currently on going, in the RPAS Air Traffic Integration domain at EDA and SESAR Joint Undertaking.

However, for the time being, there is not a harmonised set of rules and procedures to operate these RPAS integrated with other airspace users. Unless it is demonstrated that there are no safety risks, the current approach for such medium altitude UAS operations is to comply as much as possible to the existing regulation for manned aviation.

To support European Member States with the military RPAS transit flight as GAT, EASA Executive Director and EDA Chief Executive agreed to cooperate and develop jointly these guidelines for the operation of military RPAS in non-segregated airspace. These guidelines propose a basis for the Member States and their civil ANSPs[5], to conduct their own safety assessment, develop their operational procedures and process allowing these operations in a more regular basis. Nevertheless the ANSPS shall comply with European ATM/ANS Regulation[6]. In addition, **it is ultimately the responsibility of the Member States to ensure safe operations in their airspace under their sovereignty**.

For the next 5-10 years, the number of such flights simultaneously in the same airspace with manned aviation will be limited. This will allow the operations of such flights according to the existing regulation with appropriate mitigation measures. In the meantime, it is expected that a related civil set of rules and procedures will be developed for civil UAS and their integration into the EATM Network[7] at the European and worldwide level, possibly based on military experience.

2.2 Objective

So far, there are Concept of Operations that are being development or have already been developed by different entities e.g. EUROCONTROL, SJU, EASA, ICAO, JARUS. However, up to now, none of them aims to accommodate the operation of existing military RPAS as IFR/GAT in the European airspace for transit flights. Nevertheless, these initiatives as well as the ones by national civil ANSPs and authorities and military operators highly contributed to provide different tools and elements taken into account in the framework of this guidelines. Therefore, **these guidelines should not be considered as a revolutionary concept allowing the full RPAS integration in the EUATM but the ambition is to provide transitional procedures allowing a moderate number of military RPAS flights when flying as GAT using several tools and procedures based on best practices already in force.**

While the initial ambition of EASA and EDA was to develop a guidelines covering all phases of flights (taxiing, take-off, en-route, terminal, approach and landing), during the working sessions the scope was limited to the transit of the flights between the reserved/segregated airspaces where the core military missions are taking place**.** It is expected that during the period covered by these guidelines (i.e the following 5-10 years), the military RPAS will take off from military airfields and aerodromes and will normally be controlled during these phases by military ATS units. In the meantime, the European regulation will be developed, and the information contained in this document may no longer be valid after few years.

Finally, it is expected that the experiences gained through the implementation of these guidelines will serve as basis for the further development of the European regulatory framework for the safe integration of civil RPAS in

[5] Military ANSPs could also use it.
[6] https://www.easa.europa.eu/regulations#regulations-atmans----air-traffic-management air-navigation-services
[7] This includes but it is not limited to the harmonisation of the ANSP's integration safety assessment methods.

the European ATM system in accordance with the roadmap for safe integration of drones into all classes of airspace developed by SJU[8].

This document is not a regulation and is not binding. It has been produced as reference information and intends to provide possible guidance to develop a concept of operation and safety assessment. Other approaches to MALE-type RPAS operations during the accommodation phase can be proposed and agreed between the relevant stakeholders and competent authorities at national level.

2.3 Intended audience

The document is intended to facilitate the harmonisation of the operational concept and specific procedures for military MALE-type RPAS operations in the accommodation phase, and the civil-military coordination activities envisaged to enable these operations. It also intends to support military and civil stakeholder and authorities in the development, evaluation and approval of the safety assessments considered necessary to conduct these operations.

The main stakeholders in these processes are military operators, Military Aviation Authorities, military and civil ATCOs, and other competent authorities at national level involved in the definition and approval of operations of military RPAS in non-segregated airspace under their sovereignty.

2.4 Brief description of the Document

The document is divided in seven chapters. The first two chapters are the executive summary and the necessary introduction which is defining the scope, the objectives and what this document aims to achieve. The chapters 3 and 4 contain descriptions of existing operations, practices and a description of several platform currently used by the military operators. Chapter 3 describes in a generic manner the existing operations, while chapter 4 contains a description of the existing operational environment and its potential evolution in the near future.

Then, on the basis of the material provided in chapter 3 and 4, and given the scope defined in chapter 2, chapter 5 is detailing potential use cases and operational scenarios for which an analysis on the potential impacts on safety is made in chapter 6. Finally, chapter 7 is providing the final conclusions and some recommendations.

The information provided in chapter 3 and 4 have been provided by the military operators and industry while the description of the uses cases in chapter 5, the analysis in chapter 6 and the final conclusions and recommendations in chapter 7 have been developed by EASA with the inputs provided by the civil stakeholders, notably ANSPs.

[8] https://www.sesarju.eu/sites/default/files/documents/reports/European%20ATM%20Master%20Plan%20Drone%20roadmap.pdf

In addition, the document contains 3 Annexes with the list of acronyms, reference documents and detailed information about one the safety assessment approach proposed herein.

2.5 Acknowledgement of contributors

The document has been developed thanks to the valuable and extensive contribution of the French Air Force, the French civil ANSP, French, Italian and German Military Aviation Authority, ASD and industry partners, SJU and EUROCONTROL.

Together with those inputs and the reviews made by the rest of the Task Force Members, the document has matured to its present form.

EASA and EDA has been the co-penholders of the document on the basis of the contributions and comments received and the reviews made.

3. Existing systems and operations

3.1 Introduction

Military manned and unmanned aircraft are out of the scope of the regulation 2018/1139 (new EASA basic regulation) however, Member States shall ensure that activities and services performed by these aircraft are carried out with due regard to the safety objectives of this Regulation. Member States shall also ensure that, where appropriate, those aircraft are safely separated from other aircraft. Whereas the military have been operating large tactical and MALE type RPAS such as HERON 1 or REAPER for several decades outside Europe, there is a need to allow for a wider use of these platforms for training and transit purposes in Europe. Currently, military RPAS operations in peace time in European airspace are performed based on a case by case assessment and authorization at national level, with a different degree of segregation and different procedures for civil-military coordination.

3.2 Existing systems overview

The operations described in this section have been carried out with the General Atomics' MQ-9 (also named Reaper or Predator B) in France and Italy and the IAI/Airbus Harfang in France.
The main characteristics of the MQ-9 Reaper and the Harfang are depicted in the table below:

	MQ-9	**Harfang**
Max Weight (T)	4,76	1.2
Engine / Fuel	Turboprop. / 900 cv / F34	Rotax 914, 115 hp turbocharged
Max / Cruise Speed (kt)	249 / 180	110
Operating Speed (kt)	120 to 150	65 to 85
Cruise Level (FL)	250 to 400	FL120
Operating Level (FL)	200 to 250	6 000 ft to FL150
Rate of climb		250 ft/m up to FL140 then 200 ft/m above
Max endurance (h)	+ 20	24 h
C2 Link	RLOS and BRLOS (SATCOM)	RLOS and BRLOS (SATCOM)
CNS Equipment	1 airborne VHF, 1 Transponder A/C, 3 EGIs (Embedded GPS/INS navigation sensors)	1 Radio (VHF + UHF), Transponder A/C, GNSS and INS
ACAS	None	none

Military RPAS are certified by the national Military Aviation Authority in terms of airworthiness against national military certification specifications. Remote pilots 'airmanship is ensured since they are military, instrument rated on manned aircraft, often former fighter pilots.

3.3 Existing Operations Overview

The existing operations, as well as the operational scenarios in which some demonstrations have been performed, are described in this section. First this chapter introduces some information about these operations in Italy and France which have been the main contributors to this section. Then the nominal operations of the MALE RPAS are detailed. Finally, contingency procedures, as currently developed nationally, are presented. Those procedures (normal and contingency) are mentioned for information only.

3.3.1 *Military RPAS operations in Italian airspace*

The Italian Airforce has gained a consistent level of experience employing 2 types of MALE RPAS: Predator A since 2004 and Predator B since 2008 and participating to various real operations abroad like:

- OPERATION UNIFIED PROTECTOR (2011)
- JOINT ENTERPRISE (KFOR) (2012-ongoing)
- MARE NOSTRUM (2013- 2014)
- ISAF (2014)
- OPERATION INHERENT RESOLVE (2015 – on going)

Some of them are still ongoing and contribute to further development and improvement of the Italian RPAS procedures.

Moreover, Italy is the host nation for US RPAS systems like Predator A and B and Global Hawk stationed in Sigonella air base, Sicily. Finally, Italy is going to be the host nation of the NATO AGS based on the Global Hawk platform that will be positioned in Sigonella air base in 2019. In particular, the Italian Technical Airworthiness Authority is responsible for the NATO AGS certification. Sigonella air base is providing a great experience in managing RPAS operations since it is a Military CTR that controls a civilian airport (Catania Fontanarossa, very busy especially in summer period) and a Military airport (Sigonella, very busy especially in crisis conditions). Currently Italy is developing a MALE type RPAS called P1HH/P2HH Hammerhead that is undergoing flight testing campaign. Italian MoD in cooperation with the civilian authority and the industry is developing testing areas in the surrounding sea areas to perform RPAS experimentations.

Italian Military RPAS are certified according to military certification regulation and NATO STANAGS and are operated in coordination between civil and military ATM systems.

The Italian RPAS concept of operations involves segregated corridors and Temporary Segregated Airspace and uses the Smart Segregation concept. Smart Segregation refers to corridors' segments of Temporary Segregated Airspace dynamically open and closed according to the RPAS flight.

This Smart Segregation concept is used to ensure segregation of the military RPAS from the civilian air traffic while limiting the segregated airspace volume and timespan in line with the Flexible Use of Airspace concept. No specific procedure is needed for the separation of military RPAS from military/state air traffic.

Segregated airspaces and corridors are mainly established over the sea and published either in the Italian AIP (when permanent) or activated with a NOTAM (when Temporary). When they are established over the Italian continental territory, the operation will require the assessment of the local population density on the ground.

These population density figures and the reliability of the platform are used to guarantee that catastrophic failures[9] are effectively mitigated.

Current limitations are due to:

- Current legacy military RPAS not meeting in full the STANAG 4671 requirements (LMTC);
- Current STANAG 4671 not mature enough to consider all RPAS specificities (many MCRI);
- Operational concept and operational safety assessment approach not matured, validated and harmonized.

In fact, once the RPAS is military certified against a certification baseline that considers all aspects and specificities of RPAS and operational concept and operational safety assessments are matured , nominal transit in controlled airspace is considered feasible under civilian ATM control without major concerns while only the RPAS specificities in abnormal or emergency situations might lead to increased civ-mil coordination and specific handover procedures.

3.3.2 *Military RPAS operations in French airspace*

During the last few years the French Air Force (Armée de l'Air Française) has gained experience in MALE RPAS operations in French airspace where control of the airspace is coordinated between military and civil authorities (DSNA). Initially these operations involved the HARFANG (based on the IAI's HERON) and the Reaper from Cognac Air Force Base to different training areas and operational sites in segregated airspace.

In addition, since 2017 the French Air Force has carried out several experimental flights, in non-segregated airspace under GAT IFR controlled by civil ATS unit (Bordeaux ATC) to operational test areas over the Atlantic Ocean and in the south west of France. These round flights have been done from Cognac AFB and through Bordeaux airspace managed and controlled by civil ATCOs. These operations have been done in the framework of a three phased national strategy aiming to enable the operation of MALE RPAS in the French airspace and cross border operations in a stepwise approach as described below:

Phase 1: Several flights were conducted under the SESAR 2020 programme in January 2017, which included the development of a Concept of Operations for the HARFANG accommodation. The HARFANG followed a pre-planned flight path complying with navigation performances of 1NM lateral and 200ft altitude precision on a circular route departing from Cognac through Bordeaux approaches. Three flights were conducted under GAT IFR rules: the first with no chase aircraft; the second and third flights using cooperative air traffic to simulate IFR/VFR crossing and these flights were simulated by DSNA.

Phase 2 involved operational flights of the HARFANG under DSNA (French civil ANSP) control for the transit/en-route phases and representative military operations conducted in segregated airspace. The flight plan departed from Cognac to Bordeaux then to Toulouse and Carcassonne (where a simulated final approach has been conducted) before returning to Cognac through Bordeaux. A 'lost link' exercise was also performed when operating within Carcassonne Terminal manoeuvring area (TMA). This specific phase included many exercises notably an extensive set of emergency procedure tests. Due to the flight altitude, the en-route civil control centre was not part of the experimentation.

[9] PCUMCAT (Cumulative Probability of Catastrophic Failure) figures are used for this purpose

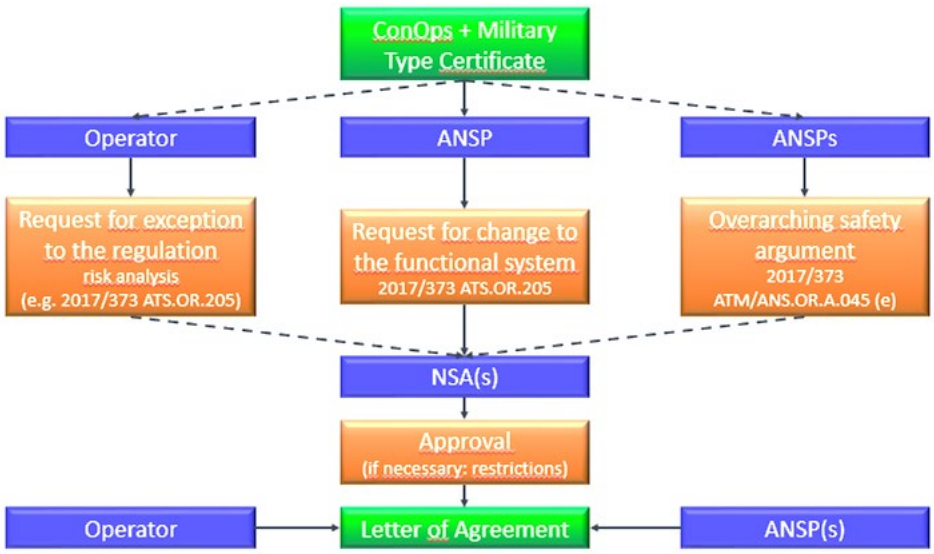
The phase 3 executed in summer 2018 aimed to enhance the coordination activities with DSNA for flights above FL190/FL200 and included some short flights in and around Cognac. The flight tests performed also involved some longer flights incorporating both operational and training flights with the Reaper under civil Air Traffic Controllers in French airspace.

3.3.3 *Military RPAS operations in Germany*

In line with the gathered experience of military HALE RPAS operations in German airspace, the relevant German stakeholders shaped a process, compliant with existing regulations, applicable for military RPAS, to operate within the national airspace structure.

The preliminary safety considerations in the European MALE RPAS for example were recently conducted with reference to this process.

With regard to the evolving specific regulations and key technologies for certified RPAS, as well as in cases where identifiable additional needs may become evident that are not already covered, additional aspects to this established and national consolidated process might need to be considered in future.



Process for the air traffic integration/accommodation of military certified MALE/HALE RPAS (certified category of operation)

<u>Explanation:</u>

The ground risk is covered by the certificate of airworthiness which besides the guidelines is the prerequisite to start the processes.

Exceptions to the regulation are dealt with as for any other aircraft. This is the responsibility of the operator.

The air risk is covered through the application of the respective methodology compliant to EU Reg 2017/373. It is assessed whether the introduction of RPAS into the functional system is compliant with the safety objectives connected to the envisaged operations. Non-acceptable risks have to be further analysed and/or mitigated until the respective safety objectives are met. This is the responsibility of the authority which is responsible for the safety of the respective volume of airspace

The establishment of an overarching safety argument may be necessary if more than one ANSP is involved (e.g. for cross border operations).

If the analysis is deemed sufficient by the respective NSA(s) an approval may be issued which may include the necessary mitigation measures in the form of restrictions.

Based on that approval the operator and the ANSP(s) establish a document including all details of the envisaged operations (e.g. procedures).

3.4 Common characteristics and best practices

This section collects the common characteristics and best practices from the Italian and French operations with military MALE-type RPAS in European airspace. First, it identifies the minimum capabilities to carry out the operations described in the previous sections and provides some insight of the current approach for civil-military coordination, including the flight planning activities. It also describes the abnormal and emergency situations and contingency procedures currently identified.

3.4.1 *Minimum RPAS capabilities*

This section lists the common RPAS capabilities related to Air Traffic Integration required for today's operation in European airspace:

- 2-way communication (VHF radio) between the Remote Pilot and the civil and military ATCO involved in the operation.
- A direct connection between the Remote Pilot and the civil and military ATCO involved in the operation. This direct connection shall be tested before each operation.
- Capability to implement all vertical and lateral instructions of ATC by the RPAS as in today's manned aviation [10].
- Navigation precision of +/- 1 NM and altitude precision of +/-200ft. With such navigation precision the standard separation minima of 5 nm and 1000ft could be kept during the operation
- Transponder mode A/C. to:
    - Make the RPA a cooperative aircraft
    - To trigger RA manoeuvres for TCAS-equipped aircraft. The RPA itself, is not equipped with TCAS, and is not executing TCAS RA manoeuvres.
- Predictable behaviour in case of degraded mode (see contingency procedures below extracted from the French Guidelines). The Civil military coordination is detailed in a national CONOPS agreed by the DSAE (Military Aviation Authority) and the DSNA (ANSP) under the control of DGAC (Direction Génerale d'Aviation Civile – National Civil aviation authority and in line with the national regulation.

[10] The RP shall inform the ATC unit concerned if unable, at any time, to comply with a specified rate of climb or descent. In such cases, the controller shall apply an alternative method to achieve an appropriate separation minimum between aircraft, without delay (ICAO 4444)

3.4.2 *Civil-Military coordination*

Current civil-military coordination for military RPAS operations focuses on the hand-over from military to civil ATCO, flight planning preparation and flight plan, transitions between OAT and GAT rules and, when needed, detailed briefings to civil stakeholders about the RPAS operations, performances and contingency procedures.
Most military RPAS operations today use segregated and reserved airspaces. The Terminal operations are performed under OAT rules within an airspace segregated from civil traffic, under military ATC control, and following RPAS specific procedures due to the specific RPAS performances. Military ATC also ensures the RPAS separation from other military air traffic during this phase.

Once the RPA reaches the cruising level in airspace class A - C[11], the mission can continue under IFR-OAT rules and segregated from the civilian traffic (e.g. in full segregation or with the use of transit corridors under smart segregation procedures). The operation in the mission/training area is carried out in a reserved airspace activated for that purpose.

Alternatively, as previously describe for the French exercises, once the RPA reaches the cruising level the mission can continue under civil control as IFR-GAT in non-segregated airspace. This approach involves different OAT and GAT phases, which currently needs as many Flight Plans as OAT and GAT segments/phases. This entails an additional burden to the civil-military coordination necessary for the management of the flight notably the related activation/deactivation in due time of the different Flight Plans during the flight. In addition, all civilian ATCOs involved in the operation must be informed through briefing notes about the operation. Finally, a controller involved in the preparation of those notes is systematically present in the control centre to assist the operational ATCOs and potentially to answer to their questions.

3.4.3 *Contingency procedures*

The current experience from military RPAS operations in segregated and non-segregated airspace shows that in normal situations there is a very limited impact regarding the ATCO workload. Abnormal and emergency situations might lead to important disruption in the ATM system if not properly coordinated in advance. The contingency procedures relating to these situations should be carefully coordinated amongst all organisation involved in the RPAS flight.

This section provides the current contingency procedures identified in today's military MALE-type RPAS operations according to the national Concept of Operations developed for the operations described in the previous sections:

3.4.3.1 Lost C2 Link

There are three Lost C2 Link procedures currently used in the framework of current operations. In all cases, once the Lost C2 Link is detected by the Remote Pilot in command, s/he will contact ATC. A direct telephone connection ensures a communication means between ATC and Remote Pilot in case of Lost C2 Link situations:

- Return to base: This procedure implies an automatic return to base following the same flight route backwards, after a predefined time (1 minute). This predefined time is used to try to recover the C2 link once the Lost C2 Link has been detected by the Remote Pilot.

[11] In some countries (e.g. France) class D airspace is very close to class C since radio contact is compulsory and information traffic is provided. Specifically in this case, Class D might be included.

- Continue then return to base: This procedure implies continuing the cleared flight plan before automatically activating the return to base procedure. A specific delay can also be introduced in the turning point.
- Continue then return to base (second option): This option is built on the previous one and has been the procedure used during the latest operations:
  - The link loss is detected by the remote pilot
  - The link loss status exceeds the established timeframe (1 min) to regain control of the aircraft,
  - The transponder, squawks the emergency code 7600 (loss of communication)[12].
  - The RPA continues the cleared flight plan until a point previously agreed/authorised by ATC
  - Holding for 20 minutes to allow ATC coordination
  - Direct route to home.

3.4.3.2 Radio/communication failure

As in the previous situation, a direct telephone connection ensures a communication means between ATC and remote pilot in case of radio failure. In this case, the mission is aborted, and the aircraft is steered towards a segregated area, following the instructions received by ATC via telephone. Depending on the location and time of the failure, the mission could be extended after consultation between military supervisors and control centres. In this case, phone connection is used as alternative means of communication between the remote pilot and ATC.

3.4.3.3 RPAS GNSS failure

In case of RPAS GPS signal loss, the RPAS will modify its navigation reference system from initial hybrid GPS-INS to INS only. Navigation based on radar vectors/headings by ATC will still be possible.

3.4.3.4 Transponder failure

Upon receiving alert of a transponder failure, the mission is aborted and a return to segregated airspace is performed according to a pre-planned route before transferring control to military ATC.

3.5 Justification for change

The current way of operating large Military RPAS impacts negatively the other Airspace Users but also the Military airspace user themselves:

- For the other airspace users: capacity is reduced due to the RPAS operations. Indeed, due the current need of segregated airspace (corridors, areas…), the civil air traffic must operate in a reduced airspace, causing delays, rerouting, level capping….
- For the military: arrangements to operate are based, depending each national approach, on a case by case basis, not harmonised in Europe. Civil-military coordination needs to be improved to enable routinely RPA flights controlled by civil ATC.

[12] 7600 is the code currently used in France. A specific transporter code (e.g. 7400) for C2 link loss is under discussion at ICAO.

To gain efficiency, for both themselves and the other Airspace Users, Military would need to:

1) Reducing the time required to plan these operations: reduce the prior-notice time and have flight plans adapted to RPAS operations (length of the mission, mission area definition, “CIA” aspects, remote pilot data in case of emergency…)
2) Enhancing civil – military coordination with standard procedures (in pre-flight phase and during the flight) to avoid the case-by-case authorization by the Authorities and handling of potential abnormal/emergency situations by ATC
3) Reducing the segregated airspace volume and related timeslot to the minimum needed, allowing gradually more operations in non-segregated airspace (e.g. terminal operations still considered segregated at the beginning of the Accommodation phase until more R&D results are available)
4) Increasing the harmonisation of rules and regulation for cross border operations (operations carried out today according national regulation).
5) Maintaining overall safety and ATM performance while increasing RPAS operations. An operational safety assessment approach will be needed before RPA flights on daily basis.

This ambitious goal cannot be met with the current way of handling RPAS operations, especially considering the growing number of MALE-type RPAS expected to be operated in the coming years. The first step to enable accommodation operations routinely is reaching a wider European approach particularly for legacy Military RPAS operations, addressing the five abovementioned points and encompassing:

- A description of envisaged common nominal/contingency procedures and near-term available technology.
- A harmonised, European wide operational safety assessment methodology to ensure the safety level of accommodation operations.

4. RPAS accommodation operational environment

4.1 Assumptions

The following assumptions have been made in the framework of this document:

ASSUMPTION 01

The Military RPAS is certified by a national Military Aviation Authority[13] in terms of airworthiness against national and/or international military certification specifications, supported when deemed relevant by civil certification specifications and standards, according to the following:

- With no persons on board the aircraft, the airworthiness objective is primarily targeted at the protection of people and property on the ground. A Military RPAS must not increase the risk to people or property on the ground compared with manned aircraft of equivalent category.

- Airworthiness standards should be set to be no less demanding than those currently applied to comparable military manned aircraft nor should they penalise RPAS by requiring compliance with higher standards.

- The protection of other airspace users is dependent on ATC/ATM separation provision/procedures commensurate to the airspace class and airspace usage requirements. These aspects are considered outside of airworthiness. However, there will be an operational safety assessment carried out by the competent authority -the Military Aviation Authority by default- to verify that the equipment and procedures designed to meet such requirements, together with the unmanned aircraft's performance, are satisfactory.

ASSUMPTION 02

The Remote Pilot in Command is licensed by a national Military Aviation Authority.

ASSUMPTION 03

The military operators are certified by a national military authority according to criteria/requirements set to be comparable to those applied for a military operator operating manned aircraft in the same class of airspace.

This near-term operational overview focuses mainly on flights in civil controlled non-segregated airspace in Europe where only cooperative traffic is allowed (airspace classes A to C). The impact of flying non-segregated outside Europe is not considered in this document

ASSUMPTION 04

The near-term operational overview focuses on flights in civil controlled non-segregated airspace in Europe where only cooperative traffic is allowed.

[13] Military certification is managed by national authority by default. Alternatively, one of novelties introduced by EASA's new Basic Regulation is the possibility for member States to decide to apply the Basic Regulation to aircraft performing State activities. For more information: https://www.easa.europa.eu/faq/70137.

In the European airspace, the near-term operational overview perimeter is the non-segregated operation in airspace classes A, B and C under nominal conditions.

ASSUMPTION 05

Under nominal conditions the RPAS will only fly in non-segregated in airspace classes A, B and C.

No availability date is known for an off-the-shelf certifiable Airborne Collision Avoidance System (ACAS) suitable to the operation of Medium Altitude Long Endurance (MALE) RPAS in European airspace.
The mitigation measures to reduce the risk of collision with cooperative and non-cooperative air traffic will be resulting from the safety assessment approved by the competent national authorities. Procedures and/or safety features could be used to mitigate the risk during this phase.

ASSUMPTION 06

The mitigation measures to reduce the risk of collision in the near-term operations will be addressed through procedures and safety features based only on technology currently available.

Only military aerodromes are considered as departure or destination aerodromes. Based upon national agreements between authorities managing traffic and authorities managing aerodromes, civil aerodromes may be used as emergency aerodromes.
Due to lack of international regulations and applicable standards considering the definition of a mission usage of the airspaces, the RPAS is under military responsibility when not transiting en-route through airspace classes A-C.

ASSUMPTION 07

The RPA in nominal conditions will only take-off and land from/on military aerodrome. Approach and departure procedures will be carried out under Military Air Traffic Control.

ASSUMPTION 08

A mission/training/operational area is a reserved airspace under military control.

4.2 MALE RPAS overview

This section describes the performances and equipment of a representative MALE-type RPAS in the accommodation timeframe, relevant for the air traffic integration capability as per the purpose of this document.

A MALE-type RPAS consists of a remotely piloted aircraft (RPA), remote pilot station (RPS) and command and control (C2) link.

4.2.1 *Remotely Piloted Aircraft (RPA)*

The following table depicts the target platform's characteristics compliant with the operational overview described in this section. The legacy platform baseline in based on the MQ-9 already operating in several European Air Forces whereas the near-term platform baseline is based on the available information from European MALE RPAS that is expected to be operational in within the accommodation timeframe.

	Legacy RPAS baseline	**Near-term RPAS baseline**
Max Weight (T)	4,76	10
Engine / Fuel	Turboprop. / 900 cv / F34	Twin prop engine
Max / Cruise Speed (kt)	249 / 180	
Operating Speed (kt)	120 to 150	200 to 280
Cruise Level (FL)	250 to 400	200
Operating Level (FL)	200 to 250	200 to 250
Rate of climb		2500ft/min up to FL100 then 1500ft/min up to FL300
Max endurance (h)	+ 20	+24
C2 Link	RLOS and BRLOS (SATCOM)	RLOS and BRLOS (SATCOM)
CNS Equipment	1 airborne VHF, 1 Transponder A/C, GNSS and INS	1 Radio (VHF + UHF), Transponder C/S, GNSS and INS, VOR, DME
ACAS	None	TCAS II coupled with autopilot

4.2.2 *Remote Pilot Station (RPS)*

For the purpose of the Guidelines, the RPS functions described in this section are relating only to RPA C2 and the interface with ATC/ATM.

The ground control segment for a generic MALE RPAS consists of:

- Fixed RPS usually located at the main operational base (MOB)
- Deployable RPS usually at the deployed operational base (DOB)

Both types of RPSs have the following capabilities:

- Mission preparation for tasked mission, including flight plan, based on a diverse type of support information and data relevant for air traffic integration: cartography, navigation database in ARINC 424 format, weather, airspace information, communications, RPA configuration and any additional information that is necessary to conduct the flight in a save manner.
- Provides means to the RP/WOC to define inside the Mission Plan the following Contingency/Emergency Route related elements:
  - Main aerodrome and Alternate aerodrome
  - Emergency aerodromes or Emergency Landing Fields or Flight Termination Areas
  - Navigation routes

  - o Landing procedures
  - o Termination procedures
  - o Link Loss Strategy
- Provides means to the RP/WOC to define, before and/or during the flight, the behaviour to be executed by the RPA in case of defined external/internal events appearing including confirmed Lost C2 Link.
- Provides means to the RP/WOC to request clearance from the military Control and Reporting Centre (CRC), the Air Traffic Control services and the Air Traffic Management (ATM), of any flight path included in a Mission Plan in digital form in accordance with ICAO FPL 2012 (ICAO Doc 4444 Ed.15).
- Mission execution that includes: RPS systems initialisation, manual or automatic taxi, automatic take-off and landing, C2 of the RPA and its sensors, C2 of the communication links.
- RP can follow the evolution of the RPA along its flight plan (nominal or contingency) as well as prediction for time of arrival & remaining energy
- During mission execution RP at the RPS can communicate with ATC and follow their instructions
- The control of the RPA can be transferred to different RPSs.
- The RPS provides mission debriefing, maintenance and training capabilities.
- The RPSs ensure a secure operation, both physical and cyber.

4.2.3 *Command and Control Link (C2 Link)*

The command and control (C2) link is the data link between the remotely piloted aircraft and the remote pilot station for the purpose of managing the flight. Voice communication between RP and ATC in normal situations are also transmitted via datalink and relayed to ATC by the RPA. There are a variety of possible architectures and considerations in the design, security and management of the C2 link.

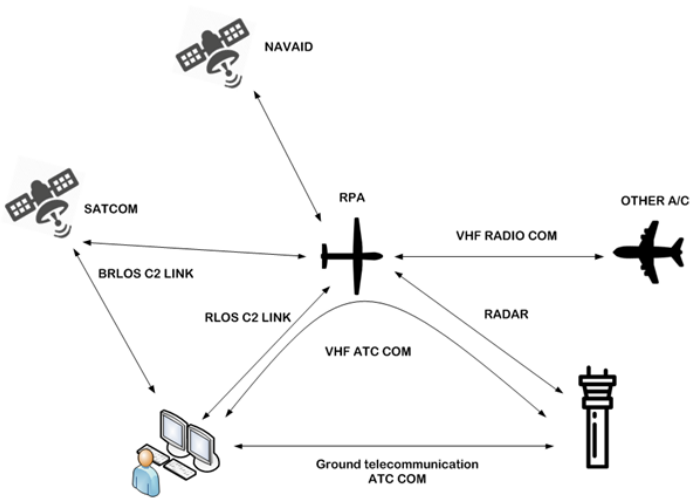
Following type of communication links are present in the MALE RPAS:

- Narrow band radio line-of-sight (RLOS) C2
- Narrow band beyond radio line-of-sight (BRLOS) via Satcom
- Wide band radio line-of-sight (RLOS)
- Wide band beyond radio line-of-sight (BRLOS) via Satcom

4.2.4 *System Interfaces*

The figure bellow provides a generic illustration of the of the interfaces of the RPAS MALE

Ground telecommunication between the Remote pilot and ATC are not routinely used but can be used, when needed, for some contingency's situations.



4.2.5 *RPAS technology expected evolution in the accommodation timeframe*

This section describes several out-of-the-shelf technical capabilities or technology that could be used in the accommodation time frame. This information is provided to support the operational safety assessment by proposing additional technical barriers. One of the expected outcomes of the abovementioned operational safety assessment is the evaluation of these barriers' effectiveness to mitigate the operational risks identified thereof.

4.2.5.1 Cooperative traffic awareness from on board sensors.

The cooperative traffic awareness functionality uses onboard cooperative sensors data to build and maintain a traffic situation picture around the RPA. This information is provided to the remote pilot who monitors and maintains his/her traffic situation awareness.

4.2.5.2 Ground based traffic awareness

The cooperative traffic awareness functionality uses onboard cooperative sensors data to build and maintain a traffic situation picture around the RPA. This information is provided to the remote pilot who monitors and maintains his/her traffic situation awareness.

In addition, traffic tracks information from the Secondary Surveillance Radars (SSR) and ADS-B from the ATM system could be integrated and displayed directly in the RPS. This information could be complemented with primary radar tracks from the military infrastructure to support the RP in detecting surrounding traffic compensating for the lack of traffic awareness function of DAA.

The integrity and reliability of this solution is the same that present ATM and military radar system and would provide an enhanced traffic awareness to the RP.

4.2.5.3 Ground based weather awareness for RP

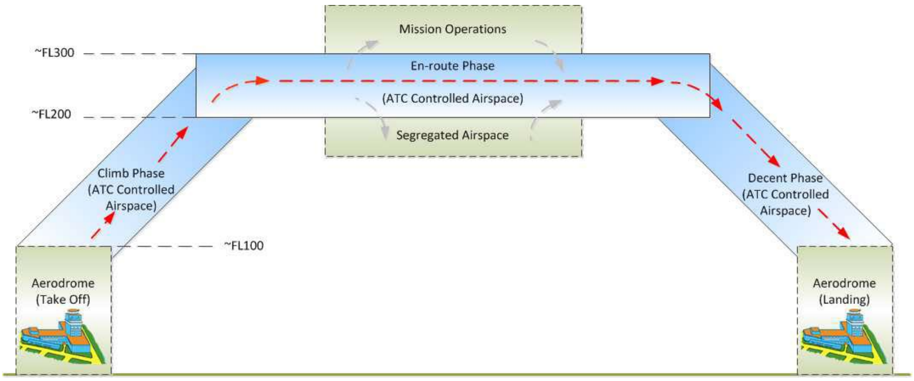
In a similar way to the previous capability, the aim of this ground capability is to mitigate the lack of on-board weather detection equipment. The RPS can be connected to real-time weather information services during operation in order to display relevant weather information of the RP. In this way, the RP will be able to detect hazardous weather conditions and to react accordingly.

4.2.5.4 RP – ATC VoIP direct connection

Depending to the progress regarding the initiatives at SESAR JU and EUROCAE WG-67 (VoIP1 for ATM), this functionality would replace and enhance the current telephone-based backup communication between the RP and ATCO

4.3 Operation overview

The typical operational/training mission will depart from a military aerodrome, in segregated airspace until the RPA control is transferred to civil ATC[14]. From this point, the RPA is operated under IFR GAT, in non-segregated airspace and transits to the training/operational[15] area in the same way than military manned aviation operates today. Once the RPA reaches entry point to the training/operational area, the control in transferred to the ATC centre in charge (either civil or military). After the operation in the training/operational area is finished (up to 24 hours) the RPA reaches the exit point of the training/operational area and the control in transferred to the ATC in charge to the sector used for the transit to the destination aerodrome, which is carried out in non-segregated airspace area in the same way than military manned aviation operates today. A final transfer to ATC in charge of the destination military aerodrome terminal operations and landing.



A typical flight: "green" in segregated and "blue" in non-segregated airspaces.

The RPAS traffic separation is ensured by ATCO, and the use of airspaces and timeframes where only cooperative traffic is allowed (cooperative environment only). The installation of TCAS in TA mode only in the military MALE RPAS type enables ACAS of other aircraft that are equipped[16].

The operational area will be in reserved airspace under military or civil air traffic control and can be located in a state's border or contain airspace of two neighbour states.

The transit from the military aerodrome to the training/operational area or another military airfield can involve several cross borders and will submit a Flight Plan in the ICAO format in accordance with applicable requirements. As military RPAS are state aircraft, prior authorisation (Diplomatic Clearance) is required for cross border operations[17]. The prior authorisation process of each country should include sharing characteristics,

[14] This control transfer is coordinated at national level. In some European countries such as Germany, civil ANSP are also in charge of military flights.
[15] As per assumption 8, training, operational and mission areas are considered segregated airspace
[16] When the MALE RPAS performance are not compatible with the TCAS required climb rates of 1500 ft/min, the TCAS shall be switched to TA only. This degraded situation is not optimal and could even present risks in the long term. Therefore, it shall be limited in time until a better mitigation mean is found.
[17] According to ICAO Manual 10019 all RPAS flights (regardless civil or military) have to be coordinated with states to be overflown

frequency spectrum, way of airspace insertion, specific regulation and behaviour of the RPAS in case of emergency or contingency.

Because the duration of the flight may be more than 24 hours, there might be the need to issue more than one flight plan for the flight.

4.4 Description of a Normal Flight

The RP/WOC files its Flight Plan to the appropriate portal in such a way that the respective entity is able to accept it within two hours; further changes in the filed Flight Plan is possible even during the RPAS operation.

Taxi, take off and initial climb are not addressed in the scope of this document.

After taxi and take off from the Military aerodrome and climbing up through segregated airspace until it joins the airspace classes A, B or C. During all flight phases the control transfer between different Air Traffic Services providers (military and civil) is equivalent to military manned aviation.

Handovers between different RPS and between RLOS and BRLOS [18] communication is possible and will only occur in terminal operations or in the mission area, in both cases in reserved airspace. Thus, no impact to ATCO is expected and no specific coordination is deemed required in this respect.

Once the RPA reaches its cruising level (FL 200 – 280) the RPA will be flown to and from the operational/training area or to another military airfield following the published ATS routes and the ATC instructions in the same manner as any aircraft present in the airspace. The RPAS might provide similar situational awareness (like traffic information, adverse weather, etc.…) to the Remote Pilot than the situational awareness of a manned aircraft pilot.

When reaching the operational/training area (reserved airspace), the hand over between different Air Traffic Services providers (civil and military) is equivalent to military manned aviation one when entering/exiting operational/training areas.

After the mission/training exercise is achieved the RPA will transit to the destination aerodrome through non-segregated airspace classes where only cooperative traffic is permitted; descending through segregated airspace or through airspace classes where only cooperative traffic is permitted until it reaches the military CTR and transferring the control to military ATC and landing and taxiing on the destination aerodrome following signs, markings and control tower instructions.

4.5 Abnormal, emergency and flight termination situations

This document uses only the terms Normal, Abnormal, Emergency and Flight Termination situations. The normal situation is the one described in the previous section.

An Abnormal situation is one in which it is no longer possible to continue the flight using normal procedures but the safety of the aircraft or persons on board or on the ground is not in danger. The main goal now is to minimise adverse effects on the air traffic system, as long as higher goals like safety of life and avoiding damage to

[18] By default, terminal operations are carried out using the RLOS datalink.

equipment remain assured. Since predictability is a key aspect of integration into the air traffic system, the contingency procedure of the RPA should be pre-planned in detail, or alternatively agreed between RP and ATC. The RPA will change to a pre-planned contingency route leading to a contingency landing site that might be the departure or destination aerodrome.

The risk associated to a landing in abnormal situation shall not be higher than that of a normal landing, therefore any contingency landing site must be equipped in a similar way as the destination aerodrome, e.g. in terms of landing aids. The same applies for a landing under link loss and consequently for link loss landing sites.

Lost C2 Link is considered an abnormal situation unless this is combined with additional occurrences.

An Emergency situation is one in which the safety of the aircraft or of persons on board or on the ground is endangered for any reason. The RPA should to act according to according to the maximum extent to generally known and accepted rules.

Flight Termination situations occur when no pre-planned landing site of any kind can be reached anymore. It is assumed that the RPA can no longer be saved, therefore the only remaining goal is to minimise risk to persons and property on ground. The RPA will fly to a suitable location and enter a flight termination manoeuvre there.

The term “contingency” is used to refer to a plan or procedure, which is triggered by a flight termination, emergency or abnormal situation.

To ease the approach to the RPAS off normal situations management, section 4.5.1 covers the general description of the abnormal , emergency and flight termination situations management in a similar way to military manned aviation, *mutatis mutandis,* and introduces the following generic procedures: “landing at the nearest suitable airfield”; “landing as soon as possible” and “immediate flight termination" [19].

Then the rest of the section 4.5 is devoted to the contingency procedures’ descriptions for abnormal and emergency situations that are **specific to RPAS operations** including but not limited to the situations involving a loss of C2 link.

4.5.1 *Generic contingency procedures*

This section covers the general description of the abnormal, emergency and flight termination situations management in a similar way to military manned aviation, once the necessary changes have been made, and introduces the following generic procedures: “landing at the nearest suitable airfield”; “landing as soon as possible” and “immediate flight termination".

4.5.1.1 Landing at the Nearest Suitable Airfield (Abnormal situation)

1) The Remote Pilot switches the associated transponder Mode 3/A code (transponder code following manned aviation regulation or according to RPAS-specific regulation if available).
2) The RP follows the applicable checklist procedures for the abnormal situation and selects, if needed, the most suitable aerodrome for the nature of the abnormal situation.

[19] Flight Termination areas might not be acceptable in all Member States. The risk assessment should provide enough flexibility not to use FTA if so required

3) If necessary, the remote pilot informs ATC about any change to the initial flight plan. ATC issues clearances for the desired flightpath that will allow the RPA to reach the selected aerodrome.
4) The controlling agencies at the selected aerodrome manages the end of the flight in close coordination with the RP.

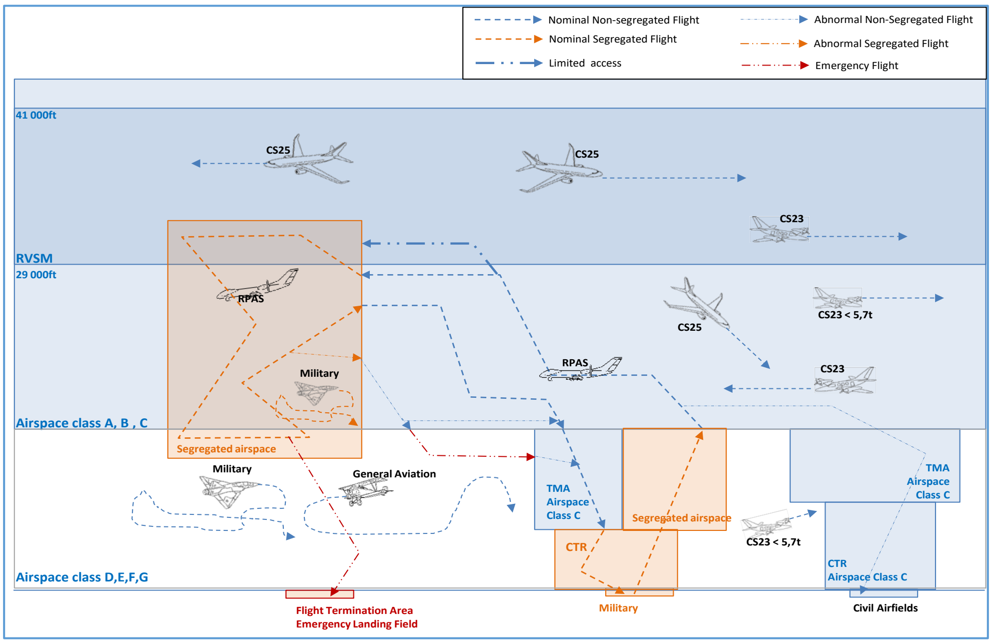
4.5.1.2 Land As Soon As Possible Procedure (Emergency situation)

1) The Remote Pilot switches the associated transponder MODE 3/A code (transponder code following manned aviation regulation or according to RPAS-specific regulation if available).
2) The Remote Pilot follows the applicable checklist procedures for the emergency situation and selects the closest aerodrome to minimise the remaining airborne time.
3) The remote pilot informs ATC about the nature of emergency and the selected aerodrome for the emergency situation.
4) ATC issues clearances for the desired flight path that will allow the RPA to reach the selected aerodrome. ATC provides the required or necessary separation between all known traffic and the communicated flight path of the RPA to the selected aerodrome.
5) Consequently, the controlling agencies at the aerodrome manages the end of the flight and the emergency situation in close coordination with the Remote Pilot.

4.5.1.3 Immediate Flight Termination (Flight Termination situation)

1) The RPAS RP uses the associated transponder mode 3/A code (transponder code following manned aviation regulation or according to RPAS-specific regulation if available).
2) The RP follows the applicable checklist procedure for the flight Termination procedure, including the selection of the area where to terminate the flight.
3) ATC is informed about the trajectory that will allow the RPAS to reach the most suitable Termination/crash area.
4) Where possible, the trajectory is adapted to mitigate as far as possible the risk for third parties.

The figure depicts the abovementioned procedures.



4.5.2 *Lost C2 Link Contingency Procedures*

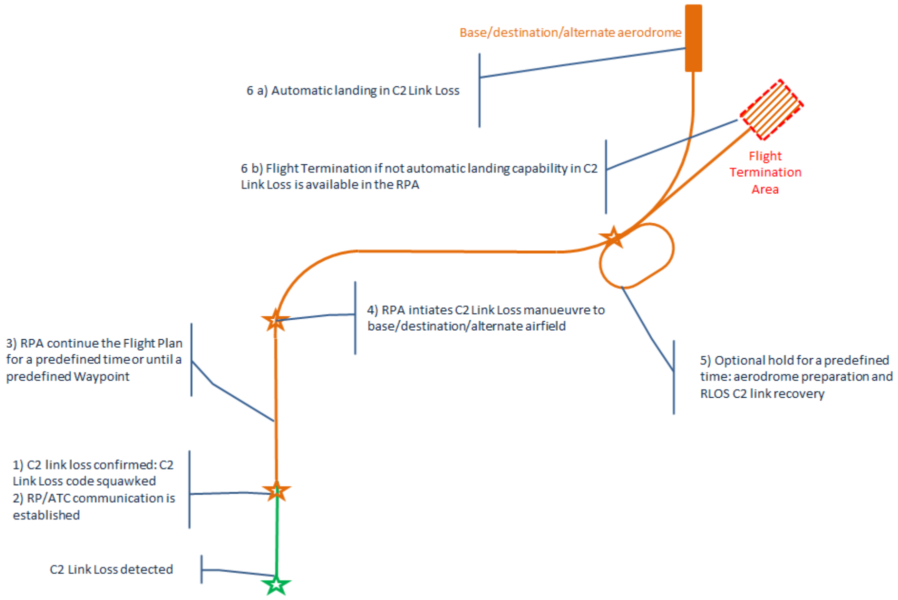
Lost C2 Link Contingency Procedures in non-segregated airspace will require standardisation at International and European level. This is envisaged to be included in the future Standard and Recommended Practices (SARPs) at ICAO and EASA's regulatory framework respectively, which are not expected to be available within the accommodation timeframe.

Until this information is available, Lost C2 Link procedures will require the coordination between all potentially impacted actors including the RPAS operator, ANSP, departure, destination and alternate aerodrome related ATCO for each operation or operational scenario.

This section provides a generic and flexible approach for Lost C2 Link contingency procedures and is intended to accommodate different platforms characteristics, operational scenarios and national preferences to deal with this situation. This procedure is based on the existing military RPAS operational experience and other available sources[20], and aims at identifying all relevant options that need to be agreed and coordinated amongst all stakeholders.

As al already mentioned, Lost C2 Link is considered in this document as an abnormal situation[21] and **the objective of the Lost C2 Link contingency procedure is to continue the operation until the nearest suitable aerodrome that might be the base or destination one**. No emergency landing or flight termination is envisaged unless there are other occurrences affecting the RPA airworthiness (see section 4.5.4)

The following figure provide the generic Lost C2 Link Procedure including all relevant options, which are further explained below:



[20] Mainly "ANSP Considerations for Unmanned Aircraft Systems (UAS) Operations" from CANSO and ICAO 10019.
[21] Other operational concepts define Lost C2 Link as an emergency situation. As long as the contingency procedure does not lead to a "Land As Soon As Possible" or "Immediate Flight Termination", this is considered just a deviation in the terminology used with no further impact.

1) Lost C2 Link declared: Once a permanent Lost C2 Link situation is confirmed by the RPA, it automatically squawks a Lost C2 Link code previously agreed to inform ATC and other airspace users of the RPA condition.

2) Remote Pilot contacts ATC via an alternate communication means such as landline.
3) The RPA continues the Flight Plan originally filed [22]
   a) During a predefined time
   b) Until a predefined waypoint is reached

4) Initiate predefined *Lost C2 Link manoeuvre*. This manoeuvre must be previously agreed in the flight planning phase and should use one of the following options.
   a) Return to base
      i) Direct
      ii) Same route backwards
   b) Continue with Flight Plan to destination aerodrome
      i) Direct
      ii) Original Flight Plan
   c) Proceed to alternate aerodrome
      i) Direct
      ii) Specific flight plan to alternate

   The *Lost C2 Link manoeuvre* should always avoid entering a prohibited area, airspaces class D to G and entering bad weather areas known before the Lost C2 Link event [23].

   In addition, the *Lost C2 Link manoeuvre* can be different in different phases of the mission as long as it is agreed and predictable. (e.g. depending on the proximity to base, alternate or destination aerodrome when the Lost C2 Link situation is produced, the availability of primary radar...)

5) Optional hold for a predefined time: before initiating the automatic Flight Completion in Lost C2 Link, the RPA holds for a predefined time in a specific waypoint in proximity (Radio Line of Sight range) of the base/destination/alternate aerodrome:
   a) To provide extra time to ensure that the aerodrome is prepared for a potential automatic flight completion
   b) To recover Radio Line of Sight C2 datalink if possible

6) Flight Completion in Lost C2 Link. If no RLOS C2 link is available, the RPA will proceed to automatic Flight Completion depending on the RPA capabilities:
   a) Automatic Landing in the aerodrome in Lost C2 Link
   b) Emergency Flight Termination in a Flight Termination Area.

The following table summarises the different options provided in the generic procedure that need to be coordinated between the different actors prior the RPAS operation:

[22] In some cases the procedure could also take into account a deviation from the Flight Plan previously cleared by ATC. In this case the RPA would follow the assigned altitude and heading for a TBD time (e.g. 7 minutes). However this will not be considered here for the sake of simplicity.

[23] This concept assumes that the RPAS' internal flight plan containing all contingency routes can be uploaded dynamically during the operation so that the C2 link loss manoeuvre will take into account all known weather phenomena before the C2 link loss event.

Step in the Lost C2 Link Generic Procedure	Options
1) Lost C2 Link transponder code	- E.g. 7400, 7600
2) RP/ATC communication means	- Landline AND; - Common situational awareness if available
3) RPA continues the Flight Plan	-Time in minutes OR Waypoint in the Flight Plan
4) Manoeuvre to base/alternate/destination aerodrome	- Base: Direct OR backwards route OR; - Alternate: Direct OR Flight Plan to alternate OR; - Destination: Direct OR Original Flight Plan
5) Optional hold	- Holding waypoint AND; - Minutes of holding pattern
6) Flight Completion in Lost C2 Link	- Automatic landing in aerodrome OR; - Emergency Flight Termination in FTA

4.5.3 *Loss of transponder*

Operation of an aircraft[24] without a transponder, or with a dysfunctional one, constitutes a single threat with the potential to "pass" through all the existing safety barriers up to "see and avoid". "See and avoid" is a mitigation layer for the manned aviation but not for the unmanned one. Combination of the other mitigations should be used in order to compensate for the lack of "see and avoid" in the Accommodation timeframe.

The most common transponder failures are "Total loss" (feature not available), "Corrupted" (feature operating but wrong data output), "Intermittent" (feature working with interruptions) and "Duplicated" (two or more aircraft transmitting the same information).

<u>Prevention Barriers</u>
Prevention barriers are designed to reduce the probability of occurrence of the event (operation without or with a dysfunctional transponder). Following the **company SOPs and the aircraft manufacturer's maintenance schedule** will reduce the probability of equipment failures, including transponder-related ones. Prevention barriers are the same for manned and unmanned aircraft.

<u>Repairable mitigation Barriers</u>
Mitigation barriers are designed to reduce the impact of the event after it has already happened. A mitigation barrier is called "repairable" when a failure has reduced the effectiveness of a barrier in the system, but certain actions may still be able to restore the effectiveness of this barrier. The main repairable mitigation barriers types are:

- Application of transponder code validation procedures on first contact;
- More effective flight plan data;
- Tactical conflict management:

[24] From manned aviation information at https://www.skybrary.aero/index.php/Operation_without_a_Transponder_or_with_a_Dysfunctional_Transponder

- Regular air situation scanning by ATCO;
    - Use of primary radar data, if available;
    - Detection of transponder failure by flight crew;
    - Built-in alerting functions for the transponder failure at the flight deck
    - Built-in alerting function in the automated ATM system issuing warning when under specific circumstances the surveillance track data, and respectively, the track to flight plan correlation is lost.

Repairable mitigations barriers are the same for manned and unmanned aircraft.

New and Existing Mitigation Barriers

The following generic barriers could mitigate the effects of operation without or with dysfunctional transponder:

- Design and strategic planning:
    - Airspace design – e.g. using de-conflicted Area Navigation Systems routes;
    - Procedure design taking account of potential transponder malfunction;
    - Appropriate ATC system design and calibration;
- Sector capacity planning reducing the probability of very high ATC workload periods;
- Use of voice reporting by flight crews;
- Tactical conflict management:
    - Alert for change in track status;
    - Use of voice reporting;
- ATC collision avoidance - collision avoidance via procedural control;

Those mitigations barriers are the same for manned and unmanned aircraft.

4.5.4 *Lost C2 Link and Additional Occurrences*

This section describes the situation of a multiple simultaneous failures including the C2 Datalink Loss.

4.5.4.1 *Lost C2 Link and Loss of Transponder*

The priority in this case is to confirm that the RPA continue the Lost C2 Link agreed procedure in a safe way until the Flight Completion. This can be achieved with the following actions that would require further civil- military coordination and military-military coordination.

- ATC detects the Loss of Transponder and informs the Remote Pilot of this additional failure.
- In case civil or military primary radar coverage is available, the Remote Pilot will coordinate with the responsible entity and monitor the current RPA flight path and any potential deviation with respect to the Lost C2 Link agreed procedure.
- In case no primary radar coverage is available, or in addition to this measure, the RPA flight path can be escorted/chased by an interception manned aircraft, provided the military-military required coordination

4.5.4.2 Lost C2 Link and other failures triggering 7700

The priority in this case is to monitor the potential deviations with respect to the Lost C2 Link agreed procedure due to the additional failure.

- Remote Pilot shall manage a list of failures triggering automatically 7700 (e.g. Loss of GNSS, Loss of Power…) and inform ATC of the potential causes of emergency.
- An interception/chase aircraft might be used to further monitor the emergency, provided the military-military required coordination

Contingency procedures triggered by an Emergency under Lost C2 Link will be selected automatically by the RPA to perform an emergency landing (Land As Soon As Possible procedure). Interference with the air traffic system is considered unavoidable at this point. As emergency landings may take place at emergency landing sites, at contingency landing site or at the nominal destination, pre-planned emergency routes are required to any such landing site. For an emergency landing, a reduced safety level may be accepted, which will need further mitigations like clearing an extended safety area at the emergency landing site.

Likewise, contingency procedures triggered by a Flight Termination under Lost C2 Link will be selected automatically by the RPA to perform an flight termination when the RPA cannot fly either a Lost C2 Link route or an emergency landing route (Flight Termination procedure). The remaining goal now is to minimise risk for persons and property on ground.

Generally, contingency procedures routes are required to ensure reachability of a suitable landing or Flight Termination Area site from any point on the nominal route (and other contingency routes), also in case of RPAS malfunctions.

5. Operational use cases

5.1 Operational Processes

The existing operational scenarios has already been described in the previous sections. The guidelines address the operation of RPAS MALE type in airspace classes A, B and C under civil ATCO making use of pre-tactical and tactical mitigation means to mitigate the risk of mid-air collision with other traffic.

While the end goal is to have non-segregation in these airspace classes, the initial operational capability may require some sort of segregation (e.g. specific corridors, bubbles, increased lateral, longitudinal or vertical separation minima, by flight levels, by time) until the learning and demonstrations processes have been successfully completed. It is important to note that some of the most advanced Member States which have been operating military RPAS since decades, have done so using these sort of smart segregation procedures until now or using complete network of OAT routes. This approach may not be feasible or desired in all EU Member States, therefore the procedures and practises presented in these guidelines may not be applicable directly in those States. In addition, it is important to explain that there is a learning process to be completed and the progressive accommodation and integration of RPAS (whether civil or military) in the airspace together with other manned aircraft will be progressively done and using a stepped approach.

Therefore, this chapter will address the possible operational use cases that can be expected in the next 5 to 10 years.

5.2 Operational use cases descriptions and conditions

There are many possible operational use cases that could be used for the analysis but as the scope of these guidelines is limited to the operation of RPAS MALE type in airspace classes A, B and C, three operational use cases are used for the assessment.

The operational use cases chosen are for convenience equivalent to RPAS integration phases and they are not exclusive. They can all be applied progressively in different periods of time. While the risk associated to the operation is also increasing with the operational use case and therefore the assessment below will require more robust and thorough mitigation measures to make the residual risk acceptable.
The operational use cases are described below:

5.2.1 *Baseline operational use case*

The baseline operational use case is today situation. Today there are some use of military RPAS within the European Airspace by some European Member States, but the number is limited, and the operations are mainly within the national airspace. The operation is conducted in segregated airspace controlled mainly by military ATCOs also during the transit phases. There are not cross-border operations and the only ones are on a demonstration or test/experimental basis. This baseline scenario is not further addressed in this document.

5.2.2 *Operational use case 1*

The military RPAS operator has already gained experience with baseline operational use case and wishes to have more operational flexibility and increase the possibilities to perform more operations such as training. This operational use case foresees the operation of military RPAS in airspace classes A, B and C during the transit phase and outside the training or mission reserved airspace controlled by civil ATC / ATS Unit. The way to mitigate the risk of collision is to apply 'smart segregation procedure' which can make use of specific corridors, increase separation minima criteria for the military RPAS or can make use to time-based separation techniques. The application of one or another risk mitigation measure will depend on the specification of the RPA itself, the operation and the experience of the civil ATC unit managing the traffic in that airspace. It is expected that the RPAS is fitted with the relevant CNS equipage required to comply with the airspace usage requirements or interoperability requirements or another equipment providing equivalent performance. The application will be on case by case approach, based on a risk assessment and it necessitates discussion, coordination between the military RPAS operator and the civil ATC Unit.

The routes being flown can be the already published ATS routes as far as it is feasible. Cross border operations are feasible but require prior discussion and coordination and all the necessary safety assessments should take into account the specific national procedures. The approvals from the different competent authorities may take longer than today for manned military aircraft operations due to the specific RPAS operations, the lack of experience from the other Member States and due to the different contingency management procedures.

5.2.3 *Operational use case 2*

When sufficient operational experience is gained with the operational use case 1 or when the technical capabilities of the RPAS are such that it is fitted with a detect and avoid system or equivalent compatible with the operational environment of the European airspace, then a more ambitious operational use case can be foreseen. In this case the military RPAS can be operated accommodated with other manned civil traffic during the transit phase in airspace classes A, B and C and controlled by civil ATC/ATS units applying the same separation minima and operational procedures. In this case, the military RPAS is equipped with the CNS equipment required to fly in the EUATM network as any other manned aircraft and is compliant with the relevant airspace usage requirement or an equivalent CNS/equipage performance that can be demonstrated with a level of assurance that it can be accepted by the relevant competent authority. In this operational use case, the risk assessment of the operation is such that it is demonstrated that safety and efficiency of air traffic is not impaired. The published ATS routes are used and the flight is conducted following IFR GAT rules and therefore a flight plan is filed as any other IFR flight following the same procedures. The management of the contingency procedures in relation to ATS may need to be agreed if different from the ones already standardised in SERA/ICAO SARPS.

6. Analysis of the proposed concept of operations, and operational use cases

6.1 Background and description of the method used for the assessment

For the time being there are not commonly worldwide ATM procedures[25] for managing the RPAS operations together with civil traffic in any airspace class. Significant work is on-going at the ICAO RPAS Panel and also at European level between EASA, EDA, SJU and EURONTROL within their respective safety and regulatory, research and development and operational roles. In many guidance documents already developed and published it is assumed that in the airspace classes A-G, the RPAS shall adhere to the same rules of the air than manned aviation but many guidance documents and operational concepts published recognises that they may not be able to follow the same rules and in very specific cases different procedures may be needed to be applied to ensure safe operations. However, the main underlying principle is that the operation of RPAS in the airspace shall not impact manned aviation and shall not affect the safety and efficiency of the air traffic.

In the absence of these commonly agreed ATM procedures, it is considered that the operation of RPAS, in particular the military RPAS, in the airspace will still be dealt with on a case by case basis. In accordance with EASA's concept of operations[26], which is now reflected in draft regulation (drat Implementing Act already voted positively by the EASA Committee and Delegated Act is following the scrutiny procedure of the European Parliament and the Council) for the open and specific category, draft article40 of the Delegated Act, the following operations would fall in the certified category, and cannot be performed in the specific category:

1. UAS operations involving an unmanned aircraft with any dimension above 3 m, intended to be operated over open assemblies of people:
    - This could be applicable to military MALE RPAS
2. UAS operations for the transport of people:
    - Not applicable in this case
3. UAS operations for the carriage of dangerous goods, which may result in high risk for third parties in case of accident:
    - Although a military RPAS MALE type can could carry weapon, this is not necessarily always the case. Further to this, it could be fully demonstrated that the weapon is in such status that it would be inert in case of aircraft crash or in case it is inadvertently lost, and it should also be demonstrated that such hypothetical loss would happen with a probability significantly lower than the probability associated with the aircraft crash.
4. In addition, UAS operations shall be classified as UAS operations in the certified category where the competent authority, based on the risk assessment provided for in the same draft Implementing Act, considers that the risk of the operation cannot be adequately mitigated without the certification of the UAS and of the UAS operator and without the licensing of the remote pilot, when applicable.
    - This point should be considered as not applicable for this exercise if we take into account the limited scope and the general nature of the guidelines;

[25] Agreed at ICAO or at European level
[26] https://www.easa.europa.eu/sites/default/files/dfu/204696_EASA_concept_drone_brochure_web.pdf

Although the operation of the military MALE RPAS would normally be considered under the certify category, there is not a civil harmonised certification of the UAS, neither a civil harmonise RPL, nor a civil harmonised operator certification or civil harmonised maintenance requirements. This is the reason why from EASA point of view, the operation of MALE RPAS type is assessed under the specific category. The risk assessment performed by EASA in this chapter uses SORA methodology and considers however, that the MALE RPAS is certified by national Military Aviation Authorities following military airworthiness standards, processes and rules.

The key means to obtain authorization to operate in the specific category is the performance of a risk assessment in line with the draft article 11 of the draft regulation, and the compliance with mitigation means and safety objectives which, within the chosen risk assessment methodology, demonstrate an acceptable level of safety for the operation.

The JARUS specific Operational Risk Assessment (SORA) methodology, which complies with the applicable draft article of the draft regulation, will be adopted by EASA as AMC for the risk assessment. While there are many methodologies that could be used to conduct this generic risk assessment, EASA has selected SORA [27]in order to be compatible with the civil UAS operations. EASA believes that the application of SORA can provide to civil authorities, in particular those authorities which are familiar with this methodology and their results, more confidence on the results. Using this methodology EASA can also derive what it is named generic scenario that can be later on reproduced and use by the military RPAS MALE type operators and by the relevant competent authorities for the relevant approvals. The version of SORA used is the one published by JARUS after external consultation.

As explained the aim is to produce a generic scenario for military MALE RPAS which would be acceptable from a safety viewpoint and still cater, as far as possible, for the respective needs expressed by Military operators and captured by this document. This generic scenario would evolve and could be adapted to the operational Use Cases 1 and 2 defined in section 5 of this document.

It should also be understood that **the application of the SORA and the operation in the specific category is not in contradiction with the fact that a UAS is certified following military certification/airworthiness standards by military certification authorities. In fact, UAS military certification is a robust means to achieve the operational safety objectives (OSOs) especially for operations with high levels of inherent risk, as the ones object of this study.**

Rulemaking for the certified category of operation is ongoing in EASA. This category will potentially offer more flexibility for operators, fully authorized under the EASA rules which are harmonised for all EASA MS, to finally achieve integration in the airspace. The regulatory elements of the certified category will provide the frame to address the risk of the operation. ATS Unit authorisation to flight in the airspace they manage will still be needed, and of course key enabling technologies for integration in the airspace will have to be mature and available as certified systems, in particular DAA. However, the availability of fully interoperable DAA, which has been validated within the European airspace and certified in accordance with an agreed standard will take more time. By its nature and the case by case approval of operational scenarios, coupled with UAS characteristics, mitigation means, OSOs to be met at various robustness, the specific category does not provide full integration in the airspace. Operations are specifically authorized, or accommodated, case by case, based on the above elements. Rules for the specific category of operation include the possibility to pre-assess higher risk scenarios and issue such scenarios. The operation is still subject to authorization but the complete the set of elements is already defined usually as EASA's AMC, therefore, having proved that the elements are put in place, the operation can be authorized without further analysis / risk assessment by the competent authority

[27] The analysis which was carried out in these guidelines is referring to a SORA version which is not the latest one published by JARUS and adopted by EASA as AMC with ED Decision . In particular, step 9 of SORA regarding adjacent areas is not reflected

Due to the limited scope of this study in terms of depth of analysis of the system, inherent ground and air risks, mitigation means, accomplishment of OSOs at the appropriate robustness level, this high-risk scenario cannot include all the detail that would be necessary for a real operational authorization. More details would be needed from the military certification of military MALE RPAS. It is therefore defined "generic scenario". The nature of this scenario is therefore conceptual and does not have any claim of practical applicability at this stage.

The document refers sometimes to agreement to be reached with the competent authorities on specific concepts and quantitative data. It should be understood that, should this methodology centred on the specific category, and presented herein at a conceptual level, be used in the future as the means to approve scenarios for military MALE RPAS operation in Europe, this statement would applicable to the whole content of this document and a convergence of the EASA MSs on all aspects of the high risk scenario, to be described in detail, would be required.

Applying the SORA to assess the risk of an operational scenario it can be deduce:

a) The mitigations to be put in place (for air and ground risk, strategic and tactical, procedural and systems-related)
b) Further necessary constraints to the Guidelines

OSOs requirements must be achieved for all the elements having part in the operation (UAS design, development, maintenance; UAS operator; remote pilot). OSOs requirements are achieved in a simpler way if the UAS is certified, the operator is certified, and the remote pilot are licensed following a harmonised set of European regulations. In fact, for very high SAIL as the result will be in this case, it is considered very difficult to match OSOs requirements without certification of the RPA at least. **Therefore, military certification is considered in this document as a basis to satisfy OSOs requirements related to ground risk even if it is not harmonised**.

In summary, with regards to the ground risk, this is addressed by compliance to military airworthiness standards with high level of integrity and by adequate limitations acceptable to the Military aviation authority.

These limitations may come from SORA methodology, the military Type Certification process, or other methodologies.

6.2 Alternatives and Trade-offs Considered

It has to be noted that there are different actors involved in the operations of military RPAS in the European airspace and therefore different processes and risk assessments are being conducted:

a) The RPAS is certified following national airworthiness certification standards and by each national Military Aviation Authority.
b) Military RPAS operator is approved following national operational requirements by each national Military Aviation Authority. Still the operator needs to conduct a risk assessment for the operation being performed.
c) The civil ANSPs or ANSPs providing services primarily to General Ait Traffic (GAT) will need to perform a safety assessment to the change to their functional system when introducing a new airspace user and need to comply with ATM/ANS Regulation 2017/373 [28] by applying the EASA AMCs/GM for risk

[28] https://www.easa.europa.eu/document-library/general-publications/easy-access-rules-air-traffic-managementair-navigation

assessment. They may use, as many ANSPs do today, EUROCONTROL Safety Assessment Methodology (SAM) or derivative. For those projects aiming to perform demonstrations and validations activities under SESAR programme they usually use the SESAR Safety Reference Material.

It is important to specify that SORA is a methodology to be applied by the RPAS/UAS operator of the specific category while the AMCs/GMs to 2017/373 require that ANSPs when changing their functional systems that are typically needed when accommodating new airspace users perform a safety assessment. EASA AMC/GM to this regulation, SRM or SAM are methodologies to be used by the ANSPs when assessing changes to their functional systems (e.g. changes to the airspace, systems and procedures or training to accommodate RPAS operations in the airspace).

Therefore, both actions are needed to ensure safe and efficient accommodation of military RPAS operations in the airspace. The rest of this section addresses only the assessment made by EASA for the operation and that can be used by the military operators, the ANSPs and the relevant competent authorities. Still coordination would need to be performed between the civil ANSPs and the military operator of the military RPAS MALE type. This is coherent with EASA regulation for the specific category, requiring not only a risk assessment but, in case of operation in controlled airspace, that the operator produces evidence that there is a coordination process in place with the ANSP. The same approach would be also needed for the certified category, although for this case, harmonised set of rules and procedures will be available from the EU regulation.

6.3 Assessment results of the application of SORA for the definition of the generic scenario

The generic scenario is identified with the following methodology:

1. Definition of the target generic guidelines
2. Definition of the target generic Platform and Systems
3. Application of the SORA methodology
   a. Derivation of a range of possible mitigations for ground and air risk that could be proposed by the operator to keep the operation within acceptable level of safety, provided operational safety objectives (OSO) will be met with adequate robustness
   b. Identification of SAIL and required robustness level for the 24 OSOs
   c. Generic assessment of OSOs fulfilment, identifying those fulfilled, potentially or partially fulfilled, not fulfilled, or for which it is not possible to determine fulfilment with the available dataset
4. Summary and Conclusions

6.3.1 *Definition of the target generic guidelines of the Operation*

The scope of these guidelines is the accommodation of Military RPAS MALE type in the European airspace. This paragraph will identify only the most important elements of previous chapters necessary to carry out the risk assessment. From this viewpoint, the objective is to be able to perform transitions from the military airfield to the military mission area in non-segregated airspace. The transit operation is the object of this analysis, while the military mission operation as well as terminal operations, performed in segregated airspace and under military control, are not part of this analysis.

The Guidelines of the transit operation ("transit") for risk assessment purposes is defined as follows:

- The transit takes place in non-segregated airspace
- The transit takes place in controlled airspace
- The transit takes place in airspace where only cooperative traffic is allowed
- The transit may involve cross borders segments
- The transit may cross airspace classes A, B and C, where ATC clears and separates all civil traffic (*)
- The transit is flown at FL 200 – 280 at 175 KCAS to 250 KCAS
- A procedure is in place to coordinate the operation with the ANSP(s) competent for the airspace where the transit will be performed (**)

(*) For the longer term, also D airspace would be considered, in this case IFR flights are not separated from VFR flights but provided with VFR traffic information.

(**) Being the transit operation in controlled airspace, the specific category regulation require explicitly that the Operator has in place such procedure.

6.3.2 *Definition of the target generic platform and systems*

Reference is made to chapter 3.2, where the Reaper and Harfang RPAS are generically described. Chapter 4 also includes some technical specifications.

6.3.3 *Application of the SORA methodology*

6.3.3.1 SORA Scope and limit

It should be taken into account that the SORA was not initially conceived to authorize operations of large and complex UAS. As compensation, margins will be taken in the following analysis when possible.

The SORA addresses both air and ground risk. With regard to air risk, it should be highlighted that the SORA is not a means to obtain unrestricted access to airspace whenever its criteria are satisfied. The SORA does not fulfil by itself the SERA 3201 or ICAO 75 Annex 2 section 3.2 "See and Avoid" requirement. There are in fact two different requirements, a safety requirement (airspace safety threshold) and a regulatory requirement (See and Avoid); the SORA only addresses the former and does not solve "per se" the latter. In general, failure to meet either requirement will necessitate an authorisation from the relevant competent authority.

The methodology is applied to cover Use Case 1 and Use Case 2. Nevertheless, the two use cases do not differ with regard to application and results of the SORA methodology for ground risk, for this reason a differentiation between the two use cases can be only found in the air risk paragraph

6.3.3.2 Ground risk assessment and mitigation

The ground risk is addressed by compliance to military airworthiness standards with high level of integrity and by adequate limitations acceptable to the Military aviation authority.

These limitations may come from SORA methodology or other methodologies. In the following, the example applying the SORA is given.

In principle the chosen operation to determine the initial ground risk class could be either "BVLOS in sparsely populated environment" (Ground Risk Class = 6) of or "BVLOS in populated environment" (GRC = 10). This means that the surface included within the "operational volume" can be respectively defined and agreed with the Authority as "sparsely populated" or "populated".

Option 1:
The case for sparsely populated environment can be supported by consideration about the time of exposure. It may be possible, for example, for towns to be included, or partially included, in the operational volume, as long as the MALE would fly in those sections of the volume where portions of towns are included, for a fraction of the whole operation time (for example 5%). In this case, with respect to the "BVLOS in populated environment" case, constraints to establish feasible operational volume would be higher, but the GRC of 6 would be much less demanding in terms of mitigation means. It is still considered appropriate to have in place a medium robustness Emergency Response Plan (M3 in table 3 of the SORA below reported) and Low robustness strategic mitigations (M1) preserving a sufficient ground buffer with zones characterized by high population density (e.g.: 8 - 10 Km from the border of the operational volume covering sparsely populated areas), with deviations justified with time of exposure. The Operator would have to properly justify the qualification of the area inside the operational volume as "sparsely populated".

Option 2:
Another option would be to choose a "BVLOS in populated environment" leading to a GRC of 10, and consequently lower 10 to at least 7. The decrease of 3 points should come from Table 3 of the SORA reported below:

Mitigation Sequence	Mitigations for ground risk	Robustness		
		Low/None	Medium	High
1	M1 – Strategic mitigations for ground risk	0: None -1: Low	-2	-4
2	M2 – Effects of ground impact are reduced	0	-1	-2
3	M3 – An Emergency Response Plan (ERP) is in place, operator validated and effective	1	0	-1

Table 3 – Mitigations for Final GRC determination

The following combination could be possible:

- M3: High robustness ERP (-1)
- M1: medium robustness strategic mitigation (-2)

According to the SORA definition, the ground buffer, for a medium robustness M1, must be defined to cater for failures *unlikely to occur to each UAS during its total life but which may occur several times when considering the total operational life of the whole fleet*.

Additionally, the applicant must make use of authoritative density data relevant for the proposed area and time of operation to substantiate a lower density of people at risk (average density map for the date/time of the operation from a static sourcing (e.g. census data for night time ops) could be used). Refer to SORA Annex B for further detail on integrity and assurance requirements associated to M1 and M3.

Conclusion for ground risk

Considering the above mitigations, depending on whether Option 1 or Option 2 is chosen, the ground risk class would be reduced to 5 / 6 or 7 (7 being still acceptable for the methodology). The mitigation means provided above are linked with the SORA methodology. They can be complemented with other mitigation means linked to different risk assessment methodologies and include the design of the UAS to recognized standards (RPAS military Nevertheless and to further ensure the non-binding nature of this document, cation evidences for instance) and a fail-safe design.

6.3.3.3 Air Risk assessment and mitigation

Air Risk Mitigation for Use Case 1

Use Case 1 is based on "smart segregation". Strategic mitigation means are put in place so that it can be demonstrated that, in the operational volume, the likelihood of encounter with manned aircraft can be considered negligible. This is indeed the case because in this Use Case 1, the strategic mitigation is segregation. In this case, ARC A could be assigned. In quantitative terms, the required encounter likelihood could be derived from SORA Annex G and RTCA DO-356. The strategic mitigation means to reach this likelihood and create smart segregation could be:

Boundary: in cooperation with ANSP, the operator shall identify specific corridors with very low likelihood of rate of encounter with manned aircraft.

Chronology: a "smart segregation" concept would make use of boundary and chronology means in parallel. Chronology might be used either with a "static" or "dynamic" approach. An example of a static use would be corridors which satisfy the requirement of likelihood of encounter only at night or at time of the day where the density of traffic is low. A dynamic use of chronology limitation would bring to the definition of temporary corridor segments, which, taking the approach to an extreme, would resemble isolation bubbles around the UAS.

Air Risk Mitigation for Use Case 2

With use case 2, smart segregation is superseded, and the approach evolves toward UAS accommodation in the airspace. The requirement for negligible encounter probability of Use case 1, which can be reached only with very specific corridors, is not reached here and therefore the intrinsic ARC is higher.

Considering the objective of flying above 500 ft AGL within Controlled Airspace, an AEC (airspace encounter category) of 3 is identified in Annex C of SORA, which leads to ARC D. (the highest ARC defined by the SORA)

Unless ARC D is mitigated to ARC C, the SORA would require that the UAS is equipped with a DAA system, collaborative and not collaborative, fully compliant with RTCA or EUROCAE MOPS which are expected to be validated in the European airspace and certified in the future. This would bring us very near to full integration in the airspace but is not feasible in the short / medium time frame. It is therefore necessary to implement a more gradual approach identifying mitigations that, within the SORA frame, are able to mitigate ARC D to ARC C, and, in so doing, accomplish an accommodation in the airspace.

Strategic mitigations which can be leveraged to agree with the Authority a reduction of the ARC from D to C are the following:

Boundary: volumes of airspace characterised by lower air traffic density (lower encounter rate) than the average traffic density associated to the airspace of interest must be identified.

Chronology: it could be considered to accept "limitations in time", for example fly only at night, or fly during specific slots of the day when airspace density, along the corridor or designated ATS route, can be demonstrated to be significantly lower than in the nominal case.

Behaviour: unpredictable behaviours such as sudden hover, excessive climbing and descending, etc. are interpreted as risky behaviours because they can be seen as unpredictable to other airspace users and also difficult to be managed by ATC. In order for the operator to take advantage of this mitigation scheme, they would need to have an operation so predictable in nature that all airspace users and ATC could predict the behaviour of the aircraft well in advance. This could be made available to ATC through the flight plan and the rate of adherence to the filled flight plan.

Exposure: limiting exposure time to higher risk airspace portions.

As explained in SORA Annex C, applying boundary or chronology mitigations, the SORA allows to reduce ARC D to **ARC C** if a reduction from 4 to 3, or 2, of airspace density along the chosen trajectory, with respect to the rating associated to the initial AEC (4) , is achieved. 4 and 3 are relative measure in a scale from 1 (very low density) to 5 (very high density). Conservatively, having to reduce 4 to 2 (or almost 2), this could be interpreted as demonstrating a minimum reduction of 40 – 50 % of the air density in the airspace of interest with respect to the one associated to the initial AEC. It is not allowed by SORA Annex C to lower the ARC of more than 1 level. The above mitigation means should be used in combination, for maximum flexibility, to achieve this target. Exposure time might also be used, depending on agreement with the relevant Authority.

In summary, in the military MALE RPAS case, transits operations could be performed through volumes of airspace_properly defined, in cooperation with the ANSP, to mitigate air risk, and within the operational volumes determined addressing ground risk. Additionally, other air risk mitigation means can be used when such volumes do not provide, per se, the adequate mitigation.

The volumes of airspace where the transfer can take place will have to be defined considering several aspects:

- The needs to provide adequate coverage of the European airspace for perspective military mission needs
- The need to be compatible operational volume defined to address ground risk aspects
- The necessity to fly preserving adequate margin with respect to the outer bound of the volume (contingency volume)
- The need to be able to perform a 180 degrees turn and fly back to the take-off point
- The need to shorten the time required to obtain clearance of the operation from the ATC
- The objective to reach ARC C
- The objective (part of the Guidelines assumptions) to encounter only cooperative traffic
  Boundary and chronology restrictions must be chosen to reach this aim

Tactical mitigations to address residual risk:

Alternate means of compliance to the human "see and avoid" are needed for BVLOS operation. This alternate means of mitigation can be generically described as "Detect and Avoid (DAA)" and can be achieved in several ways. According to the SORA "Tactical Mitigation Performance Requirement (TMPR) provides tactical mitigations to assist the pilot in detecting and avoiding traffic under BVLOS conditions"

Tactical mitigations may potentially differ for Use case 1 and 2, the second being in principle the more demanding case. In fact, while for Use Case 2 tactical mitigation must be adequate to address ARC C, for Use Case 1 we only address ARC A. According to Annex D of SORA, **assuming ARC A is fully proved**, the Operator may still need mitigations as deemed necessary by the Authority. It should be recognized that proving ARC A at the level required by SORA Annex G ("encounter rates less than 1E-5 type 2 encounters per flight hour") will be difficult. For this reason, and because we need to preserve a conservative approach, tactical means for Use Case 1 are proposed to be the same as for Case 2.

Given the final ARC C, medium robustness TMPR are required by the SORA. The SORA divides this into five sub-functions of DAA: Detect, Decide, Command, Execute, and Feedback Loop. "Detect" is the sub-function mostly conditioning the adopted tactical mitigation means. For medium TMPR the detection function will likely be supported by systems currently used in aviation to aid the pilot with detection of other manned aircraft. The expectation is for the Operator's DAA Plan to enable detection of approximately 90% of all aircraft in the detection volume. To accomplish this, and on top of ATC Separation Services[29], a combination of systems / services should be used, such as:

- Air based DAA
- Ground based DAA
- ADS-B In
- TCAS II
- Mode S Transponder
- ADS-B out
- Active communication with ATC and other airspace users
- (see conclusions and recommendations for a more specific identification of the means)

In addition, this requires that the RPAS is equipped with the required CNS equipment for the European airspace and comply with the relevant interoperability requirements. If this is not feasible, equivalent level of CNS performance shall be demonstrated.

Whatever the detection system chosen, the following applies:

- Documented de-confliction scheme identifying:
    - Tools / methods used for detection
    - Assessment of effectiveness of such tools
    - Adequacy of latency of remote pilot decision after detection of incoming traffic
    - Criteria applied for the decision to avoid incoming traffic

- Assessment of the human/machine interface factors that may affect the remote pilot's ability to make a timely and appropriate decision

[29] This requires that the RPAS is equipped with the required CNS equipment for the European airspace and comply with the relevant interoperability requirements. if this is not feasible, equivalent level of CNS performance shall be demonstrating.

- Assessment of failure rate and availability of the tool / methods used
- Demonstration that aircraft have adequate performance, such as airspeed, acceleration rates, climb/descend rates and turn rates, for effective avoidance
- Assessment that detection thresholds are set coherently with the scenario considering traffic that could reasonably be expected to operate in the area, traffic information update rate and latency, C2 Link latency, aircraft manoeuvrability and performance
- Evidence provided by the operator that the methods / systems will mitigate the risk of a collision with manned aircraft to an acceptable level (*) and that the probability of loss of this capability is < 1 per 1000 Flight Hours (1E-3/FH)

(*) Reference to "detection of approximately 90% of all aircraft in the detection volume" previously pointed out. Further detail can be found in SORA Annex D.

The methods and systems used in the see/detect, decide, and avoid feedback loop do not need to be the same for the entire flight plan. In principle the trajectory can be decomposed in phases and each flight phase addressed separately. In any case, they have to be agreed with the Authority.

For the operations of the military RPAS MALE type, there are some traffic awareness systems being used by existing military operators to improve situation awareness of the pilot in relation to other traffic and weather. This information can be used but procedures need to be defined to clarify roles and responsibilities. They could be used on case by case approach as detection means but not as avoiding means.

In particular, ATC separation services shall be the overarching tactical mitigation means. This is also compliant with the EASA new regulatory framework as according to UAS.SPEC.040 (b), "a procedure must be in place for coordination with the relevant service provider for the airspace". Such a procedure is the ATC providing tracking and control of the flight, and separation, performed in coordination with the remote pilot. The same procedure may include the before mentioned activation of corridors.

Air-Based DAA could in principle represent an option for specific segment of the transfer operation. A derivative of MIDCAS could also be proposed as part of the tactical mitigation means, as long as it can be demonstrated that the above risk reduction criteria are met, and it is validated within the European airspace.

Finally, a **SAIL 6** is determined on the base of final ARC C and GRC 7. This leads to HIGH robustness (high integrity and high assurance level) for all OSOs (refer to SORA Body and Annex E).

6.3.3.4 Potential alternatives for a more flexible approach

In case it may not be possible to reach, or fully reach, ARC C for some of the volumes / ATS routes, trajectories, it may be possible to increase the requirement of 90 % of aircraft detected in the detection volume. In other words, the 40%-50% of decrease in air density necessary to bring down the ARC from D to C could be balanced, if not met or not fully met, with higher performances of the DAA plan, such that the final result in term of estimated probability of collision would not change. In this case, nevertheless, a margin should be preserved. This result could be reached adopting several tactical mitigations means in parallel including ATS separation which means that RPAS is equipped with CNS equipment or equivalent.

It is important to note that the ARC is not necessarily managed and mitigated in the same way along the whole trajectory / volume of airspace. Some part of the corridor/ATS route may be mitigated to ARC C and addressed with certain tactical mitigation means, other parts may not be fully ARC C and in this case tactical mitigation means would have to feature higher performance and operate in parallel.

It should be noted that this work-around for ARC D is not included in the SORA. Nevertheless, it could be considered for the scope of this study. Such work around, or alternative methodology, still complies with the article of the principles of the new regulatory framework and can also provide acceptable level of safety provided that all the mitigation means necessary are in place. Agreement between all the relevant competent authorities shall be in place.

6.3.3.5 Generic Assessment of OSOs fulfilment

A preliminary check, also in consideration of the high-profile organizations involved (design, manufacturing, crew, operator, military certification) shows that it should be possible to reach all OSOs with high robustness as required.

The table in Annex C represents in synthesis the identified generic scenario.

7. Conclusions and recommendations

These guidelines described the expected operational concept for the accommodation of the military MALE RPAS IFR within the European controlled airspace classes A, B and C in non-segregated airspace.

The guidelines aim at accommodating existing RPAS platforms while there is also information about possible evolution of the technology of these platforms in the near future.

From the information provided in these guidelines the following conclusions can be made:

- Today there are operations of military MALE RPAS in some European Member States but operations are limited and cross border operations are done on a case by case basis through bilateral agreements;
- The existing military MALE RPAS have been certified by the national military authorities following military certification standards;

- To accommodate these new airspace users on a regular basis, the military operators of the military RPAS Male type will need to describe the operational concept in the accommodation phase and carry out a safety assessment of these operations to be approved by the military competent authorities.

- In addition, the European civil ANSPs, will be required to develop a safety assessment of the new or amended procedures and/or technical systems within their functional system. The national supervisory authorities or competent authorities will need to approve the relevant safety assessment prior to implementation.

- Due to the lack of harmonised civil certification standards regarding MALE-type RPAS operations in non-segregated airspace, EASA considers, in the framework of this document, that it is more appropriate to integrate them in the airspace following the specific operational risk assessment method as per the 'specific category' of EASA concept of operations for UAS;

- It is ultimately the responsibility of the Member States to ensure safe operations in their airspace under their sovereignty. Military RPAS operators and the competent authorities can agree at national level to deviate from the abovementioned process or to assess the safety of these operations on the basis of other national or international standards and regulations;

- Provided that the military MALE RPAS operator mitigates all the identified operational risks, they are approved by the military competent authorities and the civil ANSPs has put in place the approved operational procedures defined in the safety cases, this document describes a two-step approach for accommodation of this military RPAS in airspace classes A-C:

    - First phase (Use Case 1) in which strategic mitigation measures used are more conservative than for Use Case 2 but still using dynamic corridors, greater separation minima, more conservative time-based separation and other ATC procedures to ensure safety is maintained and to allow ATCOs to gain confidence with the performance of these platforms;

    - Second phase (Use Case 2) in which, building upon the previous experience and provided that all the risks are properly mitigated, the strategic mitigation measures can be reduced gradually without introducing new tactical mitigations, although this will be evaluated on a case by case.

- Considering the above, the following recommendations can be made:
    - It is recommended that military MALE RPAS operators, civil ANSPs and relevant competent authorities consider the information provided in these guidelines when performing their respective safety assessments and approving them prior to start operations.
    - In terms of tactical mitigation procedures and due to the lack of DAA standards validated in the European ATM Network and recognised by civil and military authorities, it is recommended that at least the RPA is equipped with required CNS equipment by the European interoperability regulations or by the European airspace users requirements or with CNS which have equivalent performance to those required today by the EU regulations:
        - For Communications, radio communication or datalink (if flying above FL285) with similar reliability;
        - For surveillance, mode S transponder. If not at least Mode C transponder. Mode A not suitable for TCAS detection;
        - For navigation, RNP/RNAV based on ground or GNSS aids or inertial which demonstrate to maintain the necessary navigation performance;
        - If claimed that they are equipped with TCAS II 7.1 version, it shall be demonstrated that the RPA is able to have the necessary performance to comply with RA indicated. If used on TA mode only, which is a degraded mode, this shall be used only as a temporary measure and should not be the final solution. Other DAA claims should to be demonstrated to the competent authority for the performance.
        - For the C2 link, performance need to be demonstrated suitable for the operations being performed in the European airspace and if the RPAS would not comply with ICAO communication loss procedures in case of Lost C2 Link, the operator shall indicate this clearly in the flight plan.
        - The different contingency procedures shall be compliant as much as possible with those included in the ICAO SARPs and as described in these guidelines.
        - The different contingency procedures, if different from previous points, shall be demonstrate that their effect is minimised, and they don't affect safety and efficiency of European ATM system.
        - EASA recommends its involvement in future RPAS projects as essential step to ensure the safety objectives of the EASA Basic Regulation are achieved.

Annex A: Acronyms and definitions list (EASA/EDA)

Acronym	Definition
ACAS	Airborne Collision Avoidance System
ADS-B	Automatic Dependent Surveillance Broadcast
AEC	Airspace Encounter Category
AFB	Air Force Base
AGL	Above Ground Level
AGS	Alliance Ground Surveillance
AIP	Aeronautical Information Publication
AMC	Acceptable Means of Compliance
ANS	Air Navigation Service
ANSP	Air Navigation Service Provider
ARC	Air Risk Classification
ARINC	Aeronautical Radio, Incorporated
ASD	Aerospace and Defence Industries Association of Europe
ATC	Air Traffic Controller
ATCO	Air Traffic Controller Officer
ATI	Air Traffic Integration
ATM	Air Traffic Management
ATS	Air Traffic Service
BRLOS	Beyond Radio Line of Sight
BVLOS	Beyond Visual Line of Sight
CNS	Communications, Navigation, Surveillance
CPDLC	Controller Pilot Data Link Communications
CRC	Control and Reporting Centre
CTR	Control Traffic Region
DAA	Detect and Avoid
DGAC	Direction Génerale d'Aviation Civile
DME	Distance Measuring Equipment
DOB	Deployed Operational Base
DSAE	Direction de la Sécurité Aéronautique d'État
DSNA	Direction des Services de la Navigation Aérienne
EASA	European Union Aviation Safety Agency
EATM	European Air Traffic Management
EATMN	European Air Traffic Management Network
EDA	European Defence Agency
ERP	Emergency Response Plan
EUROCAE	European Civil Aviation Equipment
FPL	Flight Plan
FTA	Flight Termination Area
GAT	General Air Traffic
GCS	Ground Control Station
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GRC	Ground Risk Classification
IAI	Israel Aerospace Industries

Acronym	Definition
ICAO	International Civil Aviation Organization
IFR	Instrumental Flight Rules
INS	Inertial Navigation System
ISTAR	Intelligence, Surveillance, Target Acquisition, and Reconnaissance
JARUS	Joint Authorities for Rulemaking on Unmanned Systems
KCAS	Knots Calibrated Airspeed
LOS	Line Of Sight
MALE	Medium Altitude Long Endurance
MIDCAS	Mid Air Collision System
MOB	Main Operational Base
MOPS	Minimum Operational Performance Standards
MSL	Mean Sea Level
MTOM	Maximum Take-Off Mass
NOTAM	Notice To Airmen
OAT	Operational Air Traffic
OSO	Operational Safety Objectives
RLOS	Radio Line Of Sight
RNAV	Radio Navigation – Area Navigation
RNP	Required navigation performance
RP	Remote Pilot
RPA	Remotely Piloted Aircraft
RPAS	Remotely Piloted Aircraft System
RPL	Remote Pilot License
RPS	Remote Pilot Station
RTCA	Radio Technical Commission for Aeronautics
SAIL	Specific Assurance and Integrity Level
SAM	Safety Assessment Methodology
SATCOM	Satellite Communications
SERA	Standardised European Rules of the Air
SESAR	Single European Sky ATM Research
SJU	Single European Sky ATM Research Joint Undertaking
SOP	Standard Operational Procedures
SORA	Specific Operations Risk Assessment
SRM	Safety Risk Management
STANAG	Standardization Agreement
TAACAS	Traffic Awareness and Collision Avoidance System
TCAS	Traffic alert and Collision Avoidance System
TMA	Terminal Manoeuvring Area
TMPR	Tactical Mitigation Performance Requirement
UAS	Unmanned Aircraft System
UHF	Ultra High Frequency
UTM	UAS Traffic Management
VFR	Visual Flight Rules
VHF	Very High Frequency
VOR	VHF Omnidirectional Radio Range
WOC	Wing Operational Centre

Annex B: Bibliography

The following bibliography used to develop this Guidelines is identified below:

- Regulation (EU) 2018/1139 of the European Parliament and of the Council of 4 July 2018 on common rules in the field of civil aviation and establishing a European Union Aviation Safety Agency, and amending Regulations (EC) No 2111/2005, (EC) No 1008/2008, (EU) No 996/2010, (EU) No 376/2014 and Directives 2014/30/EU and 2014/53/EU of the European Parliament and of the Council, and repealing Regulations (EC) No 552/2004 and (EC) No 216/2008 of the European Parliament and of the Council and Council Regulation (EEC) No 3922/91 (New EASA Basic Regulation)

- Commission Implementing Regulation (EU) 2017/373 of 1 March 2017 laying down common requirements for providers of air traffic management/air navigation services and other air traffic management network functions and their oversight, repealing Regulation (EC) No 482/2008, Implementing Regulations (EU) No 1034/2011, (EU) No 1035/2011 and (EU) 2016/1377 and amending Regulation (EU) No 677/2011

- Commission Implementing Regulation (EU) No 1332/2011 of 16 September 2011 laying down common airspace usage requirements and operating procedures for airborne collision avoidance

- Commission Implementing Regulation (EU) 2018/1048 of 18 July 2018 laying down airspace usage requirements and operating procedures concerning performance-based navigation

- Commission Implementing Regulation (EU) No 923/2012 of 26/09/2012 laying down the common rules of the air and operational provisions regarding services and procedures in air navigation

- Commission Implementing Regulation (EU) No 1207/2011 of 22 November 2011 laying down requirements for the performance and the interoperability of surveillance for the single European sky

- Commission Regulation (EC) No 2150/2005 of 23 December 2005 laying down common rules for the flexible use of airspace

- Commission Regulation (EC) No 29/2009 of 16 January 2009 laying down requirements on data link services for the single European sky

- https://www.easa.europa.eu/document-library/opinions/opinion-012018

- EASA concept of operations for UAS: https://www.easa.europa.eu/easa-and-you/civil-drones-rpas/drones-regulatory-framework-background

- Status of UAS regulatory framework in European: https://www.easa.europa.eu/easa-and-you/civil-drones-rpas

- JARUS Material: http://jarus-rpas.org/publications

- JARUS SORA: http://jarus-rpas.org/sites/jarus-rpas.org/files/press_release_no_30.pdf

- ICAO CONOPS: https://www.icao.int/safety/ua/documents/rpas%20conops.pdf

- ICAO RPAS Manual: https://store.icao.int/manual-on-remotely-piloted-aircraft-systems-rpas-doc-10019-english-printed-12792.html

- ICAO RPAS general: https://www.icao.int/safety/ua/Pages/default.aspx

- STANAG 4671 UAV SYSTEM AIRWORTHINESS REQUIREMENTS (USAR) Edition 3 (draft)
- Concept d'opérations de vols de drones hors espace aérien ségrégé menée entre la DSNA et la DIRCAM dans le cadre du PJ10-05 de SESAR 2020 V 1.0 ;

- Concept d'opérations de la phase 2 de l'expérimentation de vols de drones hors espace aérien ségrégé menée entre la DSNA et la DIRCAM V 1.0 ;

- ER-19 *UAS System Safety Assessment Objectives and criteria inputs to "AMC 1309";*

- ERA T-0137 Working Paper on RPAS Emergency & Contingency Concepts;

- 16.CPS.OP.213 EDA Service contract for the Standardisation of Remote Pilot Station of RPAS - D11 Conclusions and Recommendations for Follow-on Activities;

- 17.CPS.OP.017 Safety case study — accommodation of MALE-type RPAS;

- CANSO - ANSP Considerations for Unmanned Aircraft Systems (UAS) Operations V1.1 (https://www.canso.org/system/files/ANSP%20Considerations%20for%20UAS%20Operations.pdf);

Annex C: Generic Scenario for Use Case 2 with main provisions and limitations

SPECIFIC LIMITATIONS AND PROVISIONS	
1. Operational limitations	
Level of human intervention	• The remote pilot shall always be able to intervene in normal operation. • The remote pilot should operate only one UA at a time. • “Operation from a moving surface vehicle”? to be addressed if needed • Hand-over between RPS? To be addressed if needed
Range limit	Such to preserve remote pilot control considering the possibility of degraded atmospheric conditions
Overflown areas	Populated areas or sparsely populated areas, depending on option chosen (see analysis)
UA limitations	• Insert design limits for dimensions, MTOM • 250 KCAS
Flight height limit	• FL 280
Airspace	Only controlled airspace A, B, C and only cooperative traffic present
Dangerous goods	No weapon shall be carried; in case this is necessary, it would have to be discussed with the Competent Authority and fully ensured that in case of crash or accidental release such weapons would be inert

2. Operational mitigations	
Ground risk mitigation and buffers	10 Km from zone with dense population. Operational volume to include flight geography volume + external contingency volume. Fly only in-flight geography volume (refer to SORA Body representations). Operational volume (defined as geography + contingency) to include "sparsely populated" or "populated" areas depending on option chosen (see analysis).
Air risk mitigation and buffers	The volume of airspaces including adequate buffers to be used and/or the trajectories will have to be established in agreement with the Authorities. Those volumes and/or trajectories will have to satisfy ground risk mitigation requirements and buffers. The volume of airspaces should be established with the intent to also minimize encounter probability with manned aircraft (*encounter event to be defined*). See analysis for further detail. Chronology shall be used to perform the flight in such a way to limit the exposure to manned aircraft encounter. Exposure time concept might be used, as long as in agreement with the Competent Authority. The above methods will have to demonstrate a decrease in air density along the identified volume of airspace or trajectories of at least 40-50% with respect to the nominal case. Such percentage objective should be validated with the Competent Authorities, as well as the demonstration of the operator that the objective is actually reached. Tactical mitigations to address residual air risk shall include ATC separation services (which is also coherent with the requirement to have a procedure in place for coordination with ATC) and relay on a mix of communications/ surveillance/detection/collision avoidance means as a minimum: • Mode S transponder • ADS-B out • Communication required for the route to be flown • Navigation required for the route to be flown • TCAS II 7.1 Or other means such air of ground detect and avoid system identified by the Operator and proposed to the Competent Authorities shall be demonstrated to be compatible with the airspace where the RPAS is going to be flown. Tactical mitigation means shall be such that the operator's DAA Plan can be demonstrated to enable detection of approximately 90% of all aircraft in the detection volume.
Containment	Loss of containment of the RPA (existing volume or trajectory) should not happen more than 1 event per 100000 flight hours and shall be classified as catastrophic event by the safety assessment

3. Operator provisions	
Organisation and procedures	• The Operator and its organization shall be approved by the Competent Authority • An **Emergency Response Plan (ERP)** should be in place, following provisions indicated in section • At least the following should be **documented**: ○ **operational procedures** ○ **environmental conditions** required for a safe operation, and ○ **Limitations of the external systems** supporting UAS for safe operations. • The **Standard Operating Procedures (SOP)** should be included in an **Operations Manual or equivalent document** • A **de-confliction scheme** as part of contingency procedures should include the following aspects for the decision-making process: ○ <u>Decision criteria</u>: if the incoming traffic is detected at X[30] **NM** or less, the avoidance manoeuvre should be initiated, unless different criteria has been established in the Member State ○ <u>Emergency procedures</u> should include avoidance manoeuvres to avoid the collision with another aircraft, and should be defined in agreement with the Competent Authority (e.g. descending to a safe altitude, descent rate, …) • Operational procedures should be **validated against recognised standards**. • The adequacy of the contingency and emergency procedures should be proved through: ○ Dedicated **flight tests**, or, where not possible, ○ **Simulations**, provided that the representativeness of the simulation means is proven for the intended purpose
External services	If external services are used that are necessary for the safety of operations, substantiation of provisions in Subpart A (sec. 4.2.5) should at least include the level of performance of those services
4. Training provisions	
Remote flight crew	Remote pilots should be qualified by having undergone the relevant training required by the relevant military authorities for the MALE RPAS.

[30] To be discussed with the relevant ATS Unit. Could be 8 NM or less.

5. Technical provisions	
UAS and supporting means	• The RPAS should include protection mechanisms against spectrum interference • The RPAS design should be adequate to ensure that the time required between a command is given by the remote pilot and the RPA executes it does not exceed the time needed to ensure safe operations in the airspace (the more dense the airspace the more demanding performance in terms of reaction time) and shall be defined by the competent authority. • The RPA design shall incorporate measures to increase its conspicuity. • Where an electronic means is used to assist the remote pilot in being aware of RPA position in relation to potential airspace intruders, the information is provided with a latency and update rate for intruder data (e.g. position, speed, altitude, track) that support the decision criteria. • Operator's DAA Plan to enable detection of approximately 90% of all aircraft in the detection volume (see tactical mitigation means above) • Loss or degraded DAA capability should not occur more often than 1 per 1000 flight hours. Depending on the time of operations and reliance on the DAA capability the performance of the DAA are going to be more demanding.