DELIVERABLE

D2.5 – Drones regulations compliance handbook

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Abstract (few lines):	Need for growth and prioritising positive evolution of UAS domain within general aviation is a must to harmonize the operations in Europe. Various associated EU Member States (MS) with research & development institutions paved ways for projects that supports the development and allow UAS domain to nurture from its nascent level reach its maximum potential. Currently individual EU MS has their own applicable regulatory measures according to the density of operations and other applicability requirements. To reduce the complexity and have interoperability within EU MS different regulatory measures was proposed by each states. However, with the permission of EU Commission, EASA, an agency upholds the responsibilities of whole aviation sector that carries out certification, regulation and creates specific standards in Europe. Likewise with the request by EU Commission, MS and other stakeholders, EASA proposed a common regulatory framework for the whole UAS domain in Europe. In general the whole UAS domain was categorized into Open, Specific & Certified categories. Having a common vision with the proposed regulations is time consuming to realise and be compliant to perform the required normal operations. Hence this Handbook provides the simpler approach & suitable methodology to realise and be compliant with the proposed EU standards by EASA. This handbook outlines the major high-level works that are current and to be completed projects by JARUS and SESAR. The handbook covers various applicable concepts & use case(s) on the four different domains of operations viz. Transport, Logistics, Surveillance & Inspection & Agriculture. Safety methodology suggested by EASA (SORA analysis by JARUS) is detailed on this Handbook with use cases. Along with the use case(s), different algorithms that provides appropriate guidance to have an easy approach on regulatory requirements to obtain 'Permit-to-fly' is detailed. COMP4DRONES project enables the drone industry to design and develop an embedded platform based on the reusable qualified components. The project covers five main objectives that are detailed in the following pages.

DISCLAIMER

ACKNOWLEDGEMENT

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Acronyms and Abbreviations

Acronym	Title
AMC	Acceptable Means of Compliance
ARC	Air Risk Class
ATC	Air Traffic Control
ATM	Air Traffic Management
ATS	Air Traffic Services
BVLOS	Beyond Visual Line of Sight
CIS	Common Information Services
CONOPS	Concept of Operations
CORUS	Concept of Operations for U-space
CRD	Comments Response Document
CS	Certification Specifications
DAA	Detect and Avoid
DEMO	Demonstrator
DR	Delegated Regulations
EASA	European Aviation Safety Agency
EDZm	Exclusive drone zones for passenger operations
EDZp	Exclusive drone zones for planned drone operations
EDZu	Exclusive drone zones for unplanned drone operations
EU	European Union
EUROCAE	European Organization for Civil Aviation Equipment
E-VLOS	Extended Visual Line of Sight
FH	Flight hour
FL	Flight level
GM	Guidance Material
GRC	Ground Risk Class
HFR	High-level Flight Rules
JARUS	Joint Authorities of Rulemaking on Unmanned Systems
ICAO	International Civil Aviation Organization
IFR	Instrument Flight Rule
IR	Implemented Regulations
LDZ	Limited Drones Zones
LFR	Low-level flight rules
LUC	Light UAS operator certificate
MRO	Maintenance Repair & Overhaul
MS	Member States
MTOM	Maximum Take-off Mass
NA	Not applicable
NDZ	No Drones Zones
NPA	Notification for proposed amendments
OSO	Operational Safety Objectives
PANS	Procedure for Air Navigation Services
PDRA	Predefined Risk Assessment
RPA	Remotely Piloted Aircraft
RPAS	Remotely piloted aircraft system
RTCA	Radio Technical Commission for Aeronautics
SAIL	Specific Assurance and Integrity Level
SARPS	Standards and Recommended Practices
SERA	Standardized European Rules of the Air
SESAR	Single European sky ATM Research
SO	Safety Objectives

SORA V2	**Specific Operations Risk Assessment, Version-2**
STS	**Standard Scenarios**
UAS	**Unmanned Aircraft System**
UAV	**Unmanned Aircraft Vehicle**
UC	**Use case**
USSP	**U- Space Service Provider**
UTM	**U-space Traffic Management**
VFR	**Visible Flight Rules**
VLL	**Very Low Level**
VLOS	**Visual Line of Sight**

Executive Summary

This handbook is an outcome of COMP4DRONES project and have been defined in the project as D2.5 “Drones Regulatory compliance handbook”. The handbook is published in two versions. First version was published on 15th July 2020. This is second version of the handbook. The handbook is intended for use cases leaders’ general guidance and information purposes. In order to improve quality of handbook feedback from readers were requested.

This document focuses on regulations which are applicable to UAS flying within European geographical area and its allocated airspaces only in European geographical area and its allocated airspaces. Please note that this is not a legal document. The material in the handbook is obtained from various sources of European regulatory organization and standardization organization applicable EU and EU countries regulations. We have taken reasonable care to ensure that, and to the best of our knowledge, material information contained herein is in accordance with the European published regulations and standardization facts and contains no omission likely to affect its understanding.

Some contents of this handbook are proposals initiated by ALTRAN and some contents of the handbook have taken references from the work being done by many standardization organizations and regulatory authorities, which are in progress and neither published nor adapted in current regulations. Therefore, this handbook is under no circumstances intended to be used or considered as European regulatory document.

Readers should not place undue reliance on forward-looking information, which will depend on numerous factors, and any reader must make an independent assessment of such projections. As European UAS regulations are updating and modifying on day-to-day basis, there may have been changes in matters by the time user read the book. Any changes after publication date of this book will be documented and published in next version of this handbook.

Neither the issue nor delivery of this handbook shall under any circumstances create any implication that the information contained herein is correct as of any time subsequent to the date hereof or that the affairs of the EU regulations have not since changed.

The contents of this handbook are not to be construed as legal, business, or safety advice. The recommendations and safety assessment process adapted for COMP4DRONES project demonstrators have been published only for guidance purpose. Each recipient should consult with its legal, business, or safety advisors as to legal, business, and permit to fly application process.

The information contained herein may be subject to changes without prior notice. We do not accept any form of liability, neither legally nor financially, for loss (direct or indirect) caused by the understanding and/or use of this handbook or its content. This handbook is only intended for the recipients, and should not be copied or otherwise distributed, in whole or in part, to any other person.

Symbols used in the book

Any content mentioned this symbol is subject to disclaimer defined in **Error! Reference source not found.**

1 Foundations for regulatory framework for COMP4DRONES

1.1 COMP4DRONES Project

1.1.1 Introduction

Unmanned Aircraft Vehicles (UAV), also commonly referred to as drones, are air vehicles and associated equipment that do not have pilot on board, but instead fly autonomously or are remotely piloted. Drones are increasingly being considered for commercial and government civilian applications. Drones can perform air operations that manned aircrafts struggle with, and their use brings significant economic savings and environmental benefits whilst reducing the risk to human life. Drone-based services and product innovation, as driven by increased levels of connectivity and automation, are curtailed by the growing dependence on poorly interoperable proprietary technologies and the risks posed to people on the ground, to other manned and unmanned vehicles and to property (e.g., critical infrastructure). In addition, the absence of a clear regulatory framework at EU level does not currently allow the growth of strong European market for drone services and air vehicles, which limits the potential for jobs and growth creation in this new sector of the economy. [1]

For the regulatory aspect, because the nature of drone systems, operations and services require to develop and adopt an appropriate regulatory framework, the international regulatory bodies work together in the context of JARUS [2] (Joint Authorities for Rulemaking on Unmanned Systems) initiative. In addition to national authorities, Europe participates in this work through EASA [3] (European Aviation Safety Agency). Regarding the innovation aspect, the Single European Sky Air Traffic Management Research (SESAR) [4] Joint Undertaking is developing a set of services and procedures to help drones access airspace safely and efficiently.

The handbook is an effort to compile present EU regulations and various proposal being initiated by EU regulatory and other standardization organizations in UAV domain and various projects being carried out by different European establishments such as JARUS and SESAR in the domain of UAV. This chapter is aimed at describing about necessary information related to foundations needed to understand UAS regulatory framework. Proper understanding of concepts described in this chapter is a must to understand content of this handbook. It will also explain about the motivation and intention of writing this handbook. This handbook is both a reference material and the outcome of the project COMP4DRONES. We have defined general information about this project in next section. Readers are invited to visit COMP4DRONES website [1]for published deliverable for more information about the project.

1.1.2 COMP4DRONES Objectives

The aim of the COMP4DRONES project, supported by Electronic Components and Systems for European Leadership (ECSEL) Joint Undertaking, is to provide a framework of key enabling technologies for safe and autonomous drones. In particular, COMP4DRONES will leverage composability and modularity for customizable and trusted autonomous drones for civilian services. The project will take into account recent regulation developments in this area from EASA and, by extension, JARUS. One of the main rules directly linked to COMP4DRONES is “EASA has proposed a risk-based approach to settle a performance-based framework for regulation related to drones”. We will also consider the SESAR-JU studies concerning civilian drones and will adhere to the U-space approach and protocols given in section 2.2. [5]

The approach is to enable the drone industry to design and develop an embedded platform based on reusable qualified components. The project will provide an agile engineering environment to support the embedded platform development and customization. The project will mainly focus on the following specific objectives:

1) Objective O1: Ease the integration and customization of embedded drone systems.

2) Objective O2: Enable drones to take safe autonomous decisions.

3) Objective O3: Ensure the deployment of trusted communications.

4) Objective O4: Minimize the design and verification effort for complex drone applications.

5) Objective O5: Ensure sustainable impact and creation of an industry-driven community.

The success of the project and its objectives are directly related to the ability to perform the **five use-cases** (shown in **Error! Reference source not found.**), these use-cases include **eleven demonstrators** that have been used as an input to get the unified list of drone usages:

- **Transport:** Application of drones to optimize and enhance activities such as transport control, and infrastructure management (e.g., traffic status and incidents, monitoring and maintenance of road conditions).
- **Construction:** Smart application of drones for the digitalization of the state of a construction process, and analysis of underground constructions status.
- **Logistics:** Logistic using heterogeneous drones' fleet.
- **Surveillance and Inspection:** Drone and wheeled robotic systems are going to be used for inspection, surveillance, and rescue operations with enhanced navigation and autonomous abilities.
- **Agriculture:** Smart and precision agriculture using drones and rovers.

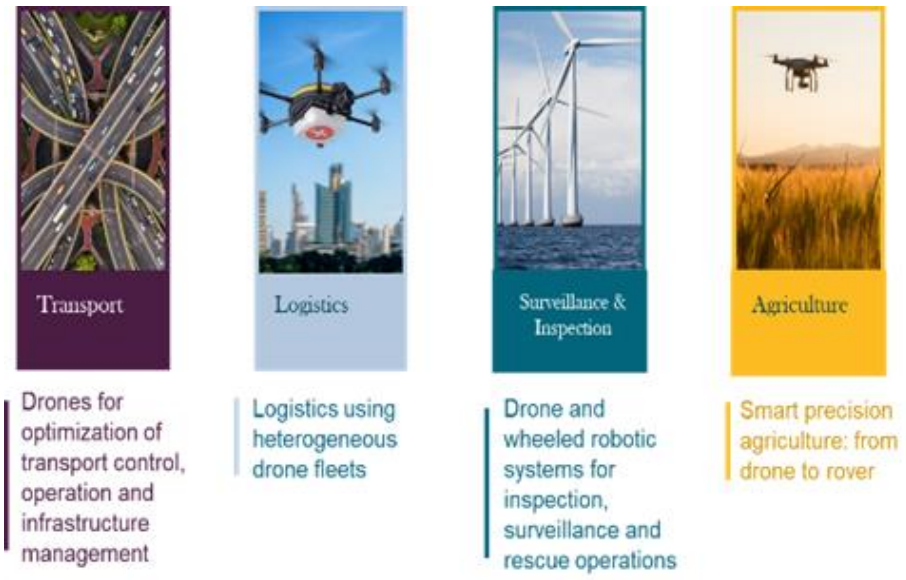


Figure 1 Use-cases driving the key enabling technologies

1.1.3 Objectives and scope of handbook

Today in Europe, most of the countries have developed their own UAV regulations. Intermediate ConOps Annex J – Current regulatory environment of Europe published by CORUS [6] summarize current UAS regulations of different European countries. Operators require demonstrations of safe operations in a test flight of proposed UAS operation before releasing drones into the airspace. As the high level of risks for the safety of goods and persons, the demonstrations are more complex. This is particularly true for the UAS operations performed in BVLOS (Beyond Visual Line of Sight) operational environment or in urban environments for delivery, public safety, and security in a long-term applications. We also need to ensure that professional drone operators shall operate safely in compliance with manned aviation and in a dynamically challenging environment. [5]

In recent years, national, European and international regulatory organizations have come together to streamline this situation. Many research projects have been initiated worldwide including in Europe. Many European projects have contributed important projects (like CORUS, SECOPS, IMPETUS, etc.) in drone research which have been basis for further advanced research.

Additionally, in today's scenarios there are several documents and resources available in this context including regulatory documents, manuals, procedures, and standards. In this context, it is very difficult for UAV stakeholders involved in drones operations to know about all information and all applicable and non-applicable requirements of regulations, policies and procedures.

The objectives of this handbook are to present the main expectations of the Authorities in terms of qualification and the main design rules in order to ease the process of obtaining of a "permit-to-fly" of drone's operations in European region. Another aim of this simplified documentation (handbook type) will be to allow value chain actors to have a macroscopic understanding of the regulatory framework and qualification process of drone systems through the study of civilian drone's regulation and its future trends. In order to achieve these objectives, this document will cover all aspects required for wide range of drone's operations in European region. [5]

In order to achieve these objectives, this handbook will start with exploring basic concepts in chapter 1, which are required to understand various topics covered in further chapters. In chapter 2, we cover the basic regulations to be followed by any stakeholders for any types of UAV operations in European airspace. We will also describe about evolution of UAV regulations along with major extracts of European UAV regulations. In anticipation of both an expansion of UAS traffic and its interaction with current manned traffic, drone's regulatory compliance handbook will describe U-Space regulations and operational concept from an ATM perspective. Furthermore, it will describe procedures to be adapted by operators and manufactures of drones in order to get "permit-to-fly" from competent authorities.

The content of this handbook is fully complementary to the EU regulations and all underlying process leading to that. Additionally, it will also propose recommendations, based on methodologies adapted by COMP4DRONES use cases operations, in order to get "permit-to-fly" for the types of operations not covered by EU regulations in today's scenarios.

Therefore, this handbook version is an effort to compile current common applicable regulations and standards at European level along with providing additional recommendations gained from COMP4DRONES project for the topics not covered by regulatory and standardization bodies in today's scenarios.

This UAS regulatory compliance handbook version 1 is a "living document". Major stakeholders of this version of handbook are COMP4DRONES project partners. It is requested by all COMP4DRONES partners specially WP (Work Package) 2, WP1 and WP6 to review the document and provide feedback to make this document more useful. We will use readers' comments, opinions and recommendations to update this version.

Additionally, in future, when more information from use cases will be available, we will enrich this document by adding major recommendations resulted by use cases outcomes. Therefore, we request cooperation of all stakeholders by providing their comments and sharing results from practical studies. This, together with lessons learnt during deployment and implementation, will lead to improvements in the maturity of the handbook and will act as a key document for UAS domain stakeholders.

1.1.4 Organization of handbook

This handbook is version 1 document. It has been divided into 5 chapters.

First chapter, Chapter-1 will describe foundations of this handbook. It involves objectives and scope of handbook, applicable regulations and standards, necessary definitions and acronyms to understand the concepts and applicable stakeholders.

Second chapter, Chapter-2 will describe European regulations, which are important for all stakeholders in order to get involved directly or indirectly into any UAS operations. These regulations include regulations for drones as well as U-space and UTM.

Furthermore, in Chapter-3, we have described procedure to be adapted by various types of UAS operators in order to apply and receive operational authorization. It includes responsibilities assigned by current applicable European regulation for operators, remote pilots and LUC operators. Therefore, chapter 4 will help operators to get macroscopic understanding of procedure for

operational authorization along with other important aspects such as responsibilities and accountabilities.

Next Chapter-4 analyse COMP4DRONES use cases. All 11 demonstrators of COMP4DRONES project have been analysed and the handbook have been used to get important information needed for each demonstrator. It will help readers to understand application of this handbook for their planning drones' operations. This chapter will also provide recommendations resulted from application of handbook and current regulations for all demonstrators. This analysis will be useful for drone's operators to understand practical implementation of recommendation provided by this handbook. However, it should be noted that all recommendations are tested and approved for COMP4DRONES uses case demonstrators. They are based on our analysis and implementation and should not be considered as legal or obligatory facts. Readers should consult their safety experts for application of our recommendation in their proposed operations.

Last Chapter- 5 is dedicated to bibliography and mentioned necessary details to get access of resources for further understanding of topics covered in this handbook.

1.1.5 References

In order to write this handbook, we have used several available National, European and International regulations and standards.

Regulations are legal acts that apply automatically and uniformly to all countries as soon as they enter into force by respective countries regulatory authorities. In case of European regulation, it will be applicable for all European countries without needing to be transposed into national law. They are binding in their entirety on all EU countries.

Standards will help operators, manufacturer, and other stakeholders to comply with regulations. They are not binding in nature, but regulatory authorities may recommend them as an acceptable means of compliance (AMC). This will help operators and manufacturers to understand the way to comply with regulations. However, stakeholders may choose **AMC** and guidance materials (**GM**) prescribed by other competent authorities of their country or any other means subject to successful demonstration of compliance with regulations. Overall objectives are to be complied with regulatory requirements asked in the regulations articles.

List of references and standards used for this handbook is summarized in this section. However, there are several other useful resources, which are described in bibliography section (4.3).

Below is a brief overview of relevant organizations which have been contributing significantly in UAV domains. Most of the references provided in this document are developed by those organizations.

1.1.6 Brief overview of relevant organizations

As shown in Figure 2, several actors are contributing to the development of regulations and standards in Europe:

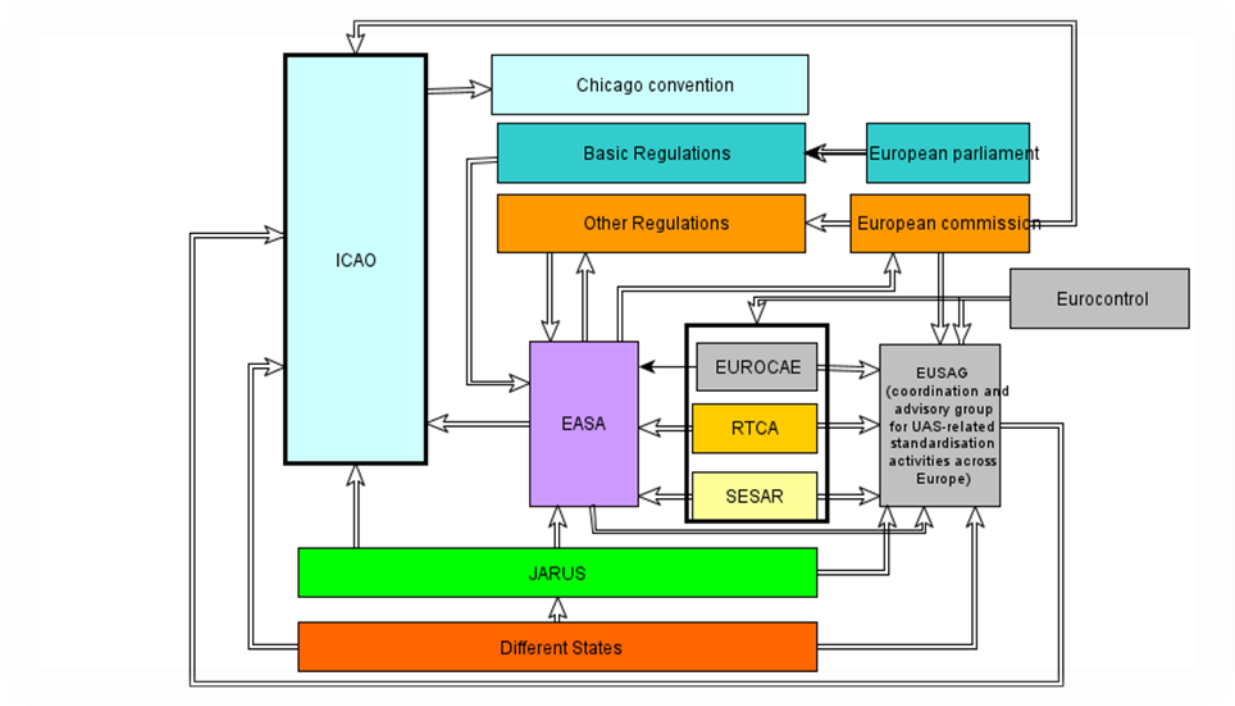


Figure 2 Relationship among UAS regulatory and standardization organization

1.1.6.1 ICAO

The International Civil Aviation Organization (ICAO) [7] is a United Nations (UN) specialized agency, established by States in 1944 to manage the administration and governance of the Convention on International Civil Aviation (Chicago Convention). ICAO works with the Convention's 193 Member States and industry groups to reach consensus on international civil aviation Standards and Recommended Practices (SARPs), Operational Manuals and Policies…in support of a safe, efficient, secure, economically sustainable, globally harmonized and environmentally responsible civil aviation sector**.** [7]

In 2007, ICAO agreed to adopt the term "unmanned aircraft systems (UAS)" for consistency with technical specifications being developed within and coordinated between RTCA Inc. and the European Organization for Civil Aviation Equipment (EUROCAE). An ICAO UAS Study Group (UASSG) was formed as a focal point to ensure global harmonization and interoperability. In 2009, the UASSG decided to focus its efforts on "remotely piloted aircraft systems (RPAS)," being of the view "that only unmanned aircraft that are remotely piloted could be integrated alongside manned aircraft in non-segregated airspace and at aerodromes." In 2014, an RPAS Panel was established to continue the work begun by the UASSG. The term unmanned aircraft (UA) may refer to a remotely piloted aircraft, an autonomous aircraft, or a model aircraft. As used within this roadmap, unless otherwise specified, UA, UAV, and UAS are synonymous with remotely piloted aircraft and RPAS, respectively. Further discussion of technical differences in UAS-related taxonomy, terminology, and definitions is beyond the scope of this document and is addressed in standards development.

1.1.6.2 EASA

The European Aviation Safety Agency (EASA) [3] is the centerpiece of the European Union's strategy for aviation safety. It was legally established in the year 2002. Its mission is to promote the highest common standards of safety and environmental protection in civil aviation. The Agency develops common safety and environmental rules at the European level. The mission of EASA are as follows:

1. Ensure the highest common level of safety protection for EU citizens.
2. Ensure the highest common level of environmental protection.
3. Single regulatory and certification process among Member States
4. Facilitate the internal aviation single market & create a level playing field.

5. Work with other international aviation organizations & regulators [3]

EASA's legal powers derive from its 'Basic Regulation'- (EU) 2018/1139 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 4 July 2018. EASA is an agency of the European Union (EU) with regulatory and executive tasks in the field of civilian aviation safety. It develops and publishes rules and regulations in the form of Basic Regulations, Implementation Regulations, Delegated Regulations, etc. (Refer to 0). It monitors the implementation of standards through inspections in the Member States and provides the necessary technical expertise, training and research. The Agency works hand in hand with ICAO, EUROCONTROL and the national authorities which continue to carry out many operational tasks, such as certification of individual aircraft or licensing of pilots. [3]

1.1.6.3 JARUS

Joint Authorities for Rulemaking on Unmanned Systems (JARUS) [2] is a group of experts gathering regulatory expertise from all around the world. At present, 61 countries, as well as the European Aviation Safety Agency (EASA) and EUROCONTROL, are contributing to the development of JARUS work products. The purpose of JARUS is "To recommend a single set of technical, safety and operational requirements for all aspects linked to the safe operation of the Remotely Piloted Aircraft Systems (RPAS)". This requires review and consideration of existing regulations and other material applicable to manned aircraft, the analysis of the specific tasks linked to RPAS and the drafting of material to cover the unique features of RPAS. [2]

1.1.6.4 EUROCONTROL

EUROCONTROL [8] is a pan-European, civil-military organization dedicated to supporting European aviation. It supports its Member States and stakeholders (including air navigation service providers, civil and military airspace users, airports and aircraft/equipment manufacturers) in a joint effort to make aviation in Europe harmonized, interoperable, safer, more efficient, more cost-effective and with a minimal environmental impact. [8]

1.1.6.5 EUROCAE

EUROCAE [9] is a non-profit organization formed at Lucerne, Switzerland, in 1963, as a European forum focusing on electronic equipment for air transport. It deals exclusively with aviation standardization, for both airborne and ground systems and equipment. Working in close coordination with its pending American organization, the Radio Technical Commission for Aeronautics (RTCA) [10], EUROCAE is the European leader in the development of worldwide recognized industry standards for aviation. It develops standards by industry/members for the industry needs that: Build upon the state-of-the-art expertise of its members and address the global aviation challenges; Are fit for purpose to be adopted internationally and Support the operational, development and regulatory processes. [9]

1.1.6.6 EUSAG

European UAS Standards Coordination Group (EUSAG) [11] is a joint coordination and advisory group established to coordinate the UAS-related standardization activities across Europe, essentially stemming from the EU regulations and EASA rulemaking initiatives. The EUSCG provides a link to bridge the European activities to those at international level. The EUSCG develops, monitors and maintains an overarching European UAS standardization Rolling Development Plan (RDP), based on the standardization roadmap developed by EASA and other organizations and inputs from the EUSCG members (including the military), and where needed other key actors in the aviation domain. It facilitates the sharing of work among the Regulators and Standard Developing Organizations (SDO's) thus avoiding the risk of overlapping developments and gaps. It also monitors all relevant processes, resource availability and other related risks and issues and provides a forum to manage specific issues and resolution of conflicts. Additionally, it advises the European Commission (EC) and other organizations on standardization matters. [11]

1.1.6.7 SESAR

Single European Sky ATM Research (SESAR) [4] is the mechanism which coordinates and concentrates all EU research and development (R&D) activities in ATM, pooling together a wealth

expert to develop and support the deployment of the new generation of ATM Systems, Services and Operations in Europe. Today, SESAR unites around 3,000 experts in Europe and beyond.

In 2007, the SESAR Joint Undertaking was set up in order to manage this large scale and truly international public-private partnership. As one of the most innovative infrastructure projects ever launched by the European Union, SESAR's role is to define, develop and deploy what is needed to increase ATM performance and build Europe's intelligent air transport system. [4]

1.1.7 Applicable regulations and standards

The following list covers the applicable regulations and standards for this handbook. Besides regulations and standards, some important baseline documents, which have contributed very important role in evolution of UAS regulations and standards, but may not be termed as standards or regulations, have been also listed. Although we have used all available and applicable references, it is to be noted that regulations and standards are still evolving. This handbook will be updated in further stages in case of progress of development of more references.

SN	Name of documents	Type of documents
1	**Commission Regulation (EU) No 748/2012** Initial Airworthiness [12]	Applicable manned aircrafts regulations
2	**Commission Regulation (EU) No 2015/640** Additional airworthiness specification. [13]	
3	**Commission Regulation (EU) No 1321/2014** Continuing Airworthiness**.** [14]	
	Commission Implementing Regulation (EU) No 923/2012 *Standardized European Rules Of The Air (Sera)* *This regulation lays down the common rules of the air and operational provisions regarding services and procedures in air navigation and amending Implementing Regulation (EU) No 1035/2011 and Regulations (EC) No 1265/2007, (EC) No 1794/2006, (EC) No 730/2006, (EC) No 1033/2006 and (EU) No 255/2010*	
4	***Basic regulations EU 2018/1139*** *common rules in the field of civil aviation [16]* *The principal objective of this Regulation is to establish and maintain a high uniform level of civil aviation safety in the Union. This Regulation further aims to:* *(a) Contribute to the wider Union aviation policy and to the improvement of the overall performance of the civil aviation sector;* *(b) facilitate, in the fields covered by this Regulation, the free movement of goods, persons, services and capital, providing a level playing field for all actors in the internal aviation market, and improve the competitiveness of the Union's aviation industry;* *(c) Contribute to a high, uniform level of environmental protection;* *(d) facilitate, in the fields covered by this Regulation, the movement of goods, services and personnel worldwide, by establishing appropriate cooperation with third countries and their aviation authorities, and by promoting the mutual acceptance of certificates and other relevant documents;* *(e) promote cost-efficiency, by, inter alia, avoiding duplication, and promoting effectiveness in regulatory, certification and oversight processes as well as an efficient use of related resources at Union and national level;* *(f) contribute, in the fields covered by this Regulation, to establishing and maintaining a high uniform level of civil aviation security;* *(g) assist Member States, in the fields covered by this Regulation, in exercising their rights and fulfilling their obligations under the Chicago Convention, by ensuring a common interpretation and a uniform and timely implementation of its provisions, as appropriate;*	

	(h) promote, worldwide, the views of the Union regarding civil aviation standards and civil aviation rules, by establishing appropriate cooperation with third countries and international organizations; *(i) promote research and innovation, inter alia, in regulatory, certification and oversight processes;* *(j) promote, in the fields covered by this Regulation, technical and operational interoperability and the sharing of administrative best practices;* *(k) support passenger confidence in a safe civil aviation.*	
5	***Commission implementing regulation EU 2019/947** Rules and procedure for the operation of Unmanned Aircraft**. [18]*** *This Regulation lays down detailed provisions for the operation of unmanned aircraft systems as well as for personnel, including remote pilots and organizations involved in those operations.*	
6	***Delegated regulation EU 2019/945** on unmanned aircraft systems and on third country operators of unmanned aircraft systems**. [17]*** *This Regulation lays down the requirements for the design and manufacture of unmanned aircraft systems ('UAS') intended to be operated under the rules and conditions defined in Implementing Regulation (EU) 2019/947 and of remote identification add-ons.* *It also defines the type of UAS whose design, production and maintenance shall be subject to certification.* *It also establishes rules on making UAS intended for use in the 'open' category and remote identification add-ons available on the market and on their free movement in the Union.* *This Regulation also lays down rules for third-country UAS operators, when they conduct a UAS operation pursuant to Implementing Regulation (EU) 2019/947 within the single European sky airspace.*	
7	**Commission Implementing Regulation (EU) 2020/639** [19] of 12 May 2020 amending Implementing Regulation (EU) 2019/947 as regards standard scenarios for operations executed in or beyond the visual line of sight	
8	**Commission Implementing Regulation (EU) 2020/746** [20] of 4 June 2020 amending Implementing Regulation (EU) 2019/947 as regards postponing dates of application of certain measures in the context of the COVID-19 pandemic	
9	**Commission implementing regulation EU 2019/1058** of 27 April 2020 amending Delegated Regulation (EU) 2019/945 as regards the introduction of two new unmanned aircraft systems classes	
10	**Notice Of Proposed Amendment NPA 2020-07** Unmanned Aircraft System Beyond Visual Line Operations over Populated Areas or Assemblies Of People in the 'Specific' Category	
11	**Opinion 01/2020** High-level regulatory framework for the U-space *This future Regulation proposed by this Opinion aims to create and to harmonize the necessary conditions for manned and unmanned aircraft to operate safely in the U-space airspace, to prevent collisions between aircraft and to mitigate the air and ground risks. Therefore, the U-space regulatory framework, supported by clear and simple rules, should permit safe aircraft operations in all areas and for all types of unmanned operations.* *This Opinion proposes an effective and enforceable regulatory framework to support and enable operational, technical and business developments, and provide fair access to all airspace users, so that the market can drive the delivery of the U-space services to cater for airspace users' needs.* *This Opinion is, therefore, a first regulatory step to allow immediate implementation of the U-space after the entry into force of the Regulation and to let the unmanned aircraft systems and U-space technologies*	Future U-Space / UTM Services Regulations (Under publication)

12	**EASA Part 21** Rules for Airworthiness and Environmental Certification (Regulation (EU) No 748/2012)**.** [37]	AMC and GM to manned aircraft regulation
13	***EASA E.Y013-01*** *Policy statement airworthiness certification of UAS. [15]* *This policy establishes general principles for type-certification (including environmental protection) of an Unmanned Aircraft System (UAS). The policy complies with the current provisions of The Basic Regulation, Regulation (EC) No 1702/2003 and all Management Board Decisions relating to product certification. Where existing certification procedures are at variance to this policy, the policy will take precedence and certification procedures will be amended accordingly. This policy shall be used by the Agency's staff when certificating UAS. The policy represents a first step in the development of comprehensive civil UAS regulation and may be regarded as providing guidance to Part--21 Subpart B of Regulation (EC) No 1702/2003: Type-certificates and restricted type-certificates. This policy statement is therefore an interim solution to aid acceptance and standardization of UAS certification procedures and will be replaced in due course by AMC and guidance material to Part-21 when more experience has been gained.*	AMC and GM to Implementing and delegated UAS regulations
14	***ED Decision 2019/021/R [38]*** The Acceptable Means of Compliance and Guidance Material to the Commission Implementing Regulation (EU) 2019/947 are those laid down in Annexes I and II to this Decision: • **Annex I to ED Decision 2019/021/R** **Acceptable Means of Compliance (AMC) and Guidance Material (GM) to Commission implementing Regulation (EU) 2019/947**, Issue 1 of 9 October 2019 *The purpose of this Annex is to propose the SORA methodology to be used as an acceptable means to demonstrate compliance with Article 11 of the UAS Regulation, that is to evaluate the risks and determine the acceptability of a proposed operation of a UAS within the 'specific' category* • **Annex II to ED Decision 2019/021/R** **Acceptable Means of Compliance (AMC) and Guidance Material (GM) to Part-UAS UAS operations in the 'open' and 'specific' categories,** Issue 1 of 9 October 2019 ***Note:*** *See Amendment 1 as per* ***ED Decision 2019/022/R***	
15	***ED Decision 2020/022/R [38]*** Amendment 1 to the Acceptable Means of Compliance and Guidance Material to Commission Implementing Regulation (EU) 2019/947 and to the Annex (Part-UAS) thereto 'AMC and GM to Commission Implementing Regulation (EU) 2019/947 — Issue 1, Amendment 1' 'AMC and GM to Part-UAS — Issue 1, Amendment 1' • **Annex I to ED Decision 2020/022/R** **'Acceptable Means of Compliance (AMC) and Guidance Material (GM) to Commission Implementing Regulation (EU) 2019/947 — Issue 1, Amendment 1'** • **Annex II to ED Decision 2020/022/R 'Acceptable Means of Compliance (AMC) and Guidance Material (GM) to the Annex (Part-UAS) to Regulation (EU) 2019/947 — Issue 1, Amendment 1'** ***Note:*** *The objective of this Decision is to update the Acceptable Means of Compliance (AMC) and Guidance Material (GM) to Commission Implementing Regulation (EU) 2019/947 (the 'UAS Regulation') and to the Annex (Part-UAS) thereto, as published with Decision 2019/021/R. The amendments are expected to increase safety, improve harmonization among EASA MSs, and*	

	facilitate societal acceptance of UAS operations in the 'specific' category. The European Union Aviation Safety Agency (EASA) developed this Decision under rulemaking task (RMT).0730, which is divided into the following two subtasks: *— Subtask 1a clarifies the conditions under which unmanned aircraft system (UAS) operations over populated areas and assemblies of people can be authorized in the 'specific' category; and* *— Subtask 1b ensures the interoperability of the national registration systems, which are established and maintained by the EASA Member States (MSs), for UAS operators and for certified UAS that require registration, introduces new predefined risk assessments (PDRAs), and improves the existing PDRA.*	
16	**SC Light-UAS 01, Special Condition for Light Unmanned Aircraft Systems - Medium Risk, Issue 1** ***Applicability:*** *This SC is applicable to UAS: - Not intended to transport Humans - Operated with intervention of the remote pilot or autonomous 1 - With MTOM up to 600 Kg - Operated in the specific category of operations, medium and high risk, or in the certified category of operations.* This Special Condition addresses airworthiness specifications for UA, not the authorization of operations in the specific category. Nevertheless, as defined by Commission Implementing SPECIAL CONDITION Light Unmanned Aircraft Systems Doc. No: SC Light-UAS 01 Issue: 1 Date: 20.07.2020 ii Regulation 2019/947, some operations in the Specific category may be authorized by the NAA only if the UAS operator demonstrates that he/she is operating a UA certified by EASA. EASA has adopted AMC which provide further guidance on when the Regulation requires the certification of the UA	

Table 1 Applicable Regulations

1.1.8 Definitions

- **Unmanned aircraft system ('UAS')** means an unmanned aircraft and the equipment to control it remotely;
- **Unmanned aircraft system operator ('UAS operator')** means any legal or natural person operating or intending to operate one or more UAS;
- **Assemblies of people** means gatherings where persons are unable to move away due to the density of the people present;
- **Robustness** means the property of mitigation measures resulting from combining the safety gain provided by the mitigation measures and the level of assurance and integrity that the safety gain has been achieved;
- **Standard scenario** means a type of UAS operation in the 'specific' category, as defined in Appendix 1 of the Annex of Implementing Regulation (EU) 2019/947, for which a precise list of mitigating measures has been identified in such a way that the competent authority can be satisfied with declarations in which operators declare that they will apply the mitigating measures when executing this type of operation;
- **Visual line of sight operation ('VLOS')** means a type of UAS operation in which, the remote pilot is able to maintain continuous unaided visual contact with the unmanned aircraft, allowing the remote pilot to control the flight path of the unmanned aircraft in relation to other aircraft, people and obstacles for the purpose of avoiding collisions;
- **Beyond visual line of sight operation ('BVLOS')** means a type of UAS operation which is not conducted in VLOS;
- **Light UAS operator certificate ('LUC')** means a certificate issued to a UAS operator by a competent authority;
- **Geo-awareness** means a function that, based on the data provided by Member States, detects a potential breach of airspace limitations and alerts the remote pilots so that they can take immediate and effective action to prevent that breach;
- **Autonomous operation** means an operation during which an unmanned aircraft operates without the remote pilot being able to intervene:

- **Uninvolved persons** mean persons who are not participating in the UAS operation or who are not aware of the instructions and safety precautions given by the UAS operator;
- **Controlled ground area** means the ground area where the UAS is operated and within which the UAS operator can ensure that only involved persons are present;
- **Maximum take-off mass ('MTOM')** means the maximum Unmanned Aircraft mass, including payload and fuel, as defined by the manufacturer or the builder, at which the Unmanned Aircraft can be operated;
- **CE marking** means a marking by which the manufacturer indicates that the product is in conformity with the applicable requirements set out in Union harmonization legislation providing for its affixing;
- **Manufacturer** means any natural or legal person who manufactures a product or has a product designed or manufactured, and markets that product under their name or trademark;
- **Distributor** means any natural or legal person in the supply chain, other than the manufacturer or the importer, who makes a product available on the market.

1.1.9 Acronyms

AMC	Acceptable Means of Compliance
ARC	Air Risk Class
ATC	Air Traffic Control
ATM	Air Traffic Management
ATS	Air Traffic Services
BVLOS	Beyond Visual Line of Sight
CIS	Common Information Services
CONOPS	Concept of Operations
CORUS	Concept of Operations for U-space
CRD	Comments Response Document
CS	Certification Specifications
DAA	Detect and Avoid
DEMO	Demonstrator
DR	Delegated Regulations
EASA	European Aviation Safety Agency
EDZm	Exclusive drone zones for passenger operations
EDZp	Exclusive drone zones for planned drone operations
EDZu	Exclusive drone zones for unplanned drone operations
EU	European Union
EUROCAE	European Organization for Civil Aviation Equipment
FH	flight hour
FL	Flight level
GM	Guidance Material
GRC	Ground Risk Class
HFR	High-level Flight Rules
JARUS	Joint Authorities of Rulemaking on Unmanned Systems
ICAO	International Civil Aviation Organization
IFR	Instrument Flight Rule
IR	Implemented Regulations
LDZ	Limited Drones Zones
LFR	Low-level flight rules
LUC MRO	Light UAS operator certificate Maintenance Repair & Overhaul
MTOM	Maximum Take-off Mass
NA	Not applicable
NDZ	No Drones Zones
NPA	Notification for proposed amendments

OSO	Operational Safety Objectives
PANS	Procedure for Air Navigation Services
PDRA	Predefined Risk Assessment
RPA	Remotely Piloted Aircraft
RPAS	Remotely piloted aircraft system
RTCA	Radio Technical Commission for Aeronautics
SAIL	Specific Assurance and Integrity Level
SARPS	Standards and Recommended Practices
SERA	Standardized European Rules of the Air
SESAR	Single European sky ATM Research
SO	Safety Objectives
SORA	Specific Operations Risk Assessment, Version-2
STS	Standard Scenarios
UAS	Unmanned Aircraft System
UAV	Unmanned Aircraft Vehicle
UC	Use case
USSP	U- Space Service Provider
UTM	U-space Traffic Management
VFR	Visible Flight Rules
VLL	Very Low Level
VLOS	Visible Line of sight

1.2 Connection between manned and unmanned aviation

1.2.1 Introduction

This section will summarize the connection between manned and unmanned aviation. The objective is to inform readers about origin of the present requirements for association between two types of aviation. Additionally, efforts are made to summarize current scenarios of operation along with introduction of some important terminologies. Detailed of U-Space regulations are covered in 0 of this handbook.

1.2.2 Need for separate unmanned regulations and standards

Since few years, unmanned aircrafts are increasingly becoming a part of our day-to-day lives. This industry has huge potential to create a big economic impact in the world on the market. However, the UAS industries involved larger-scale and several small-scale suppliers, operators and manufacturers.

Manned aviation has more than hundred years of history for what it is today. It has matured technologies, operational procedures, regulations and standards. It has gained wide public acceptance and have been proved as the one of the safest modes of transportation in the world. Manned aviation is considered acceptably safe due to the contributions of many factors such as initial airworthiness (design, manufacturing quality), continuing airworthiness (maintenance) and operational approvals, the ATC system, safety nets, presence of qualified and trained pilots, cockpit automation, etc., together with many years of experience and the diligent application of lessons learned from safety events. These factors are now challenged by the introduction of a new type of airspace users, with a large number of flights, of different types and sizes, and with performance envelopes greatly different from those for which today's air traffic procedures were designed.

Although, manned aviation is at mature level, but due to very strict regulations, higher manufacturing cost and higher operation and maintenance cost, the domain has less competitors in the world than other domains such as land transportation.

In order to take full-advantage of future economic gain by UAS, provide more competition by low incurred cost and to provide higher quality of services, UAS domain need flexible regulations and less strict regulations than manned aviation. The standardizations and regulations strictness may vary for unmanned aviation based on types of services provided by operator. For instance, light UAV

with no human on-board requires less strict regulations than UAV carrying people on-board. Additionally, the worlds of manned and unmanned aircraft must be integrated in a safe and efficient way since both types of aircraft will use the same airspace. UAS-ATM integration poses many challenges. The absence of a pilot on-board the aircraft is biggest challenge. It means that technical solutions and procedures will have to be developed to integrate the aircraft into non-segregated airspace. This envisages into development of technologies such as “Detect and Avoid” to replace “See and Avoid” and/or “Remain Well Clear”. It is to be noted that necessary technologies innovations, regulations, procedure, polices and standards shall be aligned with ICAO and EU requirements.

In UAS-ATM operational concept [22], ICAO has specified **four main requirements** for UAS-ATM integration:

- The integration of UAS shall not imply a significant impact on current users of the airspace;
- UAS shall comply with the existing and future regulations and procedures laid out for manned aviation;
- UAS integration shall not compromise existing aviation safety levels nor increase risk more than an equivalent increase in manned aviation would.
- UAS operations shall be conducted in the same way as those of manned aircraft and shall be seen as equivalent by ATC and other airspace users.

In order to maintain current level of safety for manned aviation along with easily integration of drones into current aviation environment with huge business opportunities in future, there are need for separate regulations and standards for UAS. ICAO and EASA along with several industries have worked to develop necessary procedure, requirements and regulations. Some useful concepts related to UAS operations are described in following sections.

1.2.3 UAV operational level

EASA along with several European industries is working to integrate UAS into manned airspace. The objectives are also to provide efficient and safe unmanned aircraft operation, which required introduction of several concepts such as permit-to-fly, design approval, organization approval more likely manned aviation. Several documents have been published towards these steps.

First important concept for allowing UAV into airspace is to know the operational level which may be potential candidate for these new entrants.

In manned aviation any aircraft will be followed by any of two types of rules. These are VFR (Visible Flight Rules) and IFR (Instrument Flight Rules). These specify the airspaces in which, and the meteorological conditions under which, flights may take place under VFR and the conditions and equipment required for flying under IFR. ICAO Annex 11 “Air Traffic Services” has classified airspaces into seven types named as class A to class G airspace. The classification is based on types of services provided and types of traffic such as IFR and/or VFR flights are allowed in that airspace. ICAO Annex 2 “Rules of the air” defined minimum level for VFR/IFR flight operations.

For VFR flights, unless authorized by the appropriate ATS (Air Traffic Services) authority, VFR flights shall not be operated above FL 200. Except when necessary, for take-off or landing, or except by permission from the appropriate authority, a VFR flight shall not be flown over the congested areas of cities, towns or settlements or over an open-air assembly of persons at a height less than 300 m (1 000 ft.) above the highest obstacle within a radius of 600 m from the aircraft or elsewhere at a height less than 150 m (500 ft.) above the ground or water.

Except when necessary, for take-off or landing, or except when specifically authorized by the appropriate authority, an IFR flight shall be flown at a level which is not below the minimum flight altitude established by the State whose territory is overflown. In case, where no such minimum flight altitude has been established, IFR flight shall not be flown over high terrain or in mountainous areas, at a level which is at least 600 m (2 000 ft.) above the highest obstacle $located within 8 km of the estimated position of the aircraft or at a level which is at least 300 m (1 000 ft.) above the highest obstacle located within 8 km of the estimated position of the aircraft. [39]

ICAO has started recently rules making task for UAS. UAS are described as RPAS (Remotely Piloted Aircraft System) in ICAO terminologies. RPA (Remotely piloted aircraft) are one type of unmanned aircraft. All unmanned aircraft, whether remotely piloted, fully autonomous or combinations thereof, are subject to the provisions of Article 8 of the *Convention on International Civil Aviation* (Doc 7300), signed at Chicago on 7 December 1944 and amended by the ICAO Assembly. The goal of ICAO in addressing RPAS is to provide an international regulatory framework through Standards and Recommended Practices (SARPs), with supporting Procedures for Air Navigation Services (PANS) and guidance material, to underpin routine operation of RPAS throughout the world in a safe, harmonized and seamless manner comparable to that of manned operations. Most importantly, introduction of remotely piloted aircraft into non-segregated airspace and at aerodromes should in no way increase safety risks to manned aircraft. [29]

ICAO does not specify minimum level allowed for RPA. However, it clearly states that “In order for RPAS to be widely accepted, they will have to be integrated into the existing aviation system without negatively affecting manned aviation (e.g., safety or capacity reduction). If this cannot be achieved (e.g., due to intrinsic limitations of RPAS design), the RPA may be accommodated by being restricted to specific conditions or areas (e.g., visual line-of-sight (VLOS), segregated airspace or away from heavily populated areas). [29]

To attain a level of harmonization within the European Union, EUROCONTROL has been mandated to produce Standardized European Rules of the Air (SERA). SERA (Standardized European Rules of the Air (Commission Implementing Regulation (EU) No 923/2012)) is a European regulation laying down the common rules of the air and operational provisions regarding services and procedures in air navigation. The SERA transposes the ICAO Rules of the air into a European implementing regulation. This has since been amended to include standardized rules based on the other ICAO documents and other national rules.

According to the Standardized European Rules of the Air (SERA), 150m/500ft is the lowest available VFR altitude (300m/1,000ft above towns), and thus creates a possible boundary between small UAS and manned aircraft. [22]

There are currently no specific rules governing UAS other than those that govern all aircraft. “UAS ATM integration operational concept” [22] proposes two new sets of flight rule-based operation: low-level flight rules **(LFR),** below the normal minimum VFR height of 500ft in what is termed very low-level airspace **(VLL)**, and high-level flight rules (HFR), above FL600. Many VFR flights that have a good justification are authorized below 500ft AGL by competent authorities. Large numbers of small, undetectable UAS coexisting with manned operations below this altitude poses a safety challenge. Unmanned aircraft will not only be encountered at low altitudes but also in the higher altitude bands (i.e., above FL 600), normally used for specific military aircraft.

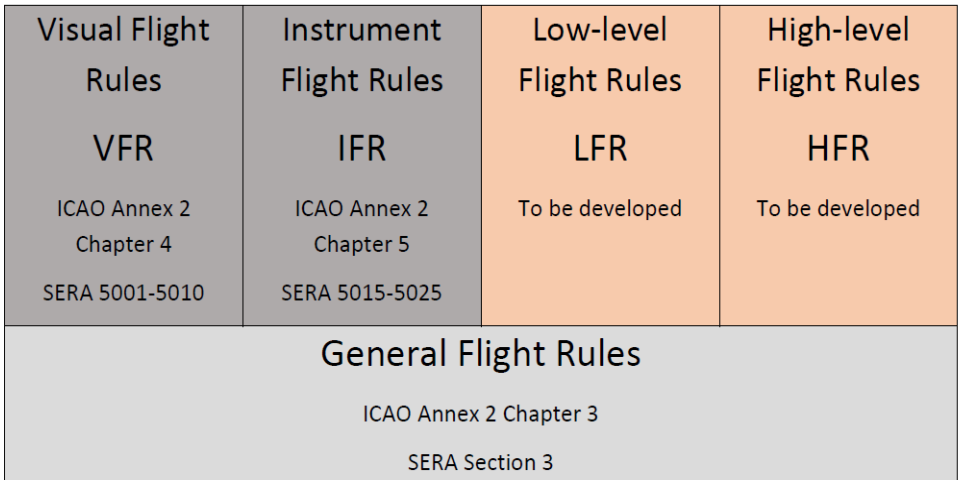


Figure 3 Proposed new flight rules by Eurocontrol

Therefore, there is a strong need to develop LFR and HFR in order to accommodate both types of traffic simultaneously. It is to be noted that LFR and HFR rules are only proposal given by Eurocontrol. It is not available today.

Besides Eurocontrol document “UAS-ATM integration operational concept”, there are several other projects such as CORUS, (Concept of Operations (ConOps) for U-space describes from a users’ perspective how operations should occur in Very Low Level (VLL) airspace, supported by U-space) and several SESAR JU projects, which support VLL operations concepts. All projects of SESAR JU and CORUS have been defined in 2.2.3.

Therefore, till the rules are being developed by competent organizations, it proposed by UAS-ATM integration concept to consider the airspace below 150m to be "drone airspace" with all other traffic having to adjust and this airspace has been termed as VLL. Since CORUS and other SESAR JU projects have also performed all operations below 500 ft., it is assumed that VLL level will be termed as operations below 500 ft.

1.2.4 UAV level considered in this handbook

As nearly all states have filed exemptions to operate below 500ft and there is no harmonization of this, the case for additional flight rules in VLL is very strong. EASA is developing harmonized rules for UAS in the EU including specific rules for small UAS**.** Supporting EASA-proposed rules with specific rules for VLL will improve European standardization and facilitate the development of UAS operations. If these rules are not supported by harmonized rules of the air, it will become very difficult to implement them in environments where the airspace is not organized in a standard way to take all users and all needs (including, for example, emergencies) into account. As per available regulations published by EASA, it is concluded that most of the operations defined by EASA in three categories of drones operations are limited to a maximum altitude of 500 ft.

1.2.5 Important terminologies for UAS

Some important concepts frequently used by UAS stakeholders are summarized in following section. For detailed information, it is advised to follow UAS-ATM integration operational concepts [22].

1.2.5.1 UAS Airspace Structures

Based on the outcome of the airspace assessment, specific or dynamic UAS structures can be used to organize traffic. Such specific UAS structures could easily be created under the legal umbrella of airspace restrictions existing in the ICAO framework (danger, restricted, prohibited). In UAS-ATM operational concept [22], the general term [22] used to define these areas is “drone zones”. These include, but are not limited to:

1. No drone zones (NDZ): UAS are totally prohibited in this volume unless granted special authorization (e.g., government UAS)
2. Limited drone zones (LDZ): UAS are allowed if they meet specific requirements and/or do not exceed a defined number in this volume
3. Exclusive drone zones for unplanned drone operations (EDZu): all other traffic is excluded from these volumes, which are reserved for unplanned UAS VLOS operations.
4. Exclusive drone zones for planned drone operations (EDZp): all other traffic is excluded from these volumes, which are reserved for planned UAS operations.
5. Exclusive drone zones for passenger operations (EDZm): all other traffic is excluded from these volumes, which are reserved for urban mobility UAS operations (DPAVs).
6. Dedicated UAS routes: Waypoints dedicated to UAS traffic create a pan-European network of UAS routes designed to support segregation of manned traffic from unmanned traffic, thus increasing the level of safety in the airspace for heavy traffic. [22]

1.2.5.2 Geo-awareness

Geo-awareness is a function that can detect a potential breach of airspace limits and provides the remote pilot with sufficient information and an appropriate alert to allow them to take effective action to prevent that breach. It helps to manage information related to UAS airspace restriction and also

help in sharing information with manned traffic. It provides additional protection to infrastructure, people and other traffic. It may consist of:

Geo-caging: aims to prevent an RPAS from flying outside of a predetermined volume (e.g., a hangar at an aerodrome when doing a fuselage inspection)

Geo-exclusion: aims to prevent a particular UA or a set of UAs from flying into a predetermined volume (e.g., protection bubble around electromagnetic source to avoid interference due to masking or damage to the UAS due to electrical overload)

1.2.5.3 UTM AREA

The UTM area is expected to be below 500ft AGL, or 1000ft above the highest obstacle in urban areas - excluding areas under the responsibility of ATS - or higher if authorized.

1.2.6 Summary

Unmanned aviation is a new concept. Since UAs will operate in same airspace as manned aircraft, it needs high integration with manned aviation. Most concepts for unmanned aviation have evolved from manned aviation. Therefore, there are several commonalities. Despite several commonalities between unmanned and manned aviation, unmanned aviation needed several new concepts and technologies. New technologies shall be able to integrate in current manned aviation environment. Additionally, new operations shall not pose additional threats for manned operations. After taking into account all consideration and available recommendations by various regulatory and standardization authorities, it has been proposed to initially standardize and regularize operation of unmanned aircraft at VLL. Since COMP4DRONES will use existing outcomes provided by various European projects including CORUS and SESAR JU projects, it will be an opportunity for COMP4DRONES to provide additional recommendations and introduction of new concepts. Eventually with introduction of new concepts, technologies by COMP4DRONES and other projects along with development of flight rules by regulatory authorizes, the scope of unmanned traffic will be extended to further level of airspace.

1.3 Stakeholder analysis

1.3.1 Introduction

In any project, stakeholders are people, groups or organization that could impact or be impacted by the project. In order to define stakeholders of the handbook, it was first needed to identify all stakeholders of UAS and U-space domain. Some parts of this task were already performed by CORUS group in definition of ConOps documents [23]. CORUS performed this task of stakeholder identification for U-space domain only. However, this concept may be extended to UAS domain too. It is because both are having same affected people or organization. U-space stakeholders and UAS stakeholders are an individual, team, or organization with interest in, or concerns relative to, any fields of UAS or the U-space. Stakeholder Role is representing an aspect of a person or organization that enables them to fulfil a particular function.

The U-space stakeholders and UAS stakeholders can be classified in the same way as it is done in CORUS project. These can be classified as:

- Operational stakeholder, who are actively consuming and/or providing services of U-space and who are manufacturing, operating or providing services such as maintenance of UAS.
- Other stakeholders, which are not operational stakeholders. These stakeholders are not taken into consideration in this identification task.

Following are major operational stakeholders of UAS domain.

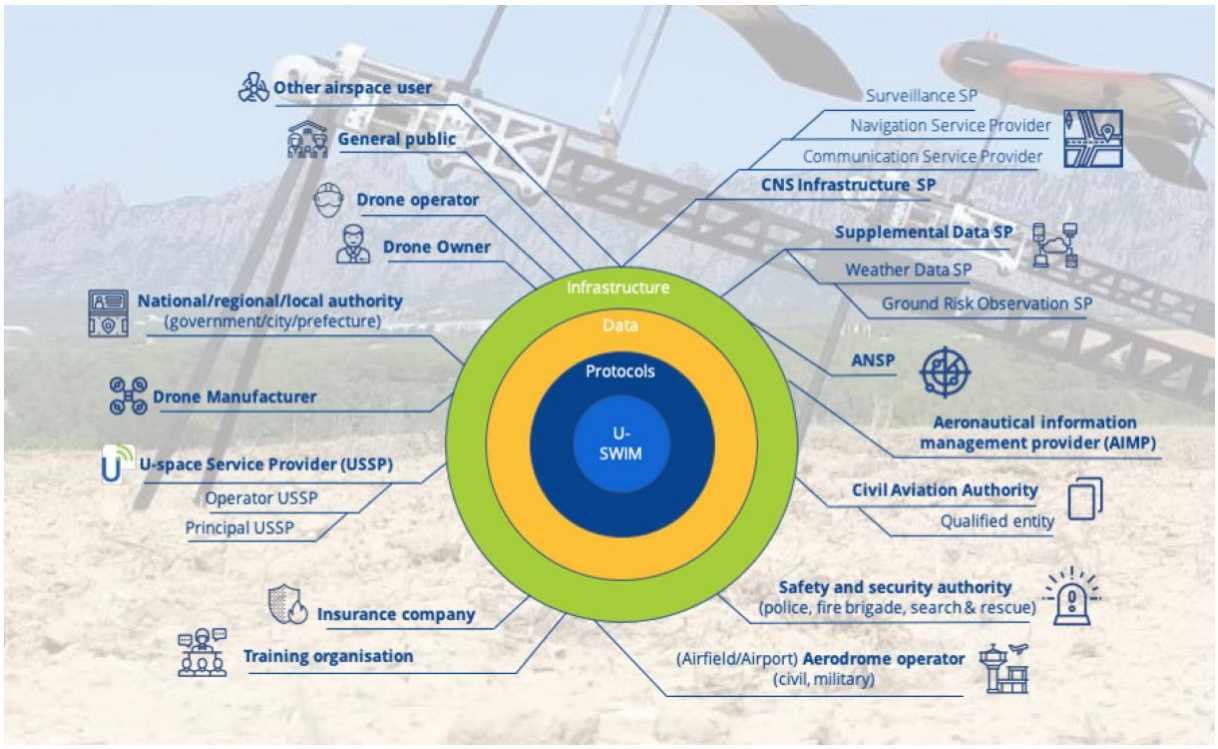


Figure 4 Stakeholders identification from CORUS ConOps

The list became reference for listing all stakeholders of this handbook. Next section will identify the stakeholders of this handbook.

1.3.1 Stakeholder identification

As per the definition of COMP4DRONES deliverable D2.5 objectives, the stakeholders are identified and described in the document. Stakeholders in context of this handbook are the person for whom this handbook may be beneficial. This includes manufacturers, pilots, and operators of UAS; manufacturers of UTM equipment and apps; etc. However, this is a high-level document and as such may be read by anyone needing to understand the general operational concept behind integrating UAS into the airspace, evolution of regulations and standards in Europe in the domains of UAS, guidelines used by UAS operators to obtain permit to fly, and criteria adapted by UAS manufacturer in order to get certification of system by competent authority.

1.4 Introduction to European UAS Regulations

1.4.1 Introduction

Regulations are the way to provide harmonization and interoperability of any types of operations. In order to provide globalized and harmonized operations, aviation has been operated in strictly regulated domain for several years. Which has made aviation domain as one of the safest modes of transportation in the world.

Addition of new entrants (UAVs) into safe aviation environment may create hazards and risk for manned aviation. Although UAVs are termed as new entrant, they are not new. UAVs are flying for limited reasons (security, military, observations, etc.) for several years in various countries and they were governed by individual Member States (MS) regulations. Within last few years the scope of drones' usage is largely growing/multiplying its domain activities as potential business opportunities for European industries. Therefore, these opportunities require the intervention of higher authorities to have the legal authorizations & achieve multiple objectives, growth of business of UAVs, with safe integration of UAS & ATM to harmonize the operations. Now, with EU active participation, its MS continuous dedication regularize integration of these new entrants into manned airspace.

The new regulations published by EU; many European industry players find it difficult to obtain enough information on available regulations. This chapter is an effort to summarize major regulations clauses posed by European and international regulations. This handbook is limited to European operations and therefore will cover applicable regulations for European geographical area only. Firstly, we have described common regulations, which are applicable to any domain and are related to fundamental rights of European citizens and common issues for other domains. Further section is divided into two main sub-domain of UAS: UAS and U-space. For each sub-domains, we have started with description about a brief history of evolution of regulation. Later, we shall summarize the current updates on the regulatory requirements. Finally, we have provided takeaways for two major stakeholders of this handbook: operators and manufacturers.

Further version of this handbook will be upgraded with more stakeholders inclusion along with corresponding requirements. Feedback of COMP4DRONES WP (work package) leaders and partners will help to improve this section.

1.4.2 European UAS Regulations Synthesis

1.4.2.1 Introduction

Regulations are legal acts that apply automatically and uniformly to all EU countries as soon as they enter into force, without needing to be transposed into national law. They are binding in their entirety on all EU countries. In today's scenarios, each European country has its own regulation for UAS operating at VLL. This has created problems for UAS manufacturer, operator and service providers. In response of this issue, EASA has published some European regulations, which will repeal all other national regulations. This section will discuss about the evolution of UAS regulations in Europe along with current applicable European regulations. Since regulations are still evolving, this chapter will be updated time to time before final publication of this handbook. Some common terminologies used to define different types of documents published by European regulatory authorities are defined in the next section.

1.4.2.2 Different regulatory documents published by EU regulatory authorities

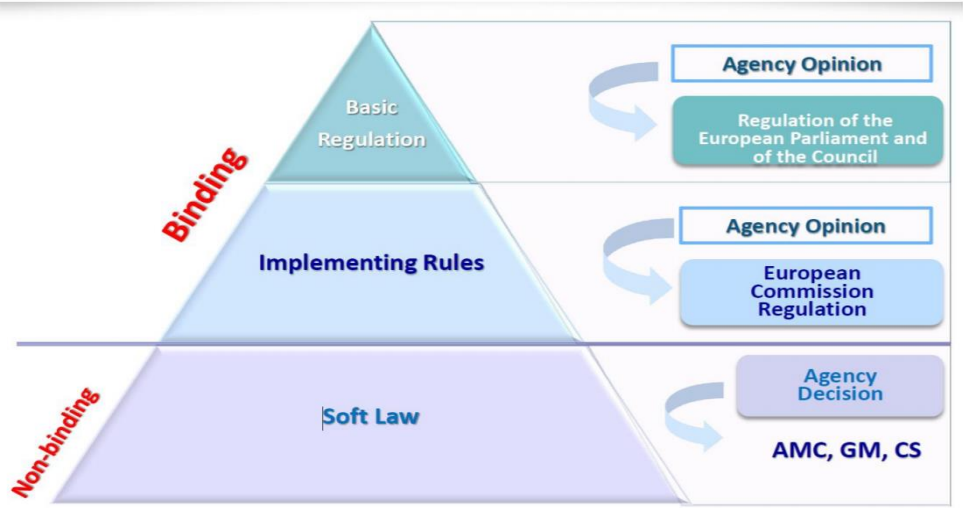


Figure 5 EU regulatory documents [46]

1. **Basic regulations**

The Basic Regulation is binding in its entirety and directly applicable in all Member States. The main objective of the Basic Regulation is to "establish and maintain a high uniform level of civil aviation safety in the Union

2. **Implementing regulations (IR)**

Implementing regulations are binding in their entirety and used to specify a high and uniform level of safety and uniform conformity and compliance. They detail how to comply with the essential requirements of the Basic Regulation and regulate the subject matters included in its scope. The IRs are adopted by the European Commission in the form of Regulations. EU law is directly applicable (full part of Member States' legal order).

3. **Delegated regulations (DR)**

This legally binding act of the European Union is directly applicable in all member states of the European Union. The delegated regulation is similar to national legislation in terms of the impact and direct effect it generates. Delegated regulations are limited in what they can set out to regulate. Delegated regulations can be used to supplement existing legislation on non-essential parts or amend specific and non-essential elements of a legislative act. [45]

4. **Opinion**

An 'opinion' is an instrument that allows the EU institutions to make a statement, without imposing any legal obligation on the subject of the opinion. An opinion has no binding force. [46]

5. **Notification for proposed amendments (NPA)**

This is used to propose any amendments in published documents. Comments are welcomed by the Agency on the following Notices of Proposed Amendments (NPAs). A Member State can request - not later than two weeks prior the expiring of the consultation deadline - an extension of the consultation period for translating the NPA at its own expenses. Such an extension may not exceed the time of 1 month in order to avoid delays in the rulemaking process.

6. **Comment response document (CRD)**

It is compilation of all comments received from member states on NPA.

7. **Acceptable Means of Compliance (AMC)**

AMC are non-binding. The AMC serves as means by which the requirements contained in the Basic Regulation and the IRs can be met. The **AMC's are non-binding standards** that are adopted by EASA to establish compliance with the Basic Regulations (BR) and Implementing Regulations (IR), by which a requirement of an implementing rule can be met. Satisfactory demonstration of compliance using a published AMC shall provide for presumption of compliance with the related requirement; it is a way to facilitate certification tasks for the applicant and the competent authority. However, NAAs and organizations may decide to show compliance with the requirements using other means.

8. **Alternative Means of Compliance (AltMoC)**

AltMoC are those that propose an alternative to an existing AMC. Those AltMoC proposals must be accompanied by evidence of their ability to meet the intent of the IR. Use of an existing AMC gives the user the benefit of compliance with the IR.

9. **Certification Specifications (CS)**

CS are non-binding technical standards adopted by EASA to meet the essential requirements of the Basic Regulation. CSs are used to establish the certification basis.

10. **Special conditions (SC)**

Special Conditions (SC) are non-binding special detailed technical specifications, if the certification specifications established by the EASA and are not available or not adequate or inappropriate to ensure conformity with the essential requirements of the basic regulations. SCs are like CSs but become binding in future.

11. **Guidance Material (GM)**

GM is non-binding explanatory and interpretation material on how to achieve the requirements contained in the Basic Regulation, the IRs, the AMCs and the CSs. It contains information, including examples, to assist the user in the correct understanding and application of the Basic Regulation, its IRs, AMCs and the CSs. [47]

1.4.3 History of evolution of UAS regulations for open and specific category UAS

On 27 September 2002**, Regulation (EC) No 1592/2002** [48] of 15 July 2002**, commonly known as "Basic Regulation" entered into force.** Through this proposal, **creation of EASA** (EU aviation safety agency) proposal was also initiated. This Regulation was applicable to the design, production, maintenance and operation of aeronautical products, parts and appliances, as well as personnel and organizations involved in the design, production and maintenance of such products, parts and

appliances and personnel and organizations involved in the operation of aircraft. In addition, the Commission adopted the necessary rules (Commission Regulations) for the **implementation of the Basic Regulation** for the certification and the continuing airworthiness of products, parts and appliances.

Pursuant to the Basic Regulation the Agency, where appropriate, issued **certification specifications, including airworthiness codes and acceptable means of compliance, as well as guidance material** for the application of the Basic Regulation and its implementing rules, as part of its regulatory framework. The Commission Regulations specify which certification specifications shall be issued. **The EASA remit**, as defined by **EC Regulation 1592/2002**, covers the airworthiness and environmental regulation of **UAVs with a maximum take-off mass of 150 kg or above,** which was not excluded by Article 1(2) or Article 4(2) and Annex II of basic regulations. Regulation of **excluded UAVs was then the responsibility of National Authorities**.
National Authorities retained responsibility for the **airworthiness and environmental regulation** of UAVs not within the scope of EASA.

UAVs within the scope of national authorities include:

a. UAVs with a maximum take-off mass below 150kg
b. UAVs of any mass specifically designed for research, experimental or scientific purposes and likely to be produced in small numbers.
c. UAVs engaged in military, customs, police or similar services (However, National Authorities shall undertake to ensure that such services have due regard as far as is practical to the EASA regulations).
d. National Authorities were also responsible for operational regulations pertaining to UAVs. ***UAVs above 150 Kg was under the responsibilities of EASA.***

In the year 2005, EASA issued A-NPA **16/2005 advance notice of proposed amendments** no **16/2005** [49] titled **'Policy for unmanned aerial vehicle (UAV) certification'.** The purpose of this Advance-Notice of Proposed Amendment (A-NPA) was to propose a general policy for **the certification of UAV (Unmanned Aerial Vehicle) Systems (the Policy)** and was a **first step** towards more comprehensive UAV regulation. The intention was to use such policy in the short term when applicants request EASA certification for an UAV. Comments response document CRD **16/2005** to notice of proposed amendment (NPA) 16-2005: policy for unmanned aerial vehicle (UAV) certification was published in February 2008.

Meanwhile, basic regulation **(EC) No 216/2008** [50] of **20 February 2008** on common rules in the field of civil aviation and establishing a European Aviation Safety Agency came into the force, which repealed **Regulation (EC) No 1592/2002** [48].

In the year 2009, EASA published policy statement "**Airworthiness certification of unmanned aircraft systems E.Y013-01 25.08.2009"** [15]**,** which was result of NPA 16/2005 and CRD 16/2005**.** The policy represents **the first step in the development of comprehensive civil UAS regulations** and may be regarded as providing guidance to Part 21 of subpart B of implementing regulation EC 1702/2003.

Finally, amended Basic Regulation **(EU) 2018/1139** [16] **4th July 2018** on **common rules in the field of civil aviation and establishing a** European Union Aviation Safety Agency comes into the effect, which repealed basic regulations (EC) No 216/2008 of the European Parliament and of the Council. **These regulations removed the threshold of 150 Kg of UAVs**.

This basic regulation **(EU) 2018/1139** along with commission **implementing** regulations **(EU) 2019/947** [18] **24 May 2019,** which was proposed to apply from **1 July 2020** '**Rules and procedures for the operation of unmanned aircraft'** and commission **delegated** regulation **(EU) 2019/945 12 March 2019** [17] on **unmanned aircraft systems and on third country operators of unmanned aircraft systems** applicable from 20th day following that of its publication in official journal of EU are the applicable regulations for UAVs.

1.5 Reading guide for applicable regulations

This section is intended to provide a reading guide of the information given in this handbook for different stakeholders involved in an operation.

Reading guide for operators:

The figure below provides some guidance for operators, it helps them to define the category of their operations and the methodology to follow in order to comply with regulatory requirements.

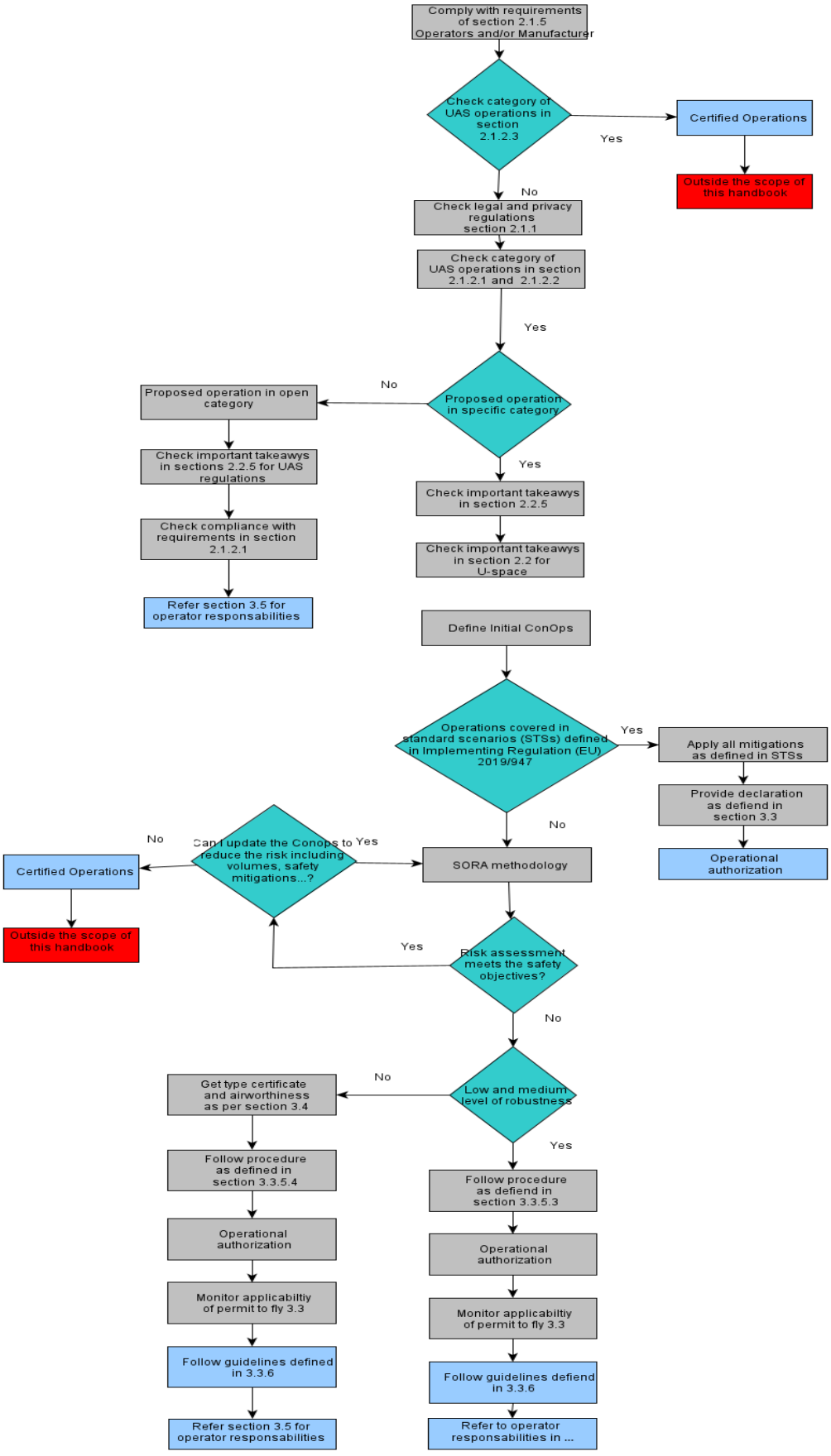


Figure 6 Reading guide for operators

Reading guide for other stakeholders:

The figure below gives a guidance for other stakeholders. It defines the applicable regulatory requirements for each stakeholder (MRO, Remote pilot, manufacturer)

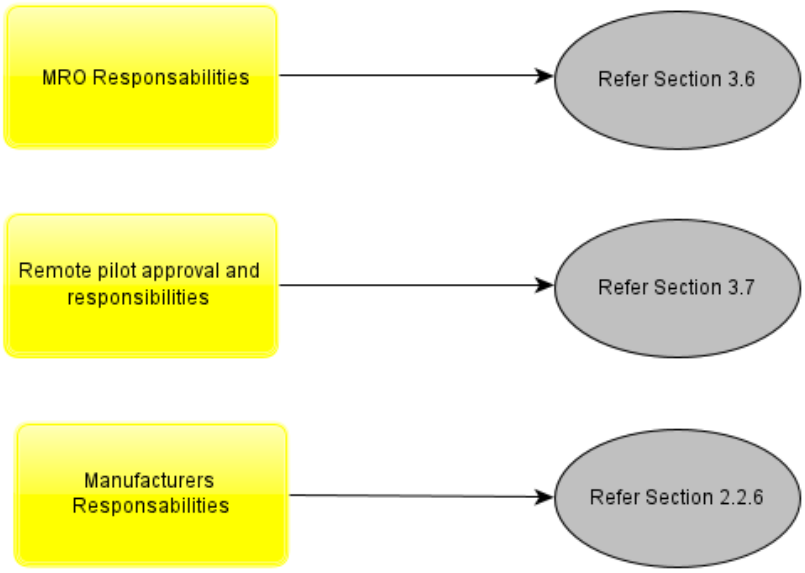


Figure 7 Reading guide for other stakeholders

1.6 Conclusion

In this chapter, we described main concepts needed to understand the objectives and motivations to write this handbook. We described about major regulatory organization and standards making organization, whose role is very important to regulate UAV into European market. However, it should be noted that the list is not exhaustive. There are several European and non-European industries, which are actively participating at different levels through participation in various projects or by providing necessary support to regulate this new domain and successfully integrate them into manned aviation. We have also given brief description of history of evolutions of drone regulations and different projects being done by European industries to develop procedures and policies for safely introduction of drones into current airspace. Detailed information of these projects is available in further chapters. All this information will help readers to understand the policies adopted today and their rationale.

In the last section of this chapter, we have given a case study of one COMP4DRONES use case to demonstrate how this handbook can be used by every stakeholder involved in the operation. Chapter 5 will describe more detailed information about all use cases of COMP4DRONES project and will provide necessary recommendations for similar types of operations performed by UAS operators.

In the next chapter, we will give an overview of major regulations for UAS and U-space and how they can be used by manufacturer and operators. This will help readers to get a complete understanding of the regulatory requirement and other requirement posed by available regulations.

2 The state of European UAS and U-space Regulations

2.1 European UAS Regulations

This section will describe current applicable European regulations in drone's domain. We have also explained important concepts needed to understand along with applicable regulations.

2.1.1 General regulations: Legal and Privacy aspects

This section is about compilation of general regulations, which seems to be important for the project. We have identified general regulation, which may be related to safety, security and privacy aspects in European geography. Most of these clauses have been mentioned in EU basic regulations [16]. This list should not be considered as complete set of general regulations. It is advised to follow latest guidelines issued by EU along with GDPR (General Data Protection Regulation) [40] for more updated and applicable information.

The rules regarding unmanned aircraft should contribute to achieving compliance with relevant rights guaranteed under Union law, and in particular the right to respect for private and family life, set out in Article 7 of the Charter of Fundamental Rights of the European Union, and with the right to protection of personal data, set out in Article 8 of that Charter and in Article 16 TFEU, and regulated by Regulation (EU) 2016/679 [40] of the European Parliament and of the Council.

As per EASA COMMISSION DELEGATED REGULATION (EU) 2019/945 [17], UAS that are not toys within the meaning of Directive 2009/48/EC [41] should comply with the relevant essential health and safety requirements set out in Directive 2006/42/EC [42] of the European Parliament and of the Council in so far as this Directive applies to them, to the extent that those health and safety requirements are not intrinsically linked to the safety of the flight by UAS.

Some important extracts of Directive **2006/42/EC** [42]are as follows:

1. Member States are responsible for ensuring the health and safety on their territory of persons, in particular of workers and consumers and, where appropriate, of domestic animals and goods, notably in relation to the risks arising out of the use of machinery.
2. The manufacturer or his authorized representative should also ensure that a risk assessment is carried out for the machinery which he wishes to place on the market. For this purpose, he should determine which are the essential health and safety requirements applicable to his machinery and in respect of which he must take measures.
3. Member States shall take all appropriate measures to ensure that machinery may be placed on the market and/or put into service only if it satisfies the relevant provisions of this Directive and does not endanger the health and safety of persons and, where appropriate, domestic animals or property, when properly installed and maintained and used for its intended purpose or under conditions which can reasonably be foreseen.

Please refer the directive **2006/42/EC** [42] **for detailed information.**

As per basic Regulation (EU) 2018/1139 [16], Article 55, Essential requirements for unmanned aircraft, the design, production, maintenance and operation of aircraft referred to in point (a) and (b) of Article 2(1), where it concerns unmanned aircraft, and their engines, propellers, parts, non-installed equipment and equipment to control them remotely, as well as the personnel, including remote pilots, and organizations involved in those activities, shall comply with the essential requirements set out in Annex IX, and, where the delegated acts referred to in Article 58 and the implementing acts referred to in Article 57 so provide, with the essential requirements set out in Annexes II, IV and V.

Directive 2014/30/EU [43] and DIRECTIVE 2014/53/EU [44] OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 16 April 2014 on the harmonization of the laws of the Member States relating to the making available on the market of radio equipment should apply to unmanned aircraft

that are not subject to certification and are not intended to be operated only on frequencies allocated by the Radio Regulations of the International Telecommunication Union for protected aeronautical use, if they intentionally emit and/or receive electromagnetic waves for the purpose of radio communication and/or radio determination at frequencies below 3 000 GHz. While this directive should not apply to unmanned aircraft that are subject to certification according to Regulation (EU) 2018/1139 [16], are exclusively intended for airborne use and intended to be operated only on frequencies allocated by the Radio Regulations of the International Telecommunication Union for protected aeronautical use.

These are all available and applicable regulations, which were thought to be useful for readers of this handbook. However, the list is not meant to be exhaustive, and users should use EU website to find out more up to date information.

2.1.2 EU- Legal requirements

This section has complied various requirements defined by different applicable regulations mentioned in previous section. Additionally, it has also defined detailed overview of different categories of drones operations allowed in European region. The objectives are to summarize all important concepts along with all important legal requirements expected from manufacturer and operators at European level at one place.

UAS placed on the market and intended to be operated in the ‘open’ category and bearing a class identification label should comply with the certification requirements for UAS operated in the ‘specific’ or ‘certified’ categories of operations, as applicable, if those UAS are used outside the ‘open’ category of operations. [17]

The implementing regulation (EU) 2019/947 and delegated regulation (EU) 2019/945 should also apply to UAS, which are considered as toys within the meaning of Directive 2009/48/EC of the European Parliament and of the Council. Those UAS should also comply with Directive 2009/48/EC. [17]

As per EASA COMMISSION IMPLEMENTING REGULATION (EU) 2020/639 of 12th May 2020, in order to improve the conspicuity of the unmanned aircraft flown at night, and in particular, to allow a person on the ground to easily distinguish the unmanned aircraft from a manned aircraft, a green flashing light should be activated on the unmanned aircraft.

As per EASA categorization of drones, UAS operations shall be performed in the ‘open’, ‘specific’ or ‘certified’ category. UAS operations in the ‘open’ category shall not be subject to any prior operational authorization, nor to an operational declaration by the UAS operator before the operation takes place. UAS operations in the ‘specific’ category shall require an operational authorization issued by the competent authority pursuant to Article 12: “Authorizing operations in the specific category” of Implemented regulation (EU) 2019/947 or an authorization received in accordance with Article 16, or, under circumstances defined in Article 5(5) of Implemented regulation (EU) 2019/947, a declaration to be made by a UAS operator. UAS operations in the ‘certified’ category shall require the certification of the UAS pursuant to Delegated Regulation (EU) 2019/945 and the certification of the operator and, where applicable, the licensing of the remote pilot.

The handbook’s scope is mainly for specific category. However, this handbook even covers the other two operational categories viz. Open & Certified. It is because in some circumstances requirements of Open category drone specifications might be required for specific category operations and vice-versa, and specific category drone specifications might be required for certified category operations and vice-versa. As per Implemented regulation (EU) 2019/947, definitions of different operations are as follows:

2.1.2.1 Article 4: ‘Open’ category of UAS operations

1. Operations shall be classified as UAS operations in the ‘open’ category only where the following requirements are met:
   a. The UAS belongs to one of the classes set out in Delegated Regulation (EU) 2019/945 or is privately built or meets the conditions defined in Article 20 of Implemented regulation (EU) 2019/947.

b. The unmanned aircraft has a maximum take-off mass of less than 25 kg.
c. The remote pilot ensures that the unmanned aircraft is kept at a safe distance from people and that it is not flown over assemblies of people.
d. The remote pilot keeps the unmanned aircraft in VLOS at all times except when flying in follow-me mode or when using an unmanned aircraft observer as specified in Part A of the Annex of Implemented regulation (EU) 2019/947.
e. During flight, the unmanned aircraft is maintained within 120 meters from the closest point of the surface of the earth, except when overflying an obstacle, as specified in Part A of the Annex (f) of Implemented regulation (EU) 2019/947, during flight, the unmanned aircraft does not carry dangerous goods and does not drop any material.

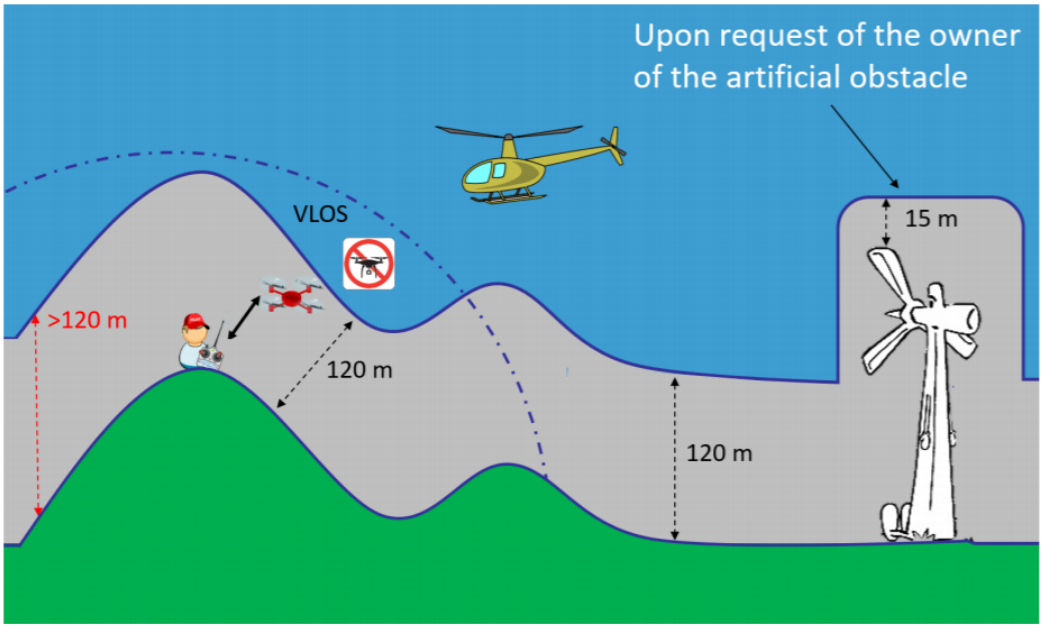


Figure 8 open category Annex I to ED Decision 2019/021/R

2. UAS operations in the limited open category shall be divided in three sub-categories: A1, A2, and A3 in accordance with the requirements set out in Part A of the Annex of Implemented regulation (EU) 2019/947.

Sub-categories	MTOM/ Speed	Operational limitation	CE marking	Remote pilot requirement		Technical requirements
A1	• MTOM less than 250 g for C0 or 900 g for C1 and speed less than 19 m/s (privately build UAS) • Max attainable height 120m • Article 20(a) of IA 2019/947.	• Privately built & C0 category drones may fly over uninvolved people. • No flight over uninvolved people (if happens should be minimized) • No flying over assemblies of people • In unexpected overflight of uninvolved person, reduce time AFAP of overflies that person	Privately built, C0 & C1 # must fulfil all requirements of corresponding CE marking.	Know user manual, training course + Exam having 40 MCQ	16 years of age, no minimum age if drone is a toy	Active and updated direct remote identification and geo-awareness systems
A2	• MTOM less than 4 Kg. • Max attainable height 120m	No overfly uninvolved person. Safe distance of minimum 30m Possible to reduce safe distance to 5	C2 # must fulfil all requirements of	Know user manual, training course + Exam	16 years of age	Active and updated direct remote identification and geo-

	• Article 20(a) of IA 2019/947.	meter based on active low speed and site conditions	corresponding CE marking	having 40 MCQ, self-practical training, additional exam of 30 MCQ		awareness systems
A3	• MTOM less than 25 kg, speed less than 19 m/s (privately build UAS) • Max attainable height 120m • Article 20(b) of IA 2019/947.	Possible to overfly on uninvolved people where pilot expects to no endangered them. Safe horizontal distance of at least 150 m from industrial, residential, commercial or recreational area.	C2, C3, C4 # must fulfil all requirements of corresponding CE marking	Know user manual, training course + Exam having 40 MCQ	16 years of age	Active and updated direct remote identification and geo-awareness systems

Note: The Age threshold of the Remote Pilots can be reduced to 12 years, but it shall be limited to only that MS (Member State)

Table 2 Open categories operations summary

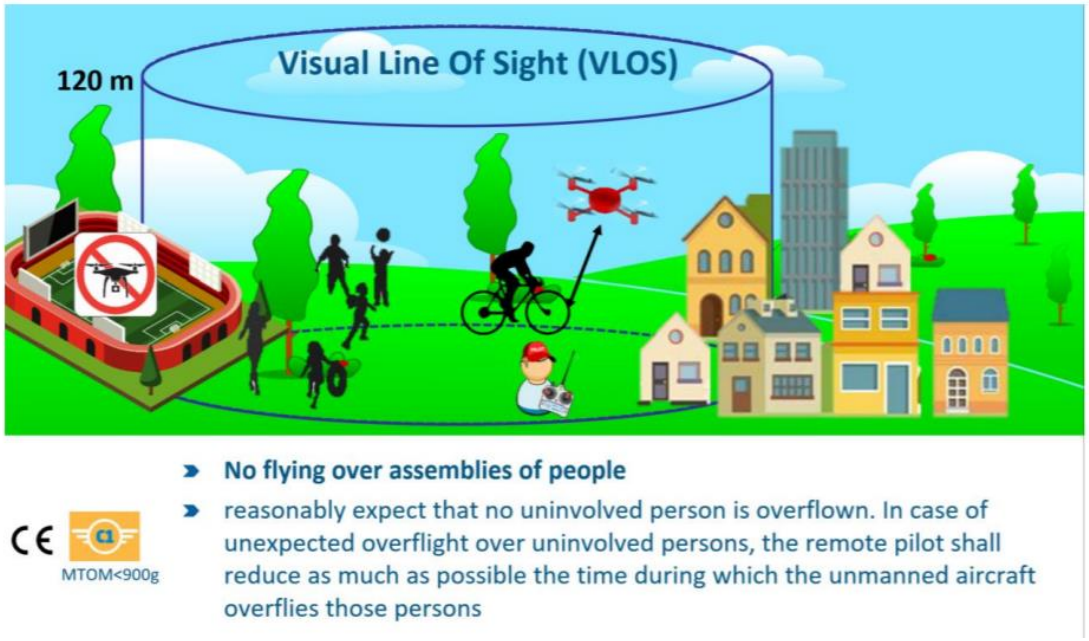


Figure 9 Visualization of VLOS Operations from Annex I to ED Decision 2019/021/R

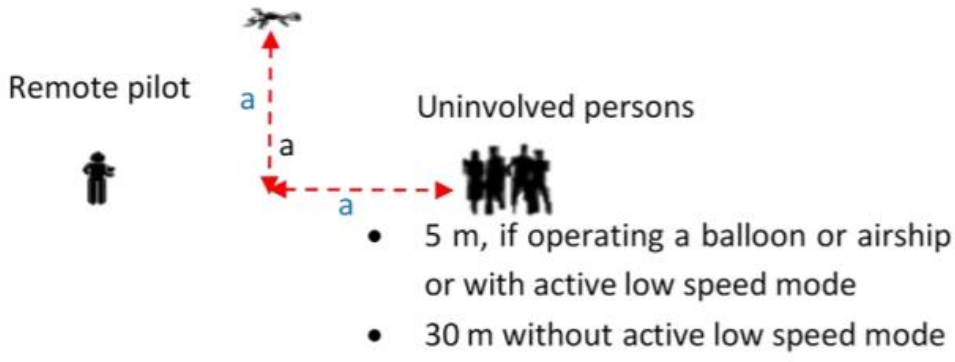


Figure 10 UAS operation in A2 subcategories Annex I to ED Decision 2019/021/R

For detailed information for open categories regulations for 2019/945, please refer Acceptable Means of Compliance (AMC) and Guidance Material (GM) to Part-UAS UAS operations in the 'open' and 'specific' categories Issue 1 dated 9 October 2019, also known as Annex I to ED Decision 2019/021/R.

2.1.2.2 Article 5 'Specific' category of UAS operations

Where one of the requirements laid down in Article 4 'Open' category of UAS operations or in Part A of the Annex of IA 2019/947 is not met, a UAS operator shall be required to obtain an operational authorization pursuant to Article 12 of IA 2019/947 from the competent authority in the Member State where it is registered.

When applying to a competent authority for an operational authorization pursuant Article 12 of IA 2019/947, the operator shall perform a risk assessment in accordance with Article 11 of IA 2019/947 and submit it together with the application, including adequate mitigating measures.

In accordance with point UAS.SPEC.040 laid down in Part B of the Annex of IA 2019/947, the competent authority shall issue an operational authorization, if it considers that the operational risks are adequately mitigated in accordance with Article 12.

The competent authority shall specify whether the operational authorization concerns: (a) the approval of a single operation or a number of operations specified in time or location(s) or both. The operational authorization shall include the associated precise list of mitigating measures; (b) the approval of an LUC, in accordance with part C of the Annex of IA 2019/947.

Where the UAS operator submits a declaration to the competent authority of the Member State of registration in accordance with point UAS.SPEC.020 laid down in Part B of the Annex of IA 2019/947 for an operation complying with a standard scenario as defined in Appendix 1 to that Annex of IA 2019/947, the UAS operator shall not be required to obtain an operational authorization in accordance with paragraphs 1 to 4 of this Article and the procedure laid down in paragraph 5 of Article 12 of IA 2019/947 shall apply.

An operational authorization or a declaration shall not be required for: (a) UAS operators holding an LUC with appropriate privileges in accordance with point UAS.LUC.060 of the Annex of IA 2019/947; (b) operations conducted in the framework of model aircraft clubs and associations that have received an authorization in accordance with Article 16 of IA 2019/947.

2.1.2.3 Article 6: 'Certified' category of UAS operations

Operations shall be classified as UAS operations in the 'certified' category only where the following requirements are met:

1. The UAS is certified pursuant to points (a), (b) and (c) of paragraph 1 of Article 40 of Delegated Regulation (EU) 2019/945.
2. The operation is conducted in any of the following conditions:
   - over assemblies of people

- involves the transport of people
- Involves the carriage of dangerous goods, which may result in high risk for third parties in case of accident.

3. 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 specific category operations defined in Article 11 of IA 2019/947, considers that the risk of the operation cannot be adequately mitigated without the certification of the UAS and of the UAS operator and, where applicable, without the licensing of the remote pilot.

Thus, Article 6 of the UAS Regulation 2019/947 should be read together with Article 40 of Regulation (EU) 2019/945 — Article 6 addresses UAS operations and Article 40 addresses the UAS. This construction was necessary to respect the EU legal order reflected in Regulation (EU) 2018/1139, which foresees that the requirements for UAS operations and registration are in the implementing act, and that the technical requirements for UAS are in the delegated act. The reading of the two articles results in the following:

a. The transport of people is always in the 'certified' category. Indeed, the UAS must be certified in accordance with Article 40 and the transport of people is one of the UAS operations identified in Article 6 as being in the 'certified' category;
b. flying over assemblies of people with a UAS that has a characteristic dimension of less than 3 m may be in the 'specific' category unless the risk assessment concludes that it is in the 'certified' category; and
c. The transport of dangerous goods is in the 'certified' category if the payload is not in a crash-protected container, such that there is a high risk for third parties in the case of an accident.

2.1.2.4 Boundaries between the categories of UAS operations

2.1.2.4.1 Boundary between 'open' and 'specific'

A UAS operation does not belong to the 'open' category when at least one of the general criteria listed in Article 4 of the UAS Regulation 2019/947 is not met (e.g., when operating beyond visual line of sight (BVLOS)) or when the detailed criteria for a subcategory are not met (e.g., operating a 10 kg UA close to people when subcategory A2 is limited to 4 kg UA).

2.1.2.4.2 Boundary between 'specific' and 'certified'

Article 6 of the UAS Regulation 2019/947 and Article 40 of Regulation (EU) 2019/945 define the boundary between the 'specific' and the 'certified' category. The first article defines the boundary from an operational perspective, while the second one defines the technical characteristics of the UA, and they should be read together.

A UAS operation belongs to the 'certified' category when, based on the risk assessment, the competent authority considers that the risk cannot be mitigated adequately without the:

- Certification of the airworthiness of the UAS;
- Certification of the UAS operator; and
- licensing of the remote pilot, unless the UAS is fully autonomous.
- UAS operations are always considered to be in the 'certified' category when they:
- are conducted over assemblies of people with a UA that has characteristic dimensions of 3 m or more; or
- involve the transport of people; or
- involve the carriage of dangerous goods that may result in a high risk for third parties in the event of an accident.

2.1.3 Applicable regulations

The current applicable regulations are listed in **Error! Reference source not found.**.

Basic Regulation **(EU) 2018/1139** is applicable today. Besides this, commission **implementing** regulations **(EU) 2019/947 were planned to** apply from **1 July 2020** and commission **delegated**

regulation **(EU) 2019/945** is already applicable. Later (EU) 2020/746 [20] postponed the applicability of commission **implementing** regulations **(EU) 2019/947 to 31st December 2020.** Additionally, **a delegated regulation (EU) 2020/1058** added two additional categories of CE marking for UAS flying in standard scenarios. It amended Delegated Regulation (EU) 2019/945 as regards the introduction of two new unmanned aircraft systems classes along with available CE class from zero to four named C0 to C4. Therefore, there are total six CE classes of UAS defined by regulation named C0 to C6. Out of six CE classes, C0 to C4 belongs to open categories while C5 and C6 belongs to specific categories-standard scenarios.

Commission Delegated Regulation **(EU) 2019/945 of 12 March 2019** on unmanned aircraft systems and on third country operators of unmanned aircraft systems covers mostly:

- CE and operator markings on a UAS.
- Technical requirements per UAS category
- Obligations of manufacturers, importers and distributors of UAS
- Requirements on non-EU country operators
- Remote identification

Commission Implementing Regulation **(EU) 2019/947 of 24 May 2019** on the rules and procedures for the operation of unmanned aircraft covers mostly:

- Different (sub) categories of UAS operations
- Rules, procedures, competency and minimum age for pilots
- Cross border operations
- Registration of UAS operators
- Tasks and designation of competent authorities.

2.1.4 Supplementary documents of applicable regulations

Risk assessment for specific categories of operations have been considered as a complicated aspect for compliance from drones operators and manufacturers**. Article 12** "Authorizing operations in the 'specific' category" of implementing regulations (EU) 2019/947 states that competent authority shall evaluate the risk assessment and the robustness of the mitigating measures that the UAS operator proposes to keep the UAS operation safe in all phases of flight and **Article 11** Rules for conducting an operational risk assessment of **implementing** regulations **(EU) 2019/947**, suggest to do risk assessment. In accordance with Article 11 of the UAS Regulation, the applicant must collect and provide the relevant technical, operational and system information needed to assess the risk associated with the intended operation of the UAS. There are two AMC published for fulfilment of this requirements. **Specific operations risk assessment** (**SORA)** [28] **is AMC1 to Article 11 of the UAS Regulation.** It provides a detailed framework for such data collection and presentation. The major input of this process is the concept of operations (ConOps) description. ConOps is the foundation for all other activities and should be as accurate and detailed as possible. The ConOps should not only describe the operation, but also provide insight into the UAS operator's operational safety culture. It should also include how and when to interact with the air navigation service provider (ANSP) when applicable. More detailed about this process have been described in further chapters.

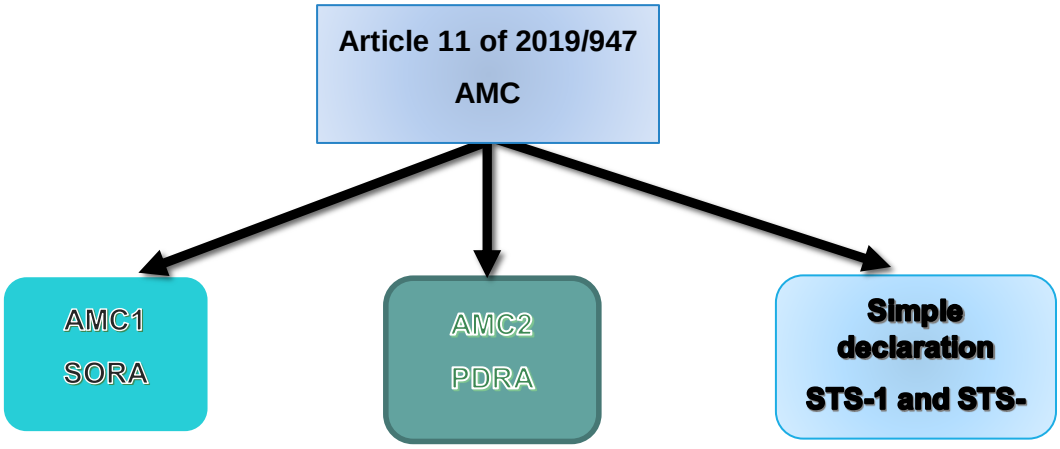


Figure 11 Various means to comply with Article 11, IR 2019/947

By EASA **opinion No 01/2018** 'Introduction of a regulatory framework for the operation of UAS in the "Open" and "specific" categories, [51] EASA introduced **concept of STSs** for UAS operations in the 'specific' category that are characterized for low-risk operations. A standard scenario involves a pre-defined/established risk assessment and includes mitigation measures. It may be followed by a declaration submitted by the UAS operator (if the implementation of the mitigation measures is considered to be simple), or by an authorization issued by the competent authority (when the implementation of the mitigation measures is considered to be more complex).

In order to identify the UAS operations to be covered by the STS, EASA carried out a survey among all MSs to identify the UAS operations which are allowed, according to national regulations, based on a declaration submitted by the UAS operator. Two types of UAS operations were then identified, and they led to the development of two STSs — **STS-01 and STS-02.** These two STSs were developed based on the experience gained in some MSs and in addition, a risk assessment, based on SORA, was carried out to validate the approach.

Name of document	Reference number	What it brings
Acceptable Means of Compliance (AMC) and Guidance Material (GM) to Commission Implementing Regulation (EU) 2019/947	Annex I to ED Decision 2019/021/R	SORA as AMC1 of Article 11 STS PDRA
Amending Implementing Regulation (EU) 2019/947 as regards standard scenarios for operations executed in or beyond the visual line of sight	(EU) 2020/639 of 12 May 2020	Amendments due to STSs.
Amending Implementing Regulation (EU) 2019/947 as regards the introduction of two new unmanned aircraft systems classes	(EU) 2020/1058 of 27 April 2020	C5 and C6 classes for UAS
Acceptable Means of Compliance (AMC) and Guidance Material (GM) to Commission Implementing Regulation (EU) 2019/947 — Issue 1, Amendment 1	Annex I to ED Decision 2020/022/R	Amendment to Annex I to ED Decision 2019/021/R

Table 3 STSs and PDRA

According to point UAS.SPEC.020 of the implemented regulations, STSs will be developed only for UAS operations in the 'specific' category with a low risk (i.e., with a specific assurance and integrity level (SAIL), as defined in SORA, not greater than 2). For these UAS operations, UAS operators will be allowed to start the operation as soon as they have submitted a declaration to the NAA of registration and have received the receipt of confirmation and completeness. Since the NAA is **not required to make any additional checks** before the start of the operation (the UAS operator will, however, be included in the oversight program of the NAA), it was decided to define the requirements

for these UAS operations in a prescriptive way. Therefore, STSs have been developed with a structure and a level of detail similar to those listed in the 'open' category.

In Implementing Regulation (EU) 2019/947 two types of STSs have been defined:

STS-01: visual line of sight (VLOS) operations at a maximum height of 120 m, at a ground speed of less than 5 m/s in the case of untethered UA, over controlled ground areas that can be in populated (e.g., urban) environments, using UAS with maximum take-off masses (MTOMs) of up to 25 kg;

STS-02: beyond visual line of sight (BVLOS) operations with the UA at not more than 2 km from the remote pilot, if visual observers (VOs) are used, at a maximum height of 120 m, over controlled ground areas in sparsely populated environments, using UA with MTOMs of up to 25 kg.

In any standard scenarios, well defined rules should apply to practical skill training and assessment of remote pilots operating under a standard scenario. That training and assessment should be provided by an entity recognized by the competent authority or by an UAS operator in compliance with requirements laid down in this Regulation. This **opinion No 05/2019** [52] mentioning '**Standards scenarios for UAS operations in specific category' are adapted in the form of Commission Delegated Regulation (EU) 2020/1058** [54] **of 27 April 2020 amending Delegated Regulation (EU) 2019/945 as regards the introduction of two new unmanned aircraft systems classes**. This added two additional classes named as C5 and C6 into already defined open categories classes named C0 to C4. The objectives of this addition were to simplify the processes of operational authorization of standard scenarios as it is for open categories.

In summary, commission implementing regulation (EU) 2019/947 has been amended by two regulations named commission implementing regulations (EU) 2020/639 and (EU) 2020/1058.

Meanwhile by Annex I to ED Decision 2019/021/R, [38] Acceptable Means of Compliance (AMC) and Guidance Material (GM) to Commission Implementing Regulation (EU) 2019/947 [53], **predefined risk assessment (PDRA)** are published. In recent regulations update EASA has included PDRA in two categories as **PDRA-S** and **PDRA-G**.

i. **PDRA-S** reflects the European STS (it covers the same operations for drones without class markings)
ii. **PDRA-G** includes the risk analyses of other specific drone operations which are relatively common in the EU.

For UAS operations following PDRA, a request for authorization may be submitted based on the mitigations and provisions described in the **predefined risk assessment (PDRA),** when the UAS operation meets the operational characterization described in **AMC2 to Article 11 to the UAS Regulation 2019/947.**

While the STSs are described in a **detailed way**, the provisions and mitigations in the PDRA are described in a **rather generic way to provide flexibility to UAS** operators and the competent authorities to establish more prescriptive limitations and provisions that are adapted to the particularities of the intended operations.

PDRA-S01						
Visual contact	**Area**	**Airspace**	**Max.height**	**Drone Properties**	**Class marking**	**Pilot skills**
VLOS	Under drone operators control, may be populated	Uncontrolled	120 m	Max circumference of 3 m and / or 34 KJ	Not required	Remote pilot certificate of competency, in accordance with open A2 & practical experience at a recognized body

PDRA-S02						
Visual contact	**Area**	**Airspace**	**Max.height**	**Drone Properties**	**Class marking**	**Pilot skills**

EVLOS Possible	Under drone operators control, sparsely populated	Uncontrolled	120 m	Max circumference of 3 m and / or 34 KJ	Not required	Remote pilot certificate of competency, in accordance with open A2 & practical experience at a recognized body

PDRA-G01						
Visual contact	**Area**	**Airspace**	**Max.height**	**Drone Properties**	**Class marking**	**Pilot skills**
EVLOS Possible	Sparsely populated	Uncontrolled	150 m	Max circumference of 3 m and / or 34 KJ	Not required	Case-specific, depending on the planned operation. Acquisition of knowledge relevant to the operation

PDRA-G02						
Visual contact	**Area**	**Airspace**	**Max.height**	**Drone Properties**	**Class marking**	**Pilot skills**
BVLOS	Sparsely populated	Reserved	No maximum altitude	Max circumference of 3 m and / or 34 KJ	Not required	Case-specific, depending on the planned operation. Acquisition of knowledge relevant to the operation.

Table 4 PDRA classification

PDRAs (AMC2 to Article 11 of the UAS Regulation) only address safety risks; consequently, additional limitations and provisions might need to be included after the consideration of other risks (e.g., security, privacy, etc.). Scope of this PDRA is the result of applying the methodology described in AMC1 to Article 11 of the UAS Regulation to UAS operations performed in the 'specific' category with the following main attributes:

1) UA with maximum characteristic dimensions (e.g., wingspan, rotor diameter/area or maximum distance between rotors in case of multirotor) up to 3 m and typical kinetic energies up to 34 kJ; (2) operated BVLOS of the remote pilot with visual air risk mitigation;
2) Over sparsely populated areas;
3) Less than 150 m (500 ft.) above the overflown surface (or any other altitude reference defined by the state); and
4) In uncontrolled airspace.

Detailed information about PDRA can be found in Annex I to ED Decision 2019/021/R and its amendment, European Union Aviation Safety Agency, Acceptable Means of Compliance (AMC) and Guidance Material (GM) to Commission Implementing Regulation (EU) 2019/947.

EASA opinion 01/2018 also proposed an optional **light UAS operator certificate (LUC)**, which allows the competent authority to issue privileges to UAS operators. This implies a significant investment from the operator's side, which should yield benefits in the medium/long term. Indeed, the LUC privileges can ultimately allow an operator to approve their own operations. These types of operators do not exist today for drones. It may need several years of experience and procedure to develop competencies in this domain. Therefore, practically this concept will be useful after few

years. However, for the operators having good experience in manned aviation, having strong safety management system, and having good understanding of UAS operation, LUC concept may be very useful. They can get LUC after submission of all necessary documents and proper demonstrations as described in section 3.3.5.5.

Recent document is Commission Implementing Regulation **(EU) 2020/639 of 12 May 2020** amending Implementing Regulation (EU) 2019/947 as regards standard scenarios for operations executed in or beyond the visual line of sight. Later by **(EU) 2020/746** [20] applicability date of **(EU) 2019/947 is extended to 31st December 2020.**

2.1.5 Takeaway for operators and manufacturers

Following is a summary of takeaways for operators and manufacturers from the published European regulations as on July 2020. It should be noted that the list is not exhaustive. The takeaways may be modified in case of amendments of existing regulations or publication of additional regulations. The handbook will be updated in next version in order to incorporate further changes of European regulations.

COMMISSION DELEGATED REGULATION (EU) 2019/945 of 12 March 2019 on unmanned aircraft systems and on third-country operators of unmanned aircraft systems	
1	All European regulation should apply to all forms of supply, including distance selling of UAS.
2	In order to ensure a high level of protection of public interest, such as health safety, and to guarantee fair competition on the Union market, economic operators should be responsible for the compliance of UAS intended to be operated in the 'open' category with the requirements laid down in EASA Regulation, in relation to their respective roles in the supply and distribution chain.
3	In order to facilitate communication between economic operators, national market surveillance authorities and consumers, economic operators supplying or distributing UAS intended to be operated in the 'open' category should provide a website address in addition to the postal address.
4	The manufacturer, having detailed knowledge of the design and production process, is best placed to carry out the conformity assessment procedure of UAS intended to be operated in the 'open' category. Conformity assessment should therefore remain solely the obligation of the manufacturer.
5	EASA Regulation should apply to any UAS intended to be operated in the 'open' category that is new to the Union market, whether a new UAS made by a manufacturer established in the Union or a new or second-hand UAS imported from a third country.
6	It is necessary to ensure that UAS from third countries entering the Union market comply with the requirements of EASA Regulation, if they are intended to be operated in the 'open' category. In particular, it should be ensured that manufacturers carry out appropriate conformity assessment procedures. Provision should therefore be made for importers to make sure that the UAS they place on the market comply with the requirements of this Regulation and that they do not place on the market UAS which do not comply with these requirements or present a risk. Provision should also be made for importers to make sure that the conformity assessment procedures have been carried out and that the CE marking, and technical documentation drawn up by the manufacturers is available for inspection by the competent national authorities.
7	The distributor who makes a UAS intended to be operated in the 'open' category available on the market should act with due care to ensure that its handling of the product does not adversely affect its compliance. Both importers and distributors are expected to act with due care in relation to the requirements applicable when placing or making products available on the market.
8	When placing on the market a UAS intended to be operated in the 'open' category, every importer should indicate on the UAS his name, registered trade name or registered

	trademark and the address at which he can be contacted. Exceptions should be provided for cases where the size of the UAS does not allow this. This includes cases where the importer would have to open the packaging to put his name and address on the UAS.
9	Any economic operator that either places a UAS intended to be operated in the 'open' category on the market under his own name or trademark or modifies a UAS intended to be operated in the 'open' category in such a way that compliance with the applicable requirements may be affected, should be considered to be the manufacturer and should assume the obligations of the manufacturer.
10	Distributors and importers, being close to the market place, should be involved in market surveillance tasks carried out by the competent national authorities, and should be prepared to participate actively, providing those authorities with all the necessary information relating to the UAS intended to be operated in the 'open' category.
11	Ensuring the traceability of a UAS intended to be operated in the 'open' category throughout the whole supply chain helps to make market surveillance simpler and more efficient. An efficient traceability system facilitates the market surveillance authorities' task of tracing economic operators who make non-compliant UAS available on the market.
12	Market surveillance authorities and UAS operators should have easy access to the EU declaration of conformity. In order to fulfil this requirement, manufacturers should ensure that each UAS intended to be operated in the 'open' category is accompanied either by a copy of the EU declaration of conformity or by the internet address at which the EU declaration of conformity can be accessed.
13	To ensure effective access to information for market surveillance purposes, the information required to identify all applicable Union acts for UAS intended to be operated in the 'open' category should be available in a single EU declaration of conformity.
14	In order to reduce the administrative burden on economic operators, it should be possible for that single EU declaration of conformity to be a dossier made up of relevant individual declarations of conformity.
15	The CE marking indicating the conformity of a product is the visible consequence of a whole process of conformity assessment in the broad sense. Regulation (EC) No 765/2008 sets out rules on the accreditation of conformity assessment bodies, provides a framework for the market surveillance of products and for controls on products from third countries, and sets out the general principles of the CE marking.
16	Manufacturers should take all appropriate measures to ensure that UAS intended to be operated in the 'open' category may be placed on the market only if, when properly stored and used for their intended purpose or under conditions, which can be reasonably foreseen, it does not endanger people's health or safety.
17	UAS intended to be operated in the 'open' category should be considered as non-compliant with the essential requirements set out in this Regulation only under conditions of use which can be reasonably foreseen, that is when such use could result from lawful and readily predictable human behaviour.
18	In order to ensure legal certainty, it is necessary to clarify that the rules on Union market surveillance and control of products entering the Union market provided for in Regulation (EC) No 765/2008, including the provisions regarding the exchange of information through the Rapid Alert System (RAPEX), apply to UAS intended to be operated in the 'open' category. EASA Regulation should not prevent Member States from choosing the competent authorities to carry out those tasks.
19	UAS placed on the market and intended to be operated in the 'open' category and bearing a class identification label should comply with the certification requirements for UAS operated in the 'specific' or 'certified' categories of operations, as applicable, if those UAS are used outside the 'open' category of operations.

20	UAS operators that have their principal place of business, are established, or are resident in a third country and that conduct UAS operations within the single European sky airspace should be subject to EASA Regulation.
COMMISSION IMPLEMENTING REGULATION (EU) 2019/947 of 24 May 2019 on the rules and procedures for the operation of unmanned aircraft	
21	Operators of unmanned aircraft should be registered where they operate an unmanned aircraft which, in case of impact, can transfer, to a human, a kinetic energy above 80 Joules or the operation of which presents risks to privacy, protection of personal data, security or the environment.
22	Studies have demonstrated that unmanned aircraft with a take-off mass of 250 g or more would present risks to security and therefore UAS operators of such unmanned aircraft should be required to register themselves when operating such aircraft in the 'open' category.
23	Considering the risks to privacy and protection of personal data, operators of unmanned aircraft should be registered if they operate an unmanned aircraft which is equipped with a sensor able to capture personal data. However, this should not be the case when the unmanned aircraft is considered to be a toy within the meaning of Directive 2009/48/EC of the European Parliament and of the Council on the safety of toys.
24	The information about registration of certified unmanned aircraft and of operators of unmanned aircraft that are subject to a registration requirement should be stored in digital, harmonized, interoperable national registration systems, allowing competent authorities to access and exchange that information. The mechanisms to ensure the interoperability of the national registers in this Regulation should be without prejudice to the rules applicable to the future repository referred to in Article 74 of Regulation (EU) 2018/1139.
25	UAS operators and remote pilots should ensure that they are adequately informed about applicable Union and national rules relating to the intended operations, in particular with regard to safety, privacy, data protection, liability, insurance, security and environmental protection.
26	Unmanned aircraft noise and emissions should be minimized as far as possible taking into account the operating conditions and various specific characteristics of individual Member States, such as the population density, where noise and emissions are of concern.
27	In order to facilitate the societal acceptance of UAS operations, Delegated Regulation (EU) 2019/945 includes maximum level of noise for unmanned aircraft operated close to people in the 'open' category. In the 'specific' category there is a requirement for the operator to develop guidelines for its remote pilots so that all operations are flown in a manner that minimizes nuisances to people and animals.
COMMISSION IMPLEMENTING REGULATION (EU) 2020/639 of 12 May 2020 amending Implementing Regulation (EU) 2019/947 as regards standard scenarios for operations executed in or beyond the visual line of sight	
28	*In order to improve the conspicuity of the unmanned aircraft flown at night, and in particular, to allow a person on the ground to easily distinguish the unmanned aircraft from a manned aircraft,* ***a green flashing light should be activated on the unmanned aircraft****.*

Table 5 Takeaways for operators and manufacturers

Recently developed European regulations have introduced various new concepts along with new role, responsibilities and accountabilities of authorities. Understanding and knowledge of all proposed requirements, regulations, and restrictions are very important for safe and efficient drone operations. We have tried to summarize all available important general aspects, legal aspects, and other regulations collected from different resources in this section. However, there may be several other legal and general aspects to be taken into consideration based on national regulations.

Readers are advised to closely monitor and follow their national regulation too. Next section will concentrate on second important field of drone operations i.e., U-space. Important concepts and information related to U-space are also added in next section.

2.2 European U-Space and UTM Regulations Synthesis

2.2.1 Introduction

Drones represent a rapidly growing sector of aviation in Europe and worldwide, offering potentially a myriad of services to business and citizens, but placing new demands on the airspace around us. Estimates vary on the volume and value of the drone industry in the future. However, the European Drones Outlook Study estimates as many as 400,000 drones will be providing services in the airspace by 2050, and a total market value in excess of EUR 10 billion annually by 2035. [54]

U-space is a set of new services and specific procedures designed to support safe, efficient and secure access to airspace for large numbers of drones. These services rely on a high level of digitalization and automation of functions, whether they are on board the drone itself, or are part of the ground-based environment. U-space provides an enabling framework to support routine drone operations, as well as a clear and effective interface to manned aviation, ATM/ANS service providers and authorities. U-space is therefore not to be considered as a defined volume of airspace, which is segregated and designated for the sole use of drones. U-space is capable of ensuring the smooth operation of drones in all operating environments, and in all types of airspace (in particular but not limited to very low-level airspace). It addresses the needs to support all types of missions and may concern all drone users and categories of drones. [55]

2.2.2 History of evolution of U-Space and UTM regulations

Recognizing the huge potential available of UAS in future, the European Commission launched U-space in 2016 [55] - an initiative aimed at ensuring the safe and secure integration of drones into the airspace. With it, the Commission set in motion a series of activities across Europe directed towards the development of appropriate rules and regulations, as well as technical and operational requirements capable of supporting future autonomous operations. This included tasking the SESAR JU to coordinate all research and development activities related to U-space and drone integration.

The SESAR JU started with the publication of the U-space Blueprint, setting out the vision and steps for the progressive deployment of U-space services from foundation services, such as registration, e-identification, geo-awareness, to more complex operations in dense airspace requiring greater levels of automation and connectivity.

Building on the blueprint, the SESAR JU then went further into detail with a roadmap for the safe integration of drones into all classes of airspace. This embeds not just the timeline for U-space, but it also outlines the steps to be taken to ensure a coordinated implementation of solutions to enable remotely piloted aircraft systems (RPAS) to fly alongside commercial aircraft. The roadmap has been included in the 2020 edition of the European ATM Master Plan, which is the main planning tool shared by all stakeholders for air traffic management modernization in Europe.

In 2017, the SESAR JU launched Co-funded by the EU's Horizon 2020 Research and Innovation Program, a set of exploratory research projects addressing everything from the concept of operations for drone operations, critical communications, surveillance and tracking, and information management to aircraft systems, ground-based technologies, cyber-resilience and geo-fencing.

In order to provide proper and unanimous acceptance of U-space services and capabilities. It was important to do live trials of the concept and record the performance. To this end, in 2018 the SESAR JU launched several demonstration projects, co-funded by the EU. The final objectives were to proof the readiness of U-space services to manage a broad range of drone operations and related applications, and their interaction with manned aviation. The projects or experiments range from parcel deliveries between two dense urban locations, medical emergencies, police interventions to air taxi trials in an airport-controlled airspace. Another target was to demonstrate how drone operators can benefit from U-space services. The operations also aimed to demonstrate different levels of automation that are possible, as well as seamless information exchange between multiple

service providers in the same geographical area at the same time. The research work brought together different types of industries from traditional aviation, start-ups, research institutes, universities, drone operators, service providers, airports, local/city authorities, law enforcement agencies and civil aviation authorities. Total 125 entities, including 25 European airports, 25 air navigation service providers, 11 universities, more than 65 start-ups and businesses, as well as 800 experts, shared their knowledge, skills and resources. [55]

The projects were conducted in close coordination with the EASA, tasked by the Commission with drafting rules to govern the safe integration of drones into manned airspace, to help identify the operational requirements needed for this regulatory framework. In addition, the SESAR JU also ensured close cooperation with the European aviation industry standards developing body, EUROCAE, and supported wider standardization work by the International Civil Aviation Organization (ICAO), in particular ICAO's Standards and Recommended Practices (SARPS) for drones operating in manned airspace due for implementation in 2023.

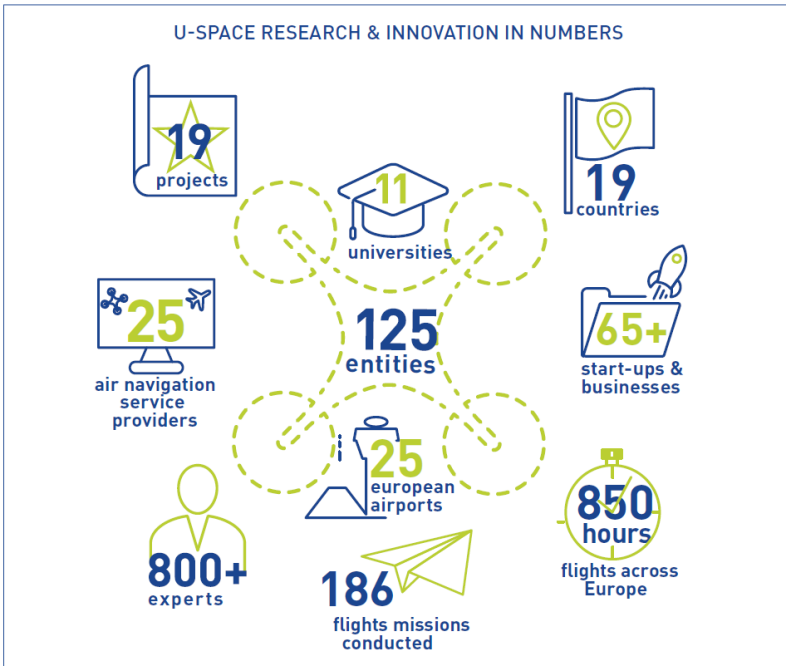


Figure 12 SESAR JU Project [55]

This domain has its research still ongoing and outcomes of all 19 projects are a big contributor for further development of U-Space. SESAR proposed 29 new projects to get further exploration in this domain. EASA has also published an Opinion No 01/2020 The European Union High-level regulatory framework for the U-space as first step towards publication of regulations in U-space.

Next section will describe regulations related to U-space. It will also summarize objectives and results of all 19 projects. The final objectives are to convey readers about major research done in this domain so that users can take advantages of these outcomes for further research and readers may also get knowledge about available technologies suggested by different projects and understand main concepts related to them.

2.2.3 State of the art European U-Space and UTM regulations

U-space is meant as a set of services provided in an airspace volume designated by each Member States' to manage a large number of UAS in VLL (very low level) operations, in a safe and efficient manner. The aim of the U-space services is to provide the UAS operators with information about where and at what altitude they can fly, the status of the airspace volume in which they intend to fly, information about other airspace users that may be conflicting with the planned trajectory/mission, and weather information such as wind, etc. Furthermore, the aim of the U-space services is to support the UAS operators by processing their flight authorization requests. [56] This section will

describe current progress in U-space domain with its core concepts that are to be understood by readers.

2.2.3.1 Key principles of U-Space [57]

1) To ensure the safety of all airspace users operating in the U-space framework, as well as people on the ground.
2) To provide a scalable, flexible and adaptable system that can respond to changes in demand, volume, technology, business models and applications, while managing the interface with manned aviation.
3) To enable high-density operations with multiple automated drones under the supervision of fleet operators.
4) To guarantee equitable and fair access to airspace for all users.
5) To enable competitive and cost-effective service provision at all times, supporting the business models of drone operators.
6) To minimize deployment and operating costs by leveraging, as much as possible, existing aeronautical services and infrastructure, including GNSS, as well as those from other sectors, such as mobile communication services.
7) To accelerate deployment by adopting technologies and standards from other sectors where they meet the needs of U-space.
8) To follow a risk-based and performance driven approach when setting up appropriate requirements for safety, security (including cyber-security) and resilience (including failure mode management), while minimizing environmental impact and respecting the privacy of citizens, including data protection. [57]

2.2.3.2 U-Space Framework

The U-space framework is an architecture to provide U-space services. It comprises of an extensive and scalable range of services based on EU standards and delivered by European service providers. These services deliver key services to organize the safe and efficient operation of drones and ensure a proper interface with manned aviation, and other relevant authorities. They may include the provision of data, supporting services for drone operators such as flight planning assistance and more structured services such as tracking or capacity management.

By the project CORUS, through the definition of ConOps for U-space, four services have already been identified. These are named as: foundation services, initial services, enhance services, and full services.

The progressive deployment of U-space is linked to the increasing availability of blocks of services and enabling technologies. Over time, U-space services will evolve as the level of automation of the drone increases, and advanced forms of interaction with the environment are enabled (including manned and unmanned aircraft) mainly through digital information and data exchange.

Description of various U-space services defined are as follows:

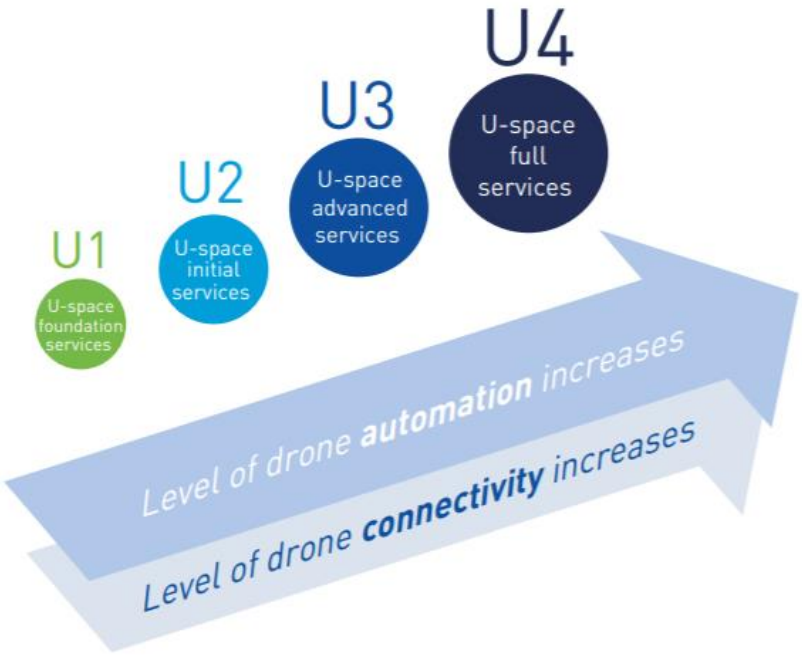


Figure 13 U-space services

U1 U-space foundation services provide e-registration, e-identification and geo-fencing.

U2 U-space initial services support the management of drone operations and may include flight planning, flight approval, tracking, airspace dynamic information, and procedural interfaces with air traffic control.

U3 U-space advanced services support more complex operations in dense areas and may include capacity management and assistance for conflict detection. Indeed, the availability of automated 'detect and avoid' (DAA) functionalities, in addition to more reliable means of communication, will lead to a significant increase of operations in all environments.

U4 U-space full services, particularly services offering integrated interfaces with manned aviation, support the full operational capability of U-space and will rely on very high level of automation, connectivity and digitalization for both the drone and the U-space system.

U-space services

U1	Foundation	▸ Registration ▸ Registration assistance ▸ e-identification ▸ Geo-awareness ▸ Drone aeronautical information management	
U2	Initial	▸ Tracking (Position report submission) ▸ Surveillance data exchange ▸ Geo-fence provision (includes dynamic geo-fencing) ▸ Operation plan preparation /optimisation ▸ Operation plan processing ▸ Risk analysis assistance ▸ Strategic Conflict Resolution ▸ Emergency Management ▸ Incident/ Accident reporting	▸ Citizen reporting service ▸ Monitoring ▸ Traffic information ▸ Navigation infrastructure monitoring ▸ Communication infrastructure monitoring ▸ Legal recording ▸ Digital logbook ▸ Weather information ▸ Procedural interface with ATC
U3	Enhance	▸ Dynamic Capacity Management ▸ Tactical Conflict Resolution ▸ Geospatial information service ▸ Population density map	▸ Electromagnetic interference information ▸ Navigation coverage information ▸ Communication coverage information ▸ Collaborative interface with ATC
U4	Full	▸ Integrated interfaces with manned aviation ▸ Additional new servicesw	

SOURCE: Based on list from U-space concept of operations – Edition 3 (see annex 1 for the full description)

Figure 14 U-space services description

U-space services are moving targets. They are changing with evolution of technologies and availability of technologies with time. The given definition is applicable as on July 2020 and may be changed in future. The handbook will be updated after publication of any amendments.

2.2.3.1 Major SESAR JU projects and their outcomes

SESAR has continuously worked to build U-space concepts by assessing present technologies to support U-space services and research towards effective implementation of future U-space services. In order to assess the maturity of U-space technologies, the SESAR research program created believe that U1 services are available and U2 services can be implemented by the use of various technologies. In order to check various services at various levels, SEASAR JU launched 19 projects. The outcomes of all projects will work as foundations for further research on this topic.

For COMP4DRONES project, the most important projects are **CORUS** (COncept of opeRations for U-Space), **SECOPS** (an integrated SECurity concept for drone OPerationS), **CLASS** (Clear Air Situation for uaS), GEOSAFE (Geo-fencing for safe and autonomous flight in Europe), **TERRA** (Technological European Research for RPAS in ATM), and **DroC2om** (Drone Critical Communications). However, the demonstrators **DIODE** (D-flight Internet Of Drones Environment), **DOMUS** (Demonstration Of Multiple U-space Suppliers), **PODIUM** (Proving Operations of Drones with initial UTM) and other projects such as **SAFIR** (Safe and Flexible Integration of Initial U-space Services in a Real Environment) may be useful too.

The summary of all 19 projects, which were run based on above two assumptions, and their outcomes are described in (**0** Annex) of the document.

In May 2020, SESAR has further launched 29 new exploratory projects [59]. Artificial intelligence, intermodal transport and common altitude reference for drone operations are among the topics to be addressed by a portfolio of 29 new exploratory projects by the SESAR Joint Undertaking within the framework of the SESAR 2020 research and innovation program. The projects aim to foster new and innovative ideas on the digital transformation of air traffic management (ATM) in Europe. The projects will build on the results from current and previous SESAR research, relevant Horizon 2020 projects and other research activities. It will help to propose more innovative solutions, which may be useful for future evolution of drones technologies and integration. [59]

2.2.4 EU- Legal requirements of U-space

EU by the means of different regulations mentioned in section **Error! Reference source not found.** has mandated various services defined by U-space various projects. One example is electronic registration (foundation services) mandate for drone operators (except operators of drones weighing below 250 grams), as well as some classes of drones used in the open category, and all drones used in the specific category. However, there was no specific regulations published by European regulatory authorities in U-space domain.

EASA has recently published Option 01/2020 on High-level regulatory framework for the U-space. The objective of this Opinion is to create and harmonize the necessary conditions for manned and unmanned aircraft to operate safely in the U-space airspace. Other objectives are to prevent collisions between aircraft and to mitigate the air and ground risks. Therefore, the U-space regulatory framework, supported by clear and simple rules, should permit safe aircraft operations in all areas and for all types of unmanned operations. This Opinion proposes an effective and enforceable regulatory framework to support and enable operational, technical and business developments, and provide fair access to all airspace users, so that the market can drive the delivery of the U-space services to cater for airspace users' needs.

This Opinion is, therefore, a **first regulatory step to allow immediate implementation of the U-space** after the entry into force of the Regulation and to let the unmanned aircraft systems and U-space technologies evolve. [56]

2.2.4.1 Summary of opinion 01/2020

U-space is an enabler to manage more complex and longer-distance UAS operations. European regulatory framework for U-space is needed in order to provide harmonization and interoperable operations to European market and also for safety and social acceptance of these new operations. The objectives are to ensure that operations such as beyond visual line of sight (BVLOS) operations or urban air mobility (UAM) are supported with services that enhance safety, security, privacy and efficiency of these operations. Given the increase of UAS traffic and UAS traffic complexity, the need for U-space airspace and U-space services is expected to increase and may cover the entire airspace in which BVLOS and operations of UAS with higher level of autonomy are conducted. [56] These concepts are also needed in order to get easy access of business and to provide affordable and quality services.

This Opinion has been developed applying the following leading principles:

- A risk-based approach.
- Fair and equal access to the airspace and the services to be provided in that airspace.
- Fostering the development of the UAS market in the EU through ensuring a level playing field and a competitive market.
- Accommodating initial BVLOS UAS operations and initial UAS operations in an urban environment or UAM in the short term.
- Recognizing and respecting the existence of today's airspace structures and rules-of-the-air principles which are applicable to manned aircraft operators.
- Fostering further development of U-space's implementation architectures and services, thus enabling more complex UAS operations in the future (e.g., advanced UAM operations, more complex airspace structure and management).

Development of detect and avoid (DAA) and sense and avoid (SAA) are in progress. New concepts such as tactical separation (separation minima, rules and procedures), and DAA systems, capabilities and technologies are not considered to be mature enough at this stage to be included or considered in a first-phase regulation on U-space. Similarly, promising developments in other areas, such as information and communications technology (ICT) and mobile telecommunications, which may become the foundation for connectivity between UAS, operators and the USSP's systems used to provide services within the U-space airspace, are still to be validated for use in a U-space environment. This is also the case for the future 'CNS' infrastructure that will support more advanced operations within the U-space airspace. Therefore, the implementation of this first-phase regulation will cater for the expected UAS traffic and complexity of the near future. Nevertheless, amendments will be done as soon as the U-space concept matures to allow for full deployment of the U-space.

In order to ensure safe operation of UAS, before maturity of needed technologies, we need cooperation of U-space participant. It means that we will need sharing of real time information of traffic. This opinion provides the means to mitigate the risk of collisions by requiring adapted services and sharing essential traffic information. We don't have mature technologies today to integrate manned and unmanned aircraft together. Therefore, this proposal will not propose to change anything in available manned aviation. But it will introduce new types of service providers into the market. One such types of service provider introduced by this opinion is common information service provider (CIS). CIS will enable the exchange of essential information between the U-space service providers (USSPs), the UAS operators, the air navigation service providers (ANSPs) and all other participants in the U-space airspace.

The principles are to support strategic and pre-tactical phase of traffic management operation.

Important points introduced by this regulation are as follows:

1	The rules shall not apply to drones that are either toys, model aircraft within clubs and associations that receive an authorization in accordance with Article 16 of Commission Implementing Regulation (EU) 2019/947 or limited in their weight and speed (the UAS within the 'open' subcategory A1). Such types of operations are not considered to be high-risk and therefore they are exempted from the application of this regulation.

2	The Member States have full authority on the designation of the U-space airspace, and therefore have the power to decide how their airspace is designed, accessed, restricted, etc.
3	The provision of U-space services/ common information services (CIS) within the EU shall be subject to certification by the relevant competent authority established by the Member States.
4	A U-space service provider (USSP) is a new entity created by the regulation and defined in Article 8 of opinion 01/2020. USSP is an organization that is certified by the relevant competent authority to provide U-space services in U-space airspace(s) designated by the Member States. When the USSP provides services of a pan-European nature, the certification authority is EASA. USSPs provide services to UAS operators or to other USSPs. More information about certification of CIS provider and USSP can be find in article 17 and article 18 of opinion 01/2020.
5	The certified CIS provider is designated by the Member State because it provides the CIS on an exclusive basis whereas the USSPs are only required to be certified. USSPs do not need to be designated as there may be more than one USSP providing services in the same U-space airspace implementation.
6	The validity of the certificate is unlimited provided that the CIS provider or USSP continues to operate in compliance with the requirements of this Regulation. Please refer article 19 of opinion 01/2020 for more information.
7	As per article 20 of opinion 01/2020, EASA is the competent authority for the certification of CIS providers or USSPs providing pan-European services that is if they provide services within more than one Member State or when the services are provided from outside the territory to which the EU Treaty applies. As per article 21 of opinion competent authorities are that perform certification, oversight and enforcement tasks in respect of the CIS provider and USSPs. It also lists a number of obligations that are directly related to the functioning of the U-space system.
8	Authorities mentioned in article 20 of OPINION 01/2020 are granted certain specific investigatory powers. Those powers should be exercised in accordance with the applicable national rules and procedures, while having due regard to a number of specific elements which are meant to ensure a fair balance between all rights and interests.
9	When designating U-space airspace and integrating USSPs to provide U-space services to UAS within controlled and uncontrolled airspace, the already established principles need to be considered and respected.
10	ANSPs provide air navigation services (ANS) to manned aircraft while USSPs provide U-space services to UAS operators. Both ANSPs and USSPs are certified to provide their respective services in a safe, secure and continuous manner.
11	Within controlled airspace, U-space airspace is designated by the Member States and is dynamically managed by the ANSP. The safety of operations is guaranteed by the fact that manned and unmanned traffic will not mix with each other as they are dynamically segregated and ANS and U-space services are not provided at the same time in the same volume of airspace.
12	In uncontrolled airspace, the airspace remains uncontrolled for manned aircraft. But when the Member States designate a volume of airspace as U-space airspace, there is a restriction (therefore it could be established as a restricted area): for UAS operators, to use U-space services to fly in that airspace; and for manned aircraft operators, to make available their position at regular intervals to the USSPs.
13	USSPs can provide manned traffic information to unmanned aircraft or can geo-fence the unmanned traffic around the manned traffic. The manned aircraft operator will also be informed about the U-space airspace and the unmanned traffic either by the FIS provider

	or by the USSP, depending on the specific implementation. This principle shall also be applied for uncontrolled traffic within controlled airspace (VFR traffic within class E).
14	The following U-space services are considered necessary and mandatory to ensure safe and efficient operations in each U-space airspace implementation: network identification, geo-awareness, traffic information and UAS flight authorization. In addition, Member States may decide that additional U-space services are needed to support safe and efficient UAS operations in specific volumes of U-space airspace implementation.
15	In order to be a USSP, the interested entity needs to demonstrate its capability of providing at least the four mandatory U-space services (network identification, geo-awareness, traffic information and UAS flight authorization).
16	Whereas the remote identification in Regulation (EU) 2019/945 supports the authorities in aspects related to security and privacy, the network identification service within U-space airspace operationally supports traffic safety and the traceability of the unmanned aircraft during its flight. Indeed, based on this information, the USSPs can share UAS traffic information between themselves and therefore provide traffic information to UAS operations.
17	The geo-awareness contained in Regulation (EU) 2019/945 is related to the UAS capabilities and the requirements for the Member States when they decide to establish geographical zones or for the UAS operators to follow and comply with the specification of these zones.
18	To provide traffic information service, the USSP may use the information on other traffic available to them through the network identification system or through other technical means (e.g., from manned aircraft ADSB, transponders, etc.) implemented in the U-space airspace. The main objective of this service is to alert and to help the UAS operator to avoid a collision. This service provides the alerts, air situation and known/predicted (e.g., if tracking service is available) traffic to the UAS operator.
19	The flight authorization service is mandatory in both controlled and uncontrolled airspace and applies to UAS operators only, not to manned aircraft. The reason for being mandatory also in uncontrolled airspace is the need for situational awareness of the USSPs of all the UAS traffic intending to operate in the U-space airspace. This allows USSPs to apply the prioritization rules prior to providing the authorization. It also allows them to pre-tactically manage traffic flow. With the information about the intended flight and other information about the type of the operations and its endurance as well as some related aircraft performance, the USSPs should be able to de-conflict the potentially conflicting flights before these flights take place.
20	When there is more than one USSP providing U-space services in the U-space airspace, all USSPs are obliged to share the flight authorization requests between themselves along with adhering to the GDPR requirements.
21	USSPs can contract out the provision of some or all U-space services to other entities as long as it remains under their management control. There can also be associations of USSPs or equivalent mechanisms as long as it is clear that there is one single entity responsible for providing the minimum set of services towards the UAS operators.
22	In relation to the flight authorization management, USSPs are required to take actions with regard to the flight authorization request of the UAS operators (e.g., checking for completeness, plausibility and accuracy, accept it or not, notify the UAS operator, etc.).
23	USSPs need to be certified if they want to provide U-space services, but they do not need to be designated for the U-space airspace in which they aim to provide U-space services. Once they are certified, they can provide services in any U-space airspace in the EU.
24	In order to ensure that the necessary information comes from trusted sources and that it is of sufficient quality, integrity and accuracy as well as security so that the USSPs and

	other users such as ASNPs can use this information with full reliability when providing their services, there is need of common information service (CIS) provider.
25	The CIS is at the heart of the U-space system. The information will be managed by the CIS provider. This provider ensures that all the information can be exchanged between the various organizations to fulfil their obligations.
26	There will be only one CIS provider per U-space airspace. There could be as many CIS providers as there are designated U-space airspaces. The reason for having one CIS provider per U-space airspace is to ensure that there is one single point of contact, one single point of truth that consolidates all the information necessary for the functioning of the U-space airspace.
27	The CIS provider cannot be a USSP itself. This is necessary to ensure that there is no conflict of interest when the common information is made available to the different USSPs and that there is fair competition in the U-space services market.
28	USSPs will report occurrences, based on the current regulation on the occurrence reporting, analysis and follow-up of occurrences in civil aviation.
29	Tracking services can be used to track the real-time and historical telemetry data of the UAS if the necessary supporting infrastructure exists and the UAS is flying in the range of the service capability. More information about this service is available in article 14 of opinion 01/2020.
30	Weather information service collects the weather information necessary to support UAS operational decisions in a specific U-space airspace and support the provision of other U-space services such as the flight authorization service. This information may be different than provided to manned aviation in today scenarios. Therefore, article 15 of opinion 01/2020 specifies a minimum content of weather information to be available for the purpose of UAS operations in the near future. However, the proposed regulation does not specify who may provide this service.
31	Conformance monitoring service checks the current track of each UAS with respect to its planned mission as defined in the approved flight authorization and compares it with it. It also considers the existence of new geo-fencing areas dynamically established and not existing before the flight authorization was approved and alerting the UAS operators when detecting non-conformities. When non-conformities of the UAS flight are detected, and potential hazardous situations are evident, the USSPs shall also alert other traffic (manned or UAS) and other USSPs or other relevant authorities with the available means.
32	The price of CIS (article 23 of opinion 01/2020) should reflect the cost for the management of the CIS, with a markup reflecting the risks associated with its activities. ANSPs and USSPs should exchange safety information through the CIS for free.
33	The implementation time of this regulation is proposed to be 1 year after Regulation enters into force.

Table 6 Important points of Opinion 01/2020

2.2.1 Takeaway for operator and manufacturer

Following are the summary of Opinion 01/2020 published by EASA in the month March 2020. This Opinion contains a draft regulation and is submitted to the European Commission, which will use it as a technical basis in order to prepare an EU regulation.

Opinion 01/2020 on High-level regulatory framework for the U-space	
Article 6: The obligations for **UAS operators when they operate in the U-space airspace**	
1	At a strategic level, the UAS operators shall consider where U-space airspace is designated when preparing for their UAS operations in that airspace and establish a contract with one

	certified USSP of their choice that provides the mandatory set of U-space services in that airspace.
2	The flight authorization service is provided on the basis of the UAS operator having filled in the flight authorization request form (former flight plan) that UAS operators need to fill in before flight departure. The format of form is attached as Appendix A of opinion 01/2020. At pre-tactical level, UAS operators are asked to submit their flight authorization request form to the USSP they have a contract with if they want to operate in U-space airspace, and to ensure that they do so in accordance with the terms and conditions of the flight authorization once it is granted by the USSP.
3	UAS operators are not allowed to commence their flight until they have been granted with a flight authorization by the USSP and they have to ensure that they are able to comply with the terms and conditions given by the USSP in the granted flight authorization. In case they cannot comply with the one granted by the USSP, they have to amend their original flight authorization request.
4	Compliance with the instructions of the USSP is required, as well as ensuring that their UAS are technically capable of receiving the U-space services and of operating in the U-space airspace.
ARTICLE 7: The obligations for operators of manned aircraft operating in U-space airspace	
1	In order to allow the USSPs to safely manage the unmanned aircraft in that U-space airspace and provide the UAS operator with manned traffic information, they need to know where the manned aircraft will be in the U-space airspace. They will then be able to take the necessary measures to ensure that the air risk is mitigated.
2	The information that manned aircraft operators need to provide is their position at regular intervals, with the necessary level of performance in terms of integrity, accuracy, continuity and availability as well as security to allow the USSPs to make use of this data for the provision of U-space services.

Table 7 Takeaways for UAS and U-space operators from U-space regulations

U-space first regulatory document ***does not specify any obligations of UAS manufacturer***. However, in order to provide mandatory services asked in the regulation, UAS manufacturer will needed to provide required technologies.

2.2.2 Conclusion

U-space is a new concept. SESAR project CORUS [1] was first project to describe U-space operational concept by publication of ConOps document. Several other SESAR projects described in (**0** Annex) have already validated many concepts proposed by CORUS ConOps.

EASA has developed first document on U-space regulatory context in very short span (15 months). Proposed opinion by EASA is first step for regulations publication of U-space by European regulatory authorities. They have not taken into consideration of necessary technologies, which are still evolving. Most concepts proposed are based on active engagement of several entities including ANS providers. New types of services and corresponding entities have been proposed. Besides this, one important point to notes is that EASA has delegated power and responsibilities to member states for major infrastructure and decisions. This document will get several revision and amendments in future based on evolutions in technologies and procedures.

3 Methodologies and framework

3.1 Introduction

This chapter includes methodologies required for UAS operators to perform any UAS operations in European airspace and framework adapted for UAS operations. It includes mandatory obligations of UAS and operators registration, permit to fly application procedure, certification, and other requirements. All these processes and obligations are mentioned by EU (European Union) in various regulatory requirements documentation. This chapter will consolidate all important information in these aspects. The regulations for UAS operations are still in development stage. There are some references, which has been considered to write this chapter, but they are still proposal of competent regulatory European authority. The procedure for inclusion of proposed amendments into European regulations is in process. We are continuously tracking updates proposed by EU and in case of any amendments in proposal or addition of any new proposals, this chapter will be modified.

As per current European regulations, following are important mandates published by EU and other procedures detailed description needed to perform UAS operations.

3.2 Registration of UAS and operators [18]

COMMISSION IMPLEMENTING REGULATION (EU) 2019/947 clause 13 to 16 clearly states about importance of registration of UAS and UAS operators. As per EU regulations, member States shall establish and maintain accurate registration systems for UAS whose design is subject to certification and for UAS operators whose operation may present a risk to safety, security, privacy, and protection of personal data or environment. It mandates and says that rules and procedures should be established for the marking and identification of unmanned aircraft and for the registration of operators of unmanned aircraft or certified unmanned aircraft.

UAS operators shall register themselves:

1. When operating within the ‘open’ category any of the following unmanned aircraft: with a MTOM of 250 g or more, or, which in the case of an impact can transfer to a human kinetic energy above 80 Joules or/and that is equipped with a sensor able to capture personal data, unless it complies with Directive 2009/48/EC [41].
2. When operating within the ‘specific’ category an unmanned aircraft of any mass.
3. When operating within the ‘certified’ category an unmanned aircraft of any mass.

In order to easily access registration information in case of need, the information about registration of certified unmanned aircraft and of operators of unmanned aircraft that are subject to a registration requirement should be stored in digital, harmonized, interoperable national registration systems, allowing competent authorities to access and exchange that information.

Article 14 of COMMISSION IMPLEMENTING REGULATION (EU) 2019/947 describe detailed information about “Registration of UAS operators and certified UAS”. It mandates all member states to register UAS as described above. This article asks many details about the UAS and operators for registration process. The summary of Article 14 is as follows:

1. The registration system shall have following information about UAS operators: Full name and date of birth of natural person and identification number of legal person; Address, email, telephone, insurance policy (if required by union or national law), obligation statement as per article 14, and operational authorization and LUC held, if any.
2. The registration systems for unmanned aircraft whose design is subject to certification shall provide the fields for introducing and exchanging the following information:

   manufacturer's name; manufacturer’s designation of the unmanned aircraft; unmanned aircraft's serial number; full name, address, email address and telephone number of the natural or legal person under whose name the unmanned aircraft is registered.

3. UAS operators shall register themselves in the Member State where they have their residence for natural persons or where they have their principal place of business for legal persons and ensure that their registration information is accurate.
4. A UAS operator cannot be registered in more than one Member State at a time.
5. Member States shall issue a unique digital registration number for UAS operators and for the UAS that require registration, allowing their individual identification.
6. The registration number for UAS operators shall be established on the basis of standards that support the interoperability of the registration systems.
7. The owner of an unmanned aircraft whose design is subject to certification shall register the unmanned aircraft. The nationality and registration mark of an unmanned aircraft shall be established in line with ICAO Annex 7.
8. An unmanned aircraft cannot be registered in more than one State at a time.
9. The UAS operators shall display their registration number on every unmanned aircraft need to be registered.

The above registration rules are important for safety and security of UAS operation in airspace. This process is also mandatory service of U-space foundation services. Any UAS operator can apply for operational authorization only after their and UAS registration. Next section will describe about permit to fly application process to be followed by all UAS operators in European region.

3.3 Permit to fly application

Permit to fly is a term used for a specific operation authorization. Since in today's scenarios, UAS domain has no standardization and harmonization process for manufacturing of systems and subsystems along with other process and procedures, each operation needs specific approval by competent authority. This section will describe necessary information to help UAS operators to understand all aspects of permit to fly application process.

3.3.1 Scope

The scope of this section is to describe the necessary procedure to be adapted to get permission for any specific operations. As defined in earlier chapter there are three types of UAS operations, and each operation has different procedure to follow. The category of operations is based on the risk posed by operations and hence categorized into open, specific, and certified operations, as per European regulations.

This chapter will describe procedure to be followed for each type of operation. It should be noted that permit-to-fly is specific for a particular operation. Operators getting benefits of LUCs will not need to apply for permit to fly application process, if their operations are within the scope of authorization provided to them in LUC.

3.3.2 Eligibility

Any UAS operator complying all requirements defined in various European regulations defined in section UAS.SPEC.050 Responsibilities of the UAS Operator are eligible for UAS operations in Europe and hence need permit-to-fly from competent authority for proposed operations. As per commission implemented regulations (EU) 2019/947:

1. UAS operations in the 'open' category shall comply with the operational limitations set out in Part A of the Annex of implemented regulations (EU) 2019/947 and subsequently delegated regulations (EU) 2019/945.
2. UAS operations in the 'specific' category shall comply with the operational limitations set out in the operational authorization as referred to in Article 12 of implemented regulations (EU) 2019/947 or the authorization as referred to in Article 16 of implemented regulations (EU) 2019/947, or in a standard scenario defined in Appendix 1 to the Annex of implemented regulations (EU) 2019/947 as declared by the UAS operator. UAS operations in the 'specific' category shall be subject to the applicable operational requirements laid down in Commission Implementing Regulation (EU) No 923/2012.

3. UAS operations in the 'certified' category shall be subject to the applicable operational requirements laid down in Implementing Regulation (EU) No 923/2012 [60] and Commission Regulations (EU) No 965/2012 [61] and (EU) No 1332/2011 [62].

If above requirements are fulfilled by UAS operator, they are eligible to fly into assigned European airspace and need operation authorization also known as permit-to-fly for any types of operations. The procedure for operational authorization for each category of operations will be defined in further sections.

3.3.3 Competent authority

As per article 15 of commission implementing regulation (EU) 2019/947, every member state may restrict or allow area of operations in their state. When defining UAS geographical zones for safety, security, privacy or environmental reasons,

Member States may:

a. prohibit certain or all UAS operations, request particular conditions for certain or all UAS operations or request a prior operational authorization for certain or all UAS operations;
b. Subject UAS operations to specified environmental standards;
c. Allow access to certain UAS classes only;
d. Allow access only to UAS equipped with certain technical features, in particular remote identification systems or geo awareness systems.

On the basis of a risk assessment carried out by the competent authority, Member States may designate certain geographical zones in which UAS operations are exempt from one or more of the 'open' category requirements. The information on the UAS geographical zones, including their period of validity, should be made publicly available in a common unique digital format.

As per article 17 of IR (EU) 2019/947, Each Member State shall designate one or more entities as the competent authority for the tasks referred to in Article 18. Where a Member State designates more than one entity as a competent authority it shall clearly define the areas of competence of each competent authority in terms of responsibilities and establish appropriate coordination mechanism between those entities to ensure the effective oversight of all organizations and persons subject to IR (EU) 2019/947.

Article 18 of commission implementing regulation (EU) 2019/947 assign various tasks for competent authority declared by member states. It includes issuing, amending, suspending, limiting, or revoking operational authorizations and LUCs and verifying completeness of declarations, which are required to carry out UAS operations in the 'specific' category of UAS operations.

However, recently by publication of NPA 2020-07 "Unmanned aircraft system beyond visual line operations overpopulated areas or assemblies of people in the 'specific' category", EASA has declared itself as competent authority for high robustness of specific categories of operation.

Summary of competent authorities based on types of operations are as follows:

Types of Operations	Competent Authority
Open category	No need for authorization Need supervision by Competent authority decided by member states
Specific category (Low and medium level of robustness)	Competent authority decided by member states
Specific category (high level of robustness)	EASA
Certified Category	EASA

Table 8 Competent authority based on UAS operations

3.3.4 ConOps description

The operational risk assessment required by Article 11 of the UAS commission implementing regulation (EU) 2019/947 may be conducted using the methodology described in AMC1 to Article 11. This methodology is known as specific operations risk assessment (SORA) developed by JARUS. Other methodologies might be used by the UAS operator as alternative means of compliance.

In accordance with Article 11 of the UAS commission implementing regulation (EU) 2019/947, the applicant must collect and provide the relevant technical, operational and system information needed to assess the risk associated with the intended operation of the UAS. This information will act as input to SORA methodology. This collection of information will be done in a document known as ConOps.

The SORA (AMC1 to Article 11 of the UAS Regulation) methodology provides a detailed framework for such data collection and presentation. The concept of operations (ConOps) description is the foundation for all other activities and should be as accurate and detailed as possible. The ConOps should not only describe the operation, but also provide insight into the UAS operator's operational safety culture. It should also include how and when to interact with the air navigation service provider (ANSP) when applicable. Annex-A of SORA V2 named "CONOPS: GUIDELINES ON COLLECTING AND PRESENTING SYSTEM AND OPERATIONAL INFORMATION FOR SPECIFIC UAS OPERATIONS" describe guidelines needed to write concept of operations. This document may be very useful, to write a ConOps by operator.

Although, JARUS SORA V2 and its annex are defined by EASA in acceptable means of compliance with article 11 of implementing regulation (EU) 2019/947, it is not adapted as it was defined by JARUS. The version adapted by EASA provides more detailed procedure to write concept of operations document. Therefore, it is recommended to UAS operators to follow AMC and GM documents published by European regulatory authorities named as ED decision 2019/021/R [38] and use Annex-A of SORA defined in this document in order to write ConOps for their operations.

In summary, ConOps defined by UAS operators shall describe all functions and requirements defined in article 11 of implementing regulation (EU) 2019/947 to perform safety assessment of proposed UAS operations. Any other additional information not defined in Annex A but important and specific to proposed operations by operator shall be added in ConOps. Once ConOps is prepared and risk assessment are done to comply with article 11 and article 12 of implementing regulation (EU) 2019/947, following procedure should follow by UAS operator to apply for permit to fly.

ConOps should take into consideration of additional requirements which may indirectly affect UAS operations. It may be to take into consideration of Security requirements, Emergency and contingencies procedure, proposed actions in case of different Accidents and serious incidents, and efforts taken in order to take consideration of environment. Besides this any additional factors which may be important for proposed operations shall take into account.

3.3.5 Application procedure and approval

As described in previous section, application procedure and approval depend upon the types of operations. Following are the description of procedure for each types of operations:

3.3.5.1 Open category/Limited Open category

UAS operations in the 'open' category shall not be subject to any prior operational authorization, nor to an operational declaration by the UAS operator before the operation takes place, however they should perform operations and follow design constraint strictly as defined in Part A of implementing regulation (EU) 2019/947 and subsequently of commission delegated regulation (EU) 2019/945. Member States will take the necessary steps to ensure that UAS intended to be operated in the 'open' category are made available on the market and put into service only where they do not compromise the health and safety of persons, domestic animals or property, when normally used. The manufacturer will provide conformity assessment which declare compliance with European law. Thus, for open category of operation, major responsibilities are remained with manufacturer, which are defined in 2.2.1. There are operator responsibilities too which are defined in European regulations. Therefore, manufacturer and operator will need to get compliance with delegated regulations (EU) 2019/945 and of implementing regulation (EU) 2019/947.

3.3.5.2 Specific category: Standard scenarios

In case of operators are following the standard scenarios defined by European regulation, they may submit an operational declaration of compliance with a standard scenario. This information is defined

in Part B, UAS.SPEC.020 operational declaration of commission implementing regulations (EU) 2019/947. This section also described standard scenarios in detailed way.

A declaration of UAS operators shall contain:

(a) Administrative information about the UAS operator;

(b) A statement that the operation satisfies the operational requirement set out in standard scenarios.

(c) The commitment of the UAS operator to comply with the relevant mitigation measures required for the safety of the operation, including the associated instructions for the operation, for the design of the unmanned aircraft and the competency of involved personnel.

(d) Confirmation by the UAS operator that an appropriate insurance cover will be in place for every flight made under the declaration, if required by Union or national law.

The declaration may be complemented by the description of the procedures to ensure that all operations are in compliance with Regulation (EU) 2016/679 [63] on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, as required by UAS.SPEC.050(1)(a)(iv) of implementing regulations (EU) 2019/947.

3.3.5.3 Specific categories: Low and medium robustness

If operation is not covered by standard scenarios and the UAS operator does not hold an LUC with the appropriate privileges, before starting an UAS operation in the 'specific' category, the UAS operator shall obtain an operational authorization from the national competent authority of the Member State of registration. This information is defined in Part B, UAS.SPEC.030 application for an operational authorization, UAS.SPEC.050 responsibilities of the UAS operator, and article 11 and article 12 of commission implementing regulations (EU) 2019/947.

The UAS operator shall submit an application for an updated operational authorization if there are any significant changes to the operation or to the mitigation measures listed in the operational authorization.

The application for an operational authorization shall be based on the risk assessment referred to in Article 11 and shall include in addition the following information:

a. The registration number of the UAS operator;
b. The name of the accountable manager or the name of the UAS operator in the case of a natural person;
c. The operational risk assessment;
d. The list of mitigation measures proposed by the UAS operator, with sufficient information for the competent authority to assess the adequacy of the mitigation means to address the risks;
e. An operations manual when required by the risk and complexity of the operation;
f. A confirmation that an appropriate insurance cover will be in place at the start of the UAS operations, if required by Union or national law.

In order to apply for operational authorization, the UAS operator should submit an application to the responsible authorities (in each MS) to obtain approvals for the specific operations (E.g., DGAC - in France). Necessary steps and required application to obtain Operational Authorisation under Specific category can be found on Page 183 as per the Easy access rules for UAS. The form requests following information:

1. The UAS operator registration number in accordance with Article 14 of the UAS Regulation
2. The name of the accountable manager or the name of the UAS operator in the case of a natural person
3. The name of the manufacturer of the UAS
4. The model of the UAS as defined by the manufacturer
5. The serial number of the UA defined by the manufacturer, or the registration mark for the UA requiring registration according to Article 14 of the UAS Regulation
6. The configuration of the UA
7. The maximum take-off mass for which the UA is designed, expressed in kg

8. The maximum cruise air speed expressed in m/s and knots in parenthesis
9. State the maximum dimensions of the UA in meters
10. In case of more than one UAV in any operations, it should be filled with the data of all the UAS intended to be operated.
11. The description of the intended operation characterizing the area where it will take place (i.e., urban, sparsely populated, industrial, etc.) and the airspace.
12. The number of the PDRA, if applicable.
13. A list of the mitigation measures and the OSOs put in place, as required by the PDRA or proposed by the UAS operator if no PDRA is available. Sufficient information should be provided to the competent authority to assess the robustness of the measures.
14. A short description of the procedures established by the UAS operator to ensure that all operations are in compliance with Regulation (EU) 2016/679 on the protection on personal data as required by point UAS.SPEC.050(1)(a) iv.

Depending on the level of the risk of the operation, the technical characteristics of the UAS may play an important role in mitigating the risk. In that case, the UAS operator may provide additional information to the NAA on the characteristics of the UAS to be operated. The NAA will, in any case, ask for additional data when needed.

3.3.5.4 Specific category (high robustness) and certified category

According to Article 40(1) (d) of Regulation (EU) 2019/945, all UASs used in the 'specific' category, for which the risk assessment considers that the risk of the operation cannot be adequately mitigated without the certification of the UAS, shall be certified.

This applies to all UAS operations for which the requested level of assurance of the OSOs associated with the design is high.

Article 40(2) of Regulation (EU) 2019/945 requires the certified UAS to comply with the applicable requirements of Regulations (EU) No 748/2012 (the 'Initial Airworthiness' Regulation), (EU) 2015/640 (the 'Additional Airworthiness Specifications' Regulation), and (EU) No 1321/2014 (the 'Continuing Airworthiness' Regulation).

Based on that, the UAS must:

1. Have a(n) (R)TC or a permit to fly according to the Initial Airworthiness Regulation.
2. A competent authority for continuing airworthiness to verify compliance with the Continuing Airworthiness Regulation; and
3. In the same way, a competent authority, designated by the EASA Member State, to verify compliance with the Additional Airworthiness Specifications Regulation, where applicable.

As long as EASA does not issue (R) TCs for UASs, BVLOS operations over a populated area or an assembly of people are only authorized with a **permit to fly**, after EASA approves the flight conditions in accordance with the requirements of point 21.A.701 of the Annex (Part 21) to the Initial Airworthiness Regulation. In such a case, the continuing airworthiness of the UAS is ensured based on the specific continuing-airworthiness requirements that are defined in that permit to fly and on those flight conditions.

As per Part B, UAS.SPEC.100 of implementing regulation (EU) 2019/947, if the UAS operation is using an unmanned aircraft for which a certificate of airworthiness or a restricted certificate of airworthiness have been issued, or using certified equipment, the UAS operator shall record the operation or service time in accordance either with the instructions and procedures applicable to the certified equipment, or with the organizational approval or authorization. Additionally, the UAS operator shall follow the instructions referred to in the unmanned aircraft certificate or equipment certificate, and also comply with any airworthiness or operational directives issued by the Agency.

3.3.5.5 Specific category- LUCs

LUC operators shall comply all regulation as per Part C of implementing regulation (EU) 2019/947. UAS operators holding an LUC in accordance with point UAS.LUC.060 of the Annex has following privileges:

Within the terms of approval, grant to an LUC holder has privilege to authorize its own operations without submitting an operational declaration or without applying for an operational authorization.

To get this approval, UAS operator will submit all necessary documentation. When satisfied with the documentation provided, the competent authority will specify the terms and conditions of the privilege granted to the UAS operator in the LUC.

Therefore, in case of LUCs operator, there is no need of operational authorization or declaration to competent authority.

3.3.6 Applicability of permit to fly

Generally, permit to fly issued for a particular operation or recurring operations shall be applicable to the operation for which authorization have been provided by competent authority. The operational authorization will specify the applicability of permit to fly. The applicability of permit to fly will be decided by competent authority as per the authorization asked by operator.

3.3.6.1 Open category

Permit to fly is not applicable.

3.3.6.2 Specific category

As per commission implementing regulation (EU) 2019/947, Article 5, for specific operations:

The competent authority shall specify whether the operational authorization concerns:

a. The approval of a single operation or a number of operations specified in time or location(s) or both. The operational authorization shall include the associated precise list of mitigating measures.
b. The approval of an LUC, in accordance with part C of the Annex of commission implementing regulation (EU) 2019/947.

As per Part B, UAS.SPEC.070 of implementing regulation (EU) 2019/947, any operational authorization is not transferable. As per Part B, UAS.SPEC.080 of implementing regulation (EU) 2019/947, the operational authorization remains valid as long as the UAS operator remains compliant with the relevant requirements of this Regulation and with the conditions defined in the operational authorization. Upon revocation or surrender of the operational authorization the UAS operator shall provide an acknowledgment in digital format that must be returned to the competent authority without delay.

3.3.6.3 Specific category- LUC

As per Part C, UAS.LUC.080 Duration and validity of an LUC of commission implementing regulation (EU) 2019/947, an LUC shall be issued for an unlimited duration. It shall remain valid subject to: (a) the LUC holder's continuous compliance with the relevant requirements of this Regulation and of the Member State that issued the certificate; and (b) it not being surrendered or revoked.

Upon revocation or surrender of an LUC, the LUC holder shall provide an acknowledgment in digital format that must be returned to the competent authority without delay.

3.3.6.4 Certified category

At the time of the writing of this Handbook, rulemaking on the Certified category of operation is ongoing. In consequence, this is not addressed by this version of this handbook.

3.3.7 Issue of a permit to fly

In case of specific category, after receiving the application, competent authority will provide authorization and regulation mentioned in UAS.SPEC.040 of implementing regulation (EU) 2019/947 or Easy access rules for UAS will be followed. The competent authority shall specify in the operational authorization the exact scope of the authorization in accordance with Article 12. In order to facilitate mutual recognition in cases of cross-border operations, the competent authority should produce an English version of the operational authorization. Issue of permit to fly is not needed for LUCs operators.

3.3.8 Obligation of holders of permit to fly

The holders of permit to fly will use permission strictly for the operation applied and as per the terms and conditions mentioned in operational authorization by competent authority. The UAS operator shall submit an application for an updated operational authorization if there are any significant changes to the operation or to the mitigation measures listed in the operational authorization.

3.3.9 Record keeping

The application and all the documentation referred to or attached will be stored by competent authority for **two years** in a manner that ensures their protection from unauthorized access, damage, alteration, and theft.

LUC operators will need to keep record as per UAS.LUC.020 Responsibilities of the LUC holder of commission implementing regulations (EU) 2019/947. As per this clause, LUC operators will keep records of the following items in a manner that ensures protection from damage, alteration and theft for a period at least 3 years for operations conducted using the privileges specified under point UAS.LUC.060 of commission implementing regulations (EU) 2019/947:

a. The operational risk assessment, when required and its supporting documentation.
b. Mitigation measures taken.
c. The qualifications and experience of personnel involved in the UAS operation, compliance monitoring and safety management.

LUC operators shall also keep personnel records of personnel involved in the UAS operation as long as the person works for the organization and shall be retained until 3 years after the person has left the organization.

3.4 Type certificate and airworthiness standards of UAS

3.4.1 Scope

As per current European regulation all UAS mentioned in 3.3.5.4 are in certified category. As defined in 3.3.5.4, such UAS need type certificate or restricted type certificate R (TC) or a permit to fly according to the Initial Airworthiness Regulation. In present scenarios, there are no certification specifications for UAS. But many work is going on by different standardization and regulatory organization to define such specifications and process. The section will describe available information related to UAS, which required type certificate or restricted type certificate.

3.4.2 Eligibility

All UAS defined in section 3.3.5.4 are subject to type certificate or restricted type certificate in order to save the time and resources to apply and receive permit to fly by competent authorities. Recently, EASA has published NPA 2020-07. In this NPA, they have defined weight and operational environmental conditions of specific categories of UAS in which condition, it will be mandatory for them to get type certificate or restricted type certificate. As per NPA 2020-07, the following operations:

- BVLOS operations over a populated area for a UAS with an MTOM of more than 4 kg; and
- BVLOS operations over an assembly of people for a UAS with a kinetic energy of more than 80 J

UAS are considered to be high-risk operations for third parties on the ground, irrespective of the mitigations proposed by applicants. Such categories of UAS will also fall into certified category.

However, this amendment is only proposed to the current version of SORA mentioned in AMC and GM of implementing regulations (EU) 2019/947 and delegated regulations (EU) 2019/945. Final inclusion of this amendment into regulation may modify the situation further.

In summary, as on July 2020, following UAS (specific and certified category) are mandated to operate into certified category in EU regulations:

SN	UAS operation types	Initial category	New category
1	it has a characteristic dimension of 3 m or more, and is designed to be operated over assemblies of people	Certified	Certified
2	it is designed for transporting people	Certified	Certified
3	it is designed for the purpose of transporting dangerous goods and requiring a high level of robustness to mitigate the risks for third parties in case of accident	Certified	Certified
4	it is used in the 'specific' category of operations defined in Article 5 of Implementing Regulation (EU) 2019/947 and the operational authorization issued by the competent authority, following a risk assessment provided for in Article 11 of Implementing Regulation (EU) 2019/947, considers that the risk of the operation cannot be adequately mitigated without the certification of the UAS	Certified	Certified
5	BVLOS operations over a populated area for a UAS with an MTOM of more than 4 kg	Specific	Certified
6	BVLOS operations over an assembly of people for a UAS with a kinetic energy of more than 80 J	Specific	Certified

Table 9 UAS operations in certified categories

3.4.3 Demonstration of capability [64]

As per EASA NPA 2020-07 [64] titled "unmanned aircraft system beyond visual line operations over populated areas or assemblies of people in the 'specific' category. Following is the definition of specific categories to operate into certified categories:

		0-250 g	250-900 g	900 g-4 kg	4-25 kg	> 25 kg
VLOS	Populated	'Open'	'Open'	'Open'	'Specific' without mandatory (R)TC	'Specific' without mandatory (R)TC
BVLOS	Populated	'Specific' without mandatory (R)TC	'Specific' without mandatory (R)TC	'Specific' without mandatory (R)TC	'Specific' with mandatory (R)TC	'Specific' with mandatory (R)TC

Table 10 Specific categories of UAS to be flown in certified categories

As per commission delegated regulation (EU) 2019/945, Article 40(2), the certified UAS have to comply with the applicable requirements of Regulations (EU) No 748/2012 (the 'Initial Airworthiness' Regulation), (EU) 2015/640 (the 'Additional Airworthiness Specifications' Regulation), and (EU) No 1321/2014 (the 'Continuing Airworthiness' Regulation). Therefore, in order to perform certified category of operation, an operator need to be complied with the applicable requirements of Regulations (EU) No 748/2012 (the 'Initial Airworthiness' Regulation), (EU) 2015/640 (the 'Additional Airworthiness Specifications' Regulation), and (EU) No 1321/2014 (the 'Continuing Airworthiness' Regulation) and will provide demonstration for compliance with defined regulations as per current AMC and GM of these regulations.

Above defined regulations were written for manned aircraft domain. Tailoring of these regulations for UAS operations based on expected risk of proposed operations is in preparation stage. Till regulatory documents for UAS are published by competent authorities, all certified UAS needed to follow strict regulations defined in above regulatory documents.

3.4.4 Means of compliance [64]

As per EASA NPA 2020-07, since certification specifications (CS) for UAS are not available today, EASA will develop a complete set of dedicated technical specifications in the form of special conditions.

EASA is also working to develop continuing airworthiness of certified UAS. It is planned that it will include an Annex for certified UAS that operate in the 'specific' category, pursuant to Article 40(1)(d) of Regulation (EU) 2019/945. The Annex will contain alleviations, compared to the continuing-airworthiness requirements laid down for UASs in the 'certified' category. All these information will be published by EASA in AMC and GM published for commission delegated regulation (EU) 2019/945 in future.

As long as EASA does not issue (R) TCs for UASs, BVLOS operations over a populated area or an assembly of people are only authorized with a permit to fly, after EASA approves the flight conditions in accordance with the requirements of point 21.A.701 of the Annex (Part 21) to the Initial Airworthiness Regulation.

In such a case, the continuing airworthiness of the UAS is ensured based on the specific continuing-airworthiness requirements that are defined in that permit to fly and on those flight conditions.

Note: *EASA has published Special Conditions for Special Condition for Light Unmanned Aircraft Systems, SC Light-UAS 01. In special conditions, they have defined that all Light UAS operations having Medium[1] and High Risk[2] and others complying with certification requirements to be certified using special conditions. This SC is applicable to light UAS with:*

- Not intended to transport Humans
- Operated with intervention of the remote pilot or autonomous 1
- With MTOM up to 600 Kg
- Operated in the specific category of operations, medium and high risk, or in the certified category of operations.

Nevertheless, there are some discrepancies between NPA and special conditions. NPA asks to follow Regulations (EU) No 748/2012 (the 'Initial Airworthiness' Regulation), (EU) 2015/640 (the 'Additional Airworthiness Specifications' Regulation), and (EU) No 1321/2014 (the 'Continuing Airworthiness' Regulation) while special conditions ask to follow them. NPA 2020/07 is not finalized yet and special conditions are also draft. Both may change with time. It is requested to amend this chapter based on actual situation as on the date of finalizing the document.

3.4.5 Competent authority

EASA is competent authority for issuing type certificate or restricted type certificate (R)TCs for high robustness of specific operations, specific category which could not demonstrate successful risk assessment, and certified category.

3.5 Operator approval and responsibilities

3.5.1 Competencies and licensing

In today's scenarios, for any category of operations, operators need to register themselves as per article 14 of commission implementing regulation (EU) 2019/947 and as per section 3.2. Most of UAS operations may be performed by any operators registered with European government by complying required UAS regulations.

In order to take advantages of special competencies and licensing, special category of operators is defined in European regulations as light UAS operator certificate (LUC). In future, when sufficient expertise will be gained by some operators or any operators who will be able to prove sufficient experiences and requirements defined in Part C, Annex of commission implementing regulation (EU) 2019/947 in today scenarios, they may be given LUC.

[1] "Medium risk" is herein utilized to refer to those operations classified at SAIL III and IV
[2] High risk operations are herein defined as those operations in SAIL V or VI.

Getting privileges of LUC by UAS operator comes with greater responsibilities and accountabilities. As per Part C of commission implementing regulations 2019/947, LUC operators will have their own safety management system, LUC manual, and other necessary infrastructures.

Although LUC shall be issued for an unlimited duration, it shall remain valid subject to: (a) the LUC holder's continuous compliance with the relevant requirements of European Regulations and of the Member State that issued the certificate and (b) it not being surrendered or revoked. Upon revocation or surrender of an LUC, the LUC holder shall provide an acknowledgment in digital format that must be returned to the competent authority without delay.

LUC operators are termed today only for specific category of operation. Necessary competencies and licensing terms related to certified category of operations are not defined yet.

3.5.2 Operators' responsibilities

As per article 41 of delegated regulation 2019/945, any UAS operators that have their principal place of business, are established, or are resident in a third country and that conduct UAS operations within the single European sky airspace should be subject to European UAS regulation. Commission implementing regulations (EU) 2019/947 defined responsibilities of UAS operators of different categories, which are defined in the following sections.

3.5.2.1 Open category

Implementing regulation (EU) 2019/947, part A, UAS.OPEN.050 define the UAS operator responsibilities in open category of UAS operation. Following section is summary of responsibilities mentioned in regulations for such operators.

The UAS operators shall comply with following responsibilities:

1. Develop operational procedures adapted to the type of operation and the risk involved.
2. Ensure that all operations effectively use and support the efficient use of radio spectrum in order to avoid harmful interference.
3. Designate a remote pilot for each UAS operation.
4. Ensure that the remote pilots and all other personnel performing a task in support of the operations are familiar with the user's manual provided by the manufacturer of the UAS, and:
   a) have appropriate competency in the subcategory of the intended UAS operations in accordance with points UAS.OPEN.020, UAS.OPEN.030 or UAS.OPEN.040 of implementing regulation (EU) 2019/947 to perform their tasks or, for personnel other than the remote pilot, have completed an on-the-job-training course developed by the operator;
   b) Are fully familiar with the UAS operator's procedures;
   c) Are provided with the information relevant to the intended UAS operation concerning any geographical zones published by the Member State of operation in accordance with Article 15 of implementing regulation (EU) 2019/947.
5. Update the information into the geo-awareness system when applicable according to the intended location of operation.
6. In the case of an operation with an unmanned aircraft of one of the classes defined in Parts 1 to 5 of Delegated Regulation (EU) 2019/945, ensure that the UAS is: (a) accompanied by the corresponding EU declaration of conformity, including the reference to the appropriate class; and (b) the related class identification label is affixed to the unmanned aircraft.
7. Ensure in the case of an UAS operation in subcategory A2 or A3, that all involved persons present in the area of the operation have been informed of the risks and have explicitly agreed to participate.

3.5.2.2 Specific category

Implementing regulation (EU) 2019/947, part B, UAS.SPEC.050 define the UAS operator responsibilities in specific category of UAS operation. Following section is summary of responsibilities mentioned in regulations for such operators.

The UAS operator shall comply with all of the following responsibilities:

1. Establish procedures and limitations adapted to the type of the intended operation and the risk involved, including:
   I. Operational procedures to ensure the safety of the operations;
   II. Procedures to ensure that security requirements applicable to the area of operations are complied with in the intended operation;
   III. Measures to protect against unlawful interference and unauthorized access;
   IV. Procedures to ensure that all operations are in respect of Regulation (EU) 2016/679 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data. In particular it shall carry out a data protection impact assessment, when required by the National Authority for data protection in application of Article 35 of Regulation (EU) 2016/679;
   V. Guidelines for its remote pilots to plan UAS operations in a manner that minimizes nuisances, including noise and other emissions-related nuisances, to people and animals.
2. Designate a remote pilot for each operation or, in the case of autonomous operations, ensure that during all phases of the operation, responsibilities and tasks especially those defined in UAS.SPEC.060 are properly allocated in accordance with the procedures established and defined in point no. 1 above.
3. Ensure that all operations effectively use and support the efficient use of radio spectrum in order to avoid harmful interference;
4. Ensure that before conducting operations, remote pilots comply with all of the following conditions:
   - Have the competency to perform their tasks in line with the applicable training identified by the operational authorization or, if point UAS.SPEC.020 (standard scenarios) applies, by the conditions and limitations defined in the appropriate standard scenario or as defined by the LUC.
   - Follow remote pilot training which shall be competency based and include the competencies set out in paragraph 2 of Article 8 of implementing regulation (EU) 2019/947.
   - Follow remote pilot training, as defined in the operational authorization, for operations requiring such authorization, it shall be conducted in cooperation with an entity recognized by the competent authority.
   - Follow remote pilot training for operations under declaration that shall be conducted in accordance with the mitigation measures defined by the standard scenario.
   - Have been informed about the UAS operator's operations manual, if required by the risk assessment and procedures established in accordance with point (a);
   - Obtain updated information relevant to the intended operation about any geographical zones defined in accordance with Article 15.
5. Ensure that personnel in charge of duties essential to the UAS operation, other than the remote pilot itself, comply with all of the following conditions:
   - Have completed the on-the-job-training developed by the operator;
   - Have been informed about the UAS operator's operations manual, if required by the risk assessment, and about the procedures established in accordance with point (a);
   - Have obtained updated information relevant to the intended operation about any geographical zones defined in accordance with Article 15;
6. Carry out each operation within the limitations, conditions, and mitigation measures defined in the declaration or specified in the operational authorization;
7. Keep a record of the information on UAS operations as required by the declaration or by the operational authorization.
8. Use UAS which, as a minimum, are designed in such a manner that a possible failure will not lead the UAS to fly outside the operation volume or to cause a fatality. In addition, Man Machine interfaces shall be such to minimize the risk of pilot error and shall not cause unreasonable fatigue;
9. Maintain the UAS in a suitable condition for safe operation by:

- As a minimum, defining maintenance instructions and employing an adequately trained and qualified maintenance staff; and
- Complying with point UAS.SPEC.100, if required;
- Using an unmanned aircraft which is designed to minimize noise and other emissions, taking into account the type of the intended operations and geographical areas where the aircraft noise and other emissions are of concern.

3.5.2.3 Certified category

Current European UAS regulations do not talk about UAS operators responsibilities for certified categories of operation. In this case, the operator's responsibilities defined for manned aircraft may be followed.

3.6 MRO approval and responsibilities

3.6.1 Competencies and licensing

As per current European regulations, there are no regulations defining MRO organization separately. Therefore, there is no section dedicated for competencies and licensing of MRO organizations.

However, UAS.SPEC.050 Responsibilities of the UAS operator of IR (EU) 2019/947 ask UAS operators to maintain the UAS in a suitable condition for safe operation by:

1. As a minimum, defining maintenance instructions and employing an adequately trained and qualified maintenance staff.
2. Complying with point UAS.SPEC.100, if required;
3. Using an unmanned aircraft which is designed to minimize noise and other emissions, taking into account the type of the intended operations and geographical areas where the aircraft noise and other emissions are of concern.

As per UAS.SPEC.100, in case of use of certified equipment and certified unmanned aircraft:

1. If the UAS operation is using an unmanned aircraft for which a certificate of airworthiness or a restricted certificate of airworthiness have been issued, or using certified equipment, the UAS operator shall record the operation or service time in accordance either with the instructions and procedures applicable to the certified equipment, or with the organizational approval or authorization
2. The UAS operator shall follow the instructions referred to in the unmanned aircraft certificate or equipment certificate, and also comply with any airworthiness or operational directives issued by the Agency.

Besides this the A.1.2.4, Annex A to SORA V2, which defines guidelines to develop ConOps, also ask UAS operators to define maintenance instruction for their UAS. SORA OSO#3 "UAS maintained by competent/proven entities" required necessary documentations to demonstrate compliance with this OSOs.

Therefore, current UAS regulations define importance of maintenance action for UAS but does not ask to delegate responsibilities to separate entity. In nutshell, it is responsibilities of UAS operators to complying with maintenance requirements and ensure safe UAS operations. Therefore, competencies and licensing required for UAS operators defined in section 3.5.1 ensure the competencies needed for MRO organization. It is the choice of UAS operators to hire separate entities for maintenance and repair works or do it by internal entities. The overall responsibilities will remain with UAS operators.

It is to be noted that work is going on develop standards to define maintenance program needed to ensure safe UAS operation. At the time of publication of this document, there is no final outcomes. In future, after publication of standards this section will be updated.

3.6.2 MRO responsibilities

As described in previous section, there is no separate sections to define MRO responsibilities. However, it is required that the operations and maintenance procedures shall be complaint with

manufacturer's user manuals. Additional operators' responsibilities for MRO tasks are already defined under the section of operator responsibilities in section 3.5.2.

3.7 Remote pilot approval and responsibilities

3.7.1 Competencies and licensing

IR (EU) 2019/947 defined importance of remote pilot as the pilot for manned aircraft. As per the IR, "As for manned aviation, a uniform implementation of and compliance with rules and procedures should apply to operators, **including remote pilots**, of unmanned aircraft and unmanned aircraft system ('UAS'), as well as for the operations of such unmanned aircraft and unmanned aircraft system". Many types of operations such as BVLOS, VLOS, or autonomous depends upon the role of remote pilot in the operation.

In UAV operation, remote pilot is the person responsible to fly UAV safe in designated airspace. Therefore, obtaining competencies to perform duties are very important. This section describes about the competencies required by any remote pilot to fly into European airspace along with certification requirements.

3.7.1.1 Major requirements

As we know that there are three categories of UAS operation defined as Open, specific, and certified in European UAS regulations. Requirements for competencies and licensing varies based on the categories of operation. As per implemented regulation (EU) 2019/947, operations in the 'certified' category should, as a principle, be subject to rules on certification of the operator, and the licensing of remote pilots, in addition to the certification of the aircraft pursuant to Delegated Regulation (EU) 2019/945. While for the 'specific' category a certificate delivered by the competent authorities for the operation of an unmanned aircraft, as well as for the personnel, including remote pilots and organizations involved in those activities, or for the aircraft pursuant to Delegated Regulation (EU) 2019/945 could also be required. This may vary based on the risk posed by the operation. Thus, licensing requirements are must for certified categories but may be needed for specific categories. Remote pilots should ensure that they are adequately informed about applicable Union and national rules relating to the intended operations, in particular with regard to safety, privacy, data protection, liability, insurance, security and environmental protection.

Article 8 - Rules and procedures for the competency of remote pilots of implemented regulation (EU) 2019/947 defined the following:

1. Remote pilots operating UAS in the 'open' category shall comply with the competency requirements set in Part A of the Annex of IR (EU) 2019/947.
2. Remote pilots operating UAS in the 'specific' category shall comply with the competency requirements set out in the operational authorization by the competent authority or in the standard scenario defined in Appendix 1 to the Annex of IR (EU) 2019/947 or as defined by the LUC and shall have at least the following competencies:
    (a) Ability to apply operational procedures (normal, contingency and emergency procedures, flight planning, pre-flight and post-flight inspections).
    (b) Ability to manage aeronautical communication.
    (c) Manage the unmanned aircraft flight path and automation.
    (d) Leadership, teamwork and self-management.
    (e) Problem solving and decision-making.
    (f) Situational awareness.
    (g) Workload management.
    (h) Coordination or handover, as applicable.
3. Remote pilots operating in the framework of model aircraft clubs or associations shall comply with the minimum competency requirements defined in the authorization granted in accordance with Article 16 of IR (EU) 2019/947.

Article 9 - Minimum age for remote pilots of implemented regulation (EU) 2019/947 defined following regarding minimum age of the remote pilot.

1. The minimum age for remote pilots operating a UAS in the 'open' and 'specific' category shall be **18 years** to perform commercial UAS operations.
2. No minimum age for remote pilots shall be required:
   (a) When they operate in subcategory A1 as specified in Part A of the Annex to this Regulation, with a UAS Class C0 defined in Part 1 of the Annex to Delegated Regulation (EU) 2019/945 that is a toy within the meaning of Directive 2009/48/EC.
   (b) For privately-built UAS with a maximum take-off mass of less than 250g.
   (c) When they operate under the direct supervision of a remote pilot complying with paragraph 1 and Article 8 of (EU) 2019/947.
3. Member States may lower the minimum age following a risk-based approach taking into account specific risks associated with the operations in their territory:
   (a) For remote pilots operating in the 'open' category by up to 4 years.
   (b) For remote pilots operating in the 'specific' category by up to 2 years.
4. Where a Member State lowers the minimum age for remote pilots, those remote pilots shall only be allowed to operate a UAS on the territory of that Member State.
5. Member States may define a different minimum age for remote pilots operating in the framework of model aircraft clubs or associations in the authorization issued in accordance with Article 16 of (EU) 2019/947.

In SORA analysis, OSO#9, OSO#15, OSO#17, and OSO#22 are related to qualifications as well as fitness of remote pilot. In order to show compliance given in above OSOs, it is needed to take care of competencies and licensing of remote pilots.

3.7.1.2 Competent authorities

Competent authorities for evaluating competencies of remote pilots will be defined as per article 17 "Designation for competent authority" of IR (EU) 2019/947. Competent authorities will be responsible to give licensing and monitoring exams to demonstrate remote pilot's competencies as per article 18 "Tasks for competent authority" of IR (EU) 2019/947.

As per Article 21 "Adaptation of authorizations, declarations and certificates":

1. Authorizations granted to UAS operators, certificates of remote pilot competency and declarations made by UAS operators or equivalent documentation, issued on the basis of national law, shall remain valid until 1 July 2021.
2. By 1 July 2021 Member States shall convert their existing certificates of remote pilot competency and their UAS operator authorizations or declarations, or equivalent documentation, including those issued until that date, in accordance with this Regulation. Without prejudice to Article 14, UAS operations conducted in the framework of model aircraft clubs and associations shall be allowed to continue in accordance with relevant national rules and without an authorization in accordance with Article 16 until 1 July 2022.

3.7.2 Duration and validity of the remote pilot license/examination results

3.7.2.1 Open category

As per Part A, UAS.OPEN.070 Duration and validity of the remote pilot online theoretical competency and certificates of remote pilot competency of IR (EU) 2019/947:

1) The remote pilot online theoretical competency, required by points (4)(b) of point UAS.OPEN.020 and point (3) of point UAS.OPEN.040, and the certificate of remote pilot competency, required by point (2) of point UAS.OPEN.030, **shall be valid for five years**.
2) The renewal of the remote pilot online theoretical competency and of the certificate of remote pilot competency is subject to the demonstration of competencies in accordance with point (2) of point UAS.OPEN.030 or point (4)(b) of point UAS.OPEN.020.

3.7.2.2 Specific category

The qualification, competencies, and licensing requirements for remote pilots for specific categories are defined in operational authorization. The minimum list of competencies defined by European

regulations are already defined in 3.7.1.1(2). However, till today, there is no tenure decided in regulations for validity of licensing.

Please refer above defined section of IR (EU) 2019/947 for detailed information.

3.7.2.2.1 Certified category

There are no specific regulations defined for this category of operation.

3.7.3 Remote pilot responsibilities

Like competencies requirements, remote pilot responsibilities depend on the types of UAS operations categorized as open, specific, or certified categories.

3.7.3.1 Open categories

As per Part A, UAS.OPEN.060 of IR (EU) 2019/947 the Responsibilities of the remote pilot are as follows:

1. Before starting an UAS operation, the remote pilot shall:
   (a) have the appropriate competency in the subcategory of the intended UAS operations in accordance with points UAS.OPEN.020, UAS.OPEN.030 or UAS.OPEN.040 to perform its task and carry a proof of competency while operating the UAS, except when operating an unmanned aircraft referred to in points (5)(a), (5)(b) or (5)(c) of point UAS.OPEN.020.
   (b) Obtain updated information relevant to the intended UAS operation about any geographical zones published by the Member State of operation in accordance with Article 15
   (c) observe the operating environment, check the presence of obstacles and, unless operating in subcategory A1 with an unmanned aircraft referred to in points (5)(a), (5)(b) or (5)(c) of point UAS.OPEN.020, check the presence of any uninvolved person.
   (d) Ensure that the UAS is in a condition to safely complete the intended flight, and if applicable, check if the direct remote identification works properly.
   (e) If the UAS is fitted with an additional payload, verify that its mass does not exceed the MTOM defined by the manufacturer or the MTOM limit of its class.
2. During the flight, the remote pilot shall:
   (a) Not perform duties under the influence of psychoactive substances or alcohol or when it is unfit to perform its tasks due to injury, fatigue, medication, sickness or other causes.
   (b) Keep the unmanned aircraft in VLOS and maintain a thorough visual scan of the airspace surrounding the unmanned aircraft in order to avoid any risk of collision with any manned aircraft. The remote pilot shall discontinue the flight if the operation poses a risk to other aircraft, people, animals, environment or property.
   (c) Comply with the operational limitations in geographical zones defined in accordance with Article 15
   (d) Have the ability to maintain control of the unmanned aircraft, except in the case of a lost link or when operating a free-flight unmanned aircraft.
   (e) Operate the UAS in accordance with the user's manual provided by the manufacturer, including any applicable limitations.
   (f) Comply with the operator's procedures when available.
3. During the flight, remote pilots and UAS operators shall not fly close to or inside areas where an emergency response effort is ongoing unless they have permission to do so from the responsible emergency response services.
4. For the purposes of point (2)(b), remote pilots may be assisted by an unmanned aircraft observer, situated alongside them, who, by unaided visual observation of the unmanned

aircraft, assists the remote pilot in safely conducting the flight. Clear and effective communication shall be established between the remote pilot and the unmanned aircraft

3.7.3.2 Specific category

As per UAS.SPEC.050 Responsibilities of the UAS operator of Part B of IR (EU) 2019/947, UAS operator is responsible for preparing guidelines for its remote pilots to plan UAS operations in a manner that minimizes nuisances, including noise and other emissions-related nuisances, to people and animals. Same section asks operators to ensure that remote pilot is competent and have enough information about the UAS operations. However, remote pilots have defined responsibilities as per UAS regulations.

As per UAS.SPEC.060 of Part B of IR (EU) 2019/947 the Responsibilities of the remote pilot in specific categories are as follows:

1. The remote pilot shall:
    a. Not perform duties under the influence of psychoactive substances or alcohol or when it is unfit to perform its tasks due to injury, fatigue, medication, sickness or other causes.
    b. Have the appropriate remote pilot competency as defined in the operational authorization, in the standard scenario defined in Appendix 1 of IR (EU) 2019/947 or as defined by the LUC and carry a proof of competency while operating the UAS.
2. Before starting an UAS operation, the remote pilot shall comply with all of the following:
    a. Obtain updated information relevant to the intended operation about any geographical zones defined in accordance with Article 15.
    b. Ensure that the operating environment is compatible with the authorized or declared limitations and conditions.
    c. Ensure that the UAS is in a safe condition to complete the intended flight safely, and if applicable, check if the direct remote identification works properly.
    d. Ensure that the information about the operation has been made available to the relevant air traffic service (ATS) unit, other airspace users and relevant stakeholders, as required by the operational authorization or by the conditions published by the Member State for the geographical zone of operation in accordance with Article 15.
3. During the flight, the remote pilot shall:
    a. Comply with the authorized or declared limitations and conditions.
    b. Avoid any risk of collision with any manned aircraft and discontinue a flight when continuing it may pose a risk to other aircraft, people, animals, environment or property.
    c. Comply with the operational limitations in geographical zones defined in accordance with Article 15.
    d. Comply with the operator's procedures.
    e. Not fly close to or inside areas where an emergency response effort is ongoing unless they have permission to do so from the responsible emergency response services.

3.8 Coordination with external organization

National or local rules require the UAS operator to coordinate with external organization(s) to be authorized to operating UAS in a specific area**. These organizations could be** Air Navigation Service Provider, Air Traffic Controller, Airport authority, Regulatory bodies, Telecommunication service providers, Defense and military organization.

4 COMP4DRONES Use cases analysis

4.1 Major services and types of operations

This chapter is intended to provide case studies of usage of the information given in this handbook for different types of UAS operations. In COMP4DRONES project there are five use cases, which include eleven demonstrators. The types of UAS services in this project are transport, logistics, agriculture, surveillance & inspection. Other UAS operations having similar types of applications and specifications can take advantage of the analysis given in this chapter. The analysis done in this chapter includes detailed safety analysis of use case 2, demonstrator-1 and high-level regulatory analysis for other UCs. Additionally, one technology analysis is provided to show importance of compliance with regulatory requirements for UAS sub systems. This is a preliminary analysis based on inputs provided from UC leaders. To perform a complete analysis, it is necessary to have an outcome ConOps.

4.2 Use case analysis

4.2.1 UC-2 description

The use case-2 is to develop the technology required to carry out any type of operation that allows the Digitalization of the State of the Constructive Process of a Transport Infrastructure.

This allows to reduce the costs and times of acquisition of data in relation to traditional technologies; either by traditional surveying or terrestrial methods. The digitalization of this process will allow generating products that allow approximating the development of construction in a BIM Model.

4.2.1.1 OBJECTIVES of use case-2

Aims to develop the technology required to carry out any type of operation that allows the Digitalization of the State of the Constructive Process of a Civil Infrastructure.

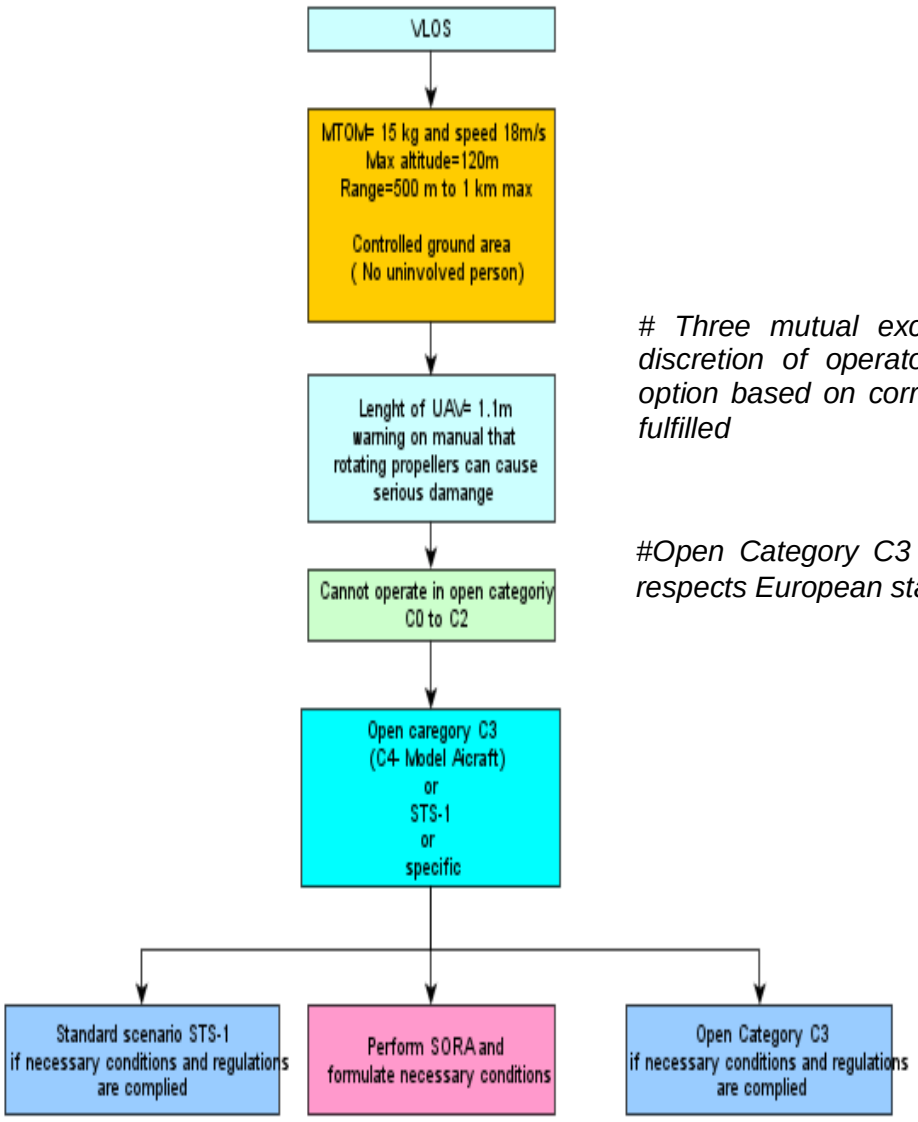
Study and definition of data will be required to create a procedure to accelerate the extraction of the elements, from a cloud of points to a geometric definition.

The study of the data and the creation of different tools will allow identifying elements related to the geometry and characteristics of the terrain of the construction site, flat surfaces of structures, recognition of fix elements and alignments.

Present stage of use case will be conducted in **VLOS with MTOM=15 kg, speed=18 m/s, max altitude=120 m and maximum range=500 m to 1 km over controlled ground area. There will be no autonomous operation.**

Next stage of operation will be conducted for BVLOS operation with more strict specs.

4.2.1.2 Algorithm to choose types of operation



 # Three mutual exclusive options. It is up to discretion of operator to choose most suitable option based on corresponding requirements are fulfilled

#Open Category C3 option is valid only if UAS respects European standards (CE marking...)

Figure 15 Use of proposed algorithm to choose types of operation

4.2.1.3 Proposed Operations methods

Based on the analysis done by the standard algorithm for this operation, the operator may get operational authorization in three ways.

i. Open Category C3

The operation can be done in open category, which does not require any types of authorization or declaration. For this condition, the operations can be performed in open category with CE marking of CE3. Please refer 4.2.1.4.1 for detail description.

ii. **Specific category-> Standard scenario (STS)-1**

This is the scenarios defined by EASA under specific categories of UAS operations by taking into consideration of most frequent types of operations done in different member states in Europe. EASA has published two standard scenarios: STS-1 and STS-2. Definition of other standard scenarios are in developing stage by EASA.

Proposed operation covered most of the aspects of high-level requirements defined in standard scenario-1. However, standard scenarios are prescriptive. In order to comply with standard scenarios, it is necessary to comply with all restrictions and detailed technical descriptions defined in standard scenarios. This option will describe all necessary regulations and restrictions. It will also give references of regulations, where detailed technical descriptions are mentioned. It is to be noted that in case of non-compliance with single requirement, the operations cannot be performed in standard scenarios. There will be needed to apply SORA for the operation in order to get operational authorization and design constraints which results in operational authorization. Please refer section 4.2.1.4.2 for detailed description.

iii. **Specific Category -> by applying SORA methodology**

In case of non-compliance of standard scenarios constraints or open categories of operation, the application of SORA will be needed for the operation belongs to specific categories. Option-3 has described SORA assessment for this operation and presented the requirements to fulfil in order to demonstrate to competent authorities about safe operation and hence to receive permit-to-fly. Please refer section 4.2.1.4.3 for detailed description.

The analysis of present operation in three cases are described in next section.

4.2.1.4 Description of three options

4.2.1.4.1 Open Category C3

The operation can be done in open category, which does not require any types of authorization or declaration. The following conditions need to be met at all times.

1. The UAS belongs to C3 class set out in Delegated Regulation (EU) 2019/945 and shall comply with all requirements defined in Part 4 of Annex of (EU) 2019/945.
2. The UAS shall comply with all requirements defined in Part A of Annex of commission implemented regulation (EU) 2019/947 related to A3 categories of operations and other general conditions for open categories of operation.
3. The remote pilot ensures that the unmanned aircraft is kept at a safe distance from people and that it is not flown over assemblies of people.
4. There will not be any uninvolved people during operation.
5. The remote pilot keeps the unmanned aircraft in VLOS at all times except when using an unmanned aircraft observer as specified in Part A of the Annex of (EU) 2019/945.
6. During flight, the unmanned aircraft is maintained within 120 meters from the closest point of the surface of the earth, except when overflying an obstacle.
7. During flight the unmanned aircraft does not carry dangerous goods and does not drop any material.
8. Remote identification system is must for all UA intended to operate below 120m to address security and privacy risk.
9. While in operation, UAS operator and remote pilot shall respect:
    - The right for private and family life set out in Article 7 of the Charter of Fundamental Rights of the European Union
    - The right to protection of personal data set out in Article 8 of that Charter and in Article 16 TFEU (Treaty on the Functioning of the European Union) and
    - Above articles regulated by Regulation (EU) 2016/679 also known as GDPR (General Data Protection Regulation) of the European Parliament and of the Council.
10. Operator should develop guidelines for its remote pilots so that all operations are flown in a manner that minimizes nuisances to people and animals. (Social acceptance 2019/947. Delegated Regulation (EU) 2019/945 includes maximum level of noise for unmanned aircraft operated close to people in the ‘open’ category for social acceptance).
11. UAS should comply with the relevant essential health and safety requirements set out in Directive 2006/42/EC of the European Parliament and of the Council.
12. Green flashing light shall be illuminated during night operation.

4.2.1.4.2 Standard scenario-1

You can fly in STS-1 category subject to compliance with following regulations & restrictions:

1. UAV shall comply with controlled ground area definition based on mass provided in UAS.STS-01.020, Appendix-1 of Commission Implementing Regulation (EU) 2020/639.
2. UAV shall not fly in autonomous mode.
3. UAV shall not be controlled by remote pilot in moving vehicle.
4. Max flight level setting in software shall be set at <120m.
5. UAV operation shall be conducted at a ground speed of less than 5 m/s.
6. Single pilot will fly UAV.
7. No handover of control between control units during flight is allowed.
8. Green flashing light shall be illuminated during night operation.
9. Flight termination function must be enabled.
10. Direct remote identification shall be available and up to date.
11. Unique serial number allowing for its identification.
12. Geo-awareness function may be needed as per member state guidelines. If geo-awareness function is there, it will follow descriptions as per Paragraph 10 of part 4 of commission delegated regulation (EU) 2019/945.
13. During flight, provide the remote pilot with clear and concise information on the height of the UA above the surface or take-off point.
14. Remote pilot should have continuous monitoring of the quality of the command-and-control link, receive an alert when it is likely that the link is going to be lost or degraded to the extent of compromising the safe conduct of the operation, and another alert when the link is lost.
15. The UAV shall have CE-5 marking affixed on UAV as per Article-16 of delegated regulation 2019/945 and complied with all requirements defined in Part 16 of the Annex to amended Delegated Regulation (EU) 2019/945 named commission delegated regulation (EU) 2020/1058.
16. The UAV manufacturer shall submit technical documentation as per article 17 of delegated regulation 2019/945 and carry out the relevant conformity assessment procedure referred to in article 13 of delegated regulation 2019/945.
17. Since UAV will carry sensor used to acquire personal data, operator registration is mandatory considering the risks to privacy and protection of personal data.
18. Operation shall be conducted by remote pilot having certificate of remote pilot theoretical knowledge and holds an accreditation of completion of the STS-01 practical skill training in accordance with Attachment-A of Appendix-1, chapter I of Commission Implementing Regulation (EU) 2020/639 (UAS.STS-01.020).
19. UAS operator will develop operator manual as per UAS.STS-01.030 and Appendix 5 of Commission Implementing Regulation (EU) 2020/639.
20. Remote pilot will ensure compliance of UAS.SPEC.060 and UAS.STS-01.040 of Commission Implementing Regulation (EU) 2020/639.
21. Unmanned aircraft noise and emissions should be minimized as far as possible taking into account the operating conditions and various specific characteristics of individual Member States, such as the population density, where noise and emissions are of concern.
22. UAS operators and remote pilots should ensure that they are adequately informed about applicable Union and national rules relating to the intended operations, in particular with regard to safety, privacy, data protection, liability, insurance, security and environmental protection.
23. While in operation, UAS operator and remote pilot shall respect:

    - The right to respect for private and family life set out in Article 7 of the Charter of Fundamental Rights of the European Union
    - The right to protection of personal data set out in Article 8 of that Charter and in Article 16 TFEU (Treaty on the Functioning of the European Union) and
    - Above articles regulated by Regulation (EU) 2016/679 also known as GDPR (General Data Protection Regulation) of the European Parliament and of the Council.

24. Operator should develop guidelines for its remote pilots so that all operations are flown in a manner that minimizes nuisances to people and animals. (Social acceptance 2019/947. Delegated Regulation (EU) 2019/945 includes maximum level of noise for unmanned aircraft operated close to people in the 'open' category for social acceptance).
25. UAS should comply with the relevant essential health and safety requirements set out in Directive 2006/42/EC of the European Parliament and of the Council.
26. After compliance with all requirements defined above operator may fly by submitting operational declaration in the form given in appendix 2 of Commission Implementing Regulation (EU) 2020/639.

4.2.1.4.3 SORA assessment

If operators do not fulfil one or more of the listed regulations and requirements mentioned in standard scenario or open category, they will need to perform SORA for the proposed operation. In order to prepare SORA analysis of this operation, reference has been taken from Opinion 05/2019 named standard scenarios published by EASA.

SORA analysis for proposed operation is as follows:

1. Step #1 — ConOps description

UAS operators who want to perform a UAS operation are required to define a concept of operations (ConOps) as per descriptions given in Annex-A of EASA SORA version.

As part of the ConOps, the UAS operator will need to define the required operational volume and ground risk buffer.

2. Step #2 — determination of the intrinsic UAS ground risk class

The intrinsic UAS ground risk relates to the unmitigated risk of a person being hit by the UA (in case of a loss of control of the UA) and it can be represented by the UAS ground risk class (GRC). The GRC is derived from the intended operation and the UAS lethal area from the table given in EASA SORA document.

VLOS controlled ground area

M=15 kg h=120m v=18 m/s size of UAV=1.1 m

Ek=2.4 kJ and Ep=17.6 kJ nearly 20 kJ

Intrinsic UAS ground risk class (GRC)				
Max UAS characteristic dimension	1 m	3 m	8 m	> 8 m
Typical kinetic energy expected	*< 700 J*	*< 34 kJ*	*< 1 084 kJ*	*> 1 084 kJ*
Operational scenarios				
VLOS/BVLOS over a controlled ground area	1	2	3	4
VLOS in a sparsely populated environment	2	3	4	5
BVLOS in a sparsely populated environment	3	4	5	6
VLOS in a populated environment	4	5	6	8
BVLOS in a populated environment	5	6	8	10
VLOS over a gathering of people	7			
BVLOS over a gathering of people	8			

Figure 16 Intrinsic GRC determination

3. Step #3 — final GRC determination

Applying mitigations M1 and M2 will not reduce the intrinsic GRC. Because as per SORA, GRC cannot be reduced less than lowest integer in any column. However, M3 will increase the intrinsic GRC. Therefore, it is recommended to fulfil M3.

		Robustness			Correction
Mitigation sequence	Mitigations for ground risk	Low / None	Medium	High	
1	M1 — Strategic mitigations for ground risk[38]	0: None -1: Low	-2	-4	0
2	M2 — Effects of ground impact are reduced[39]	0	-1	-2	0
3	M3 — An emergency response plan (ERP) is in place, validated by the operator and effective	1	0	-1	0
Total correction					0

Figure 17 Final GRC determination

[38] This mitigation is meant as a means to reduce the number of people at risk.

[39] This mitigation is meant as a means to reduce the energy absorbed by the people on the ground upon impact.

M1: We have already taken consideration of M1 by operating in controlled ground area. Controlled ground area will reduce number of people at risk. More robustness will increase cost with no gain in reduction of GRC.

M2: Operator may incorporate the means to reduce the effects of ground impact by adding parachute with UAV. Since it will not reduce GRC, it is up to discretion of operator to add this safety.

		Level of assurance		
		Low/None	Medium	High
M3 — An ERP is in place, UAS operator validated and effective	Criterion #1 (Procedures)	(a) Procedures do not require validation against either a standard or a means of compliance considered adequate by the competent authority. (b) The adequacy of the procedures and checklists is declared.	(a) The ERP is developed to standards considered adequate by the competent authority and/or in accordance with means of compliance acceptable to that authority. (b) The ERP is validated through a representative tabletop exercise[1] consistent with the ERP training syllabus.	Same as medium. In addition: (a) The ERP and the effectiveness of the plan with respect to limiting the number of people at risk are validated by a competent third party. (b) The applicant has coordinated and agreed the ERP with all third parties identified in the plan. (c) The representativeness of the tabletop exercise is validated by a competent third party.
	Comments	*N/A*	*[1]The tabletop exercise may or may not involve all third parties identified in the ERP.*	*N/A*
	Criterion #2 (Training)	Does not meet the 'medium' level criterion	(a) An ERP training syllabus is available. (b) A record of the ERP training completed by the relevant staff is established and kept up to date.	Same as medium. In addition, competencies of the relevant staff are verified by a competent third party.
	Comments	*N/A*	*N/A*	*N/A*

Figure 18 Assurance criteria for M3

		Level of integrity		
		Low/None	Medium	High
M3 — An ERP is in place, UAS operator validated and effective	Criteria	No ERP is available, or the ERP does not cover the elements identified to meet a 'medium' or 'high' level of integrity	The ERP: (a) is suitable for the situation; (b) limits the escalating effects; (c) defines criteria to identify an emergency situation; (d) is practical to use; (e) clearly delineates the duties of remote crew member(s).	Same as medium. In addition, in case of a loss of control of the operation, the ERP is shown to significantly reduce the number of people at risk, although it can be assumed that a fatality may still occur.
	Comments	*N/A*	*N/A*	*N/A*

Figure 19 Integrity criteria for M3

M3 (ERP): In order to keep the GRC at 2, an ERP is required with a 'medium' level of robustness. In order to achieve medium level of robustness, we need at least medium level of integrity and medium level of assurance:

This medium level is achieved through the requirements defined in the proposed point GM1 UAS.SPEC.030(3)(e)(7) Application for an operational authorization defined Easy Access Rules for Unmanned Aircraft Systems (Regulations (EU) 2019/947 and (EU) 2019/945), in UAS.STS-01.030(4) of the amended implemented regulation (EU) 639/2020, and in A1.3.5, Annex 1 of EASA SORA, ensuring a medium level of integrity, and may be complemented by the remote flight crew training defined in GM1 UAS.SPEC.050(1)(d).

Thus, AMC to ensure it includes:

1	GM1 UAS.SPEC.030(3)(e)(7) Application for an operational authorization
2	UAS.STS-01.030(4) of the amended implemented regulation (EU) 639/2020
3	A1.3.5, Annex 1 of EASA SORA
4	remote flight crew training defined in GM1 UAS.SPEC.050(1)(d)

Table 11 Proposed AMC for M3

Final intrinsic GRC= 2

4. **Steps #4 to #5 — Air risk assessment**

Intrinsic and residual ARC determination

The operation will be performed below 120m. It is proposed that the operation will be performed in uncontrolled airspace class F or class G or in controlled airspace after coordination and individual flight authorization by CAA in accordance with published procedure for the area of operation. This will ensure a low probability of the UA encountering manned aircraft or other airspace users.

In case of uncontrolled airspace in rural area: ARC=b

In case of controlled airspace in rural area: ARC=c

 # Rural area is considered because operation is going to perform in controlled ground area.

Since it is assumed that in case of controlled airspace, operation will be performed after coordination and individual flight authorization by CAA, residual ARC=b.

As any ARC-b reduction would result in ARC-a. A UAS operator claiming a reduction to ARC-a should demonstrate that all the requirements that define atypical or segregated airspace have been met. It is assumed that final ARC will be considered as ARC-b.

5. **Steps #6 TMPR and robustness levels**

- VLOS is considered to be an acceptable tactical mitigation for collision risk for all ARC levels. Notwithstanding the above, the UAS operator is advised to consider additional means to increase the situational awareness with regard to air traffic operating in the vicinity of the operational volume.

- Operational UAS flights under VLOS do not need to meet the TMPR, nor the TMPR robustness requirements. Notwithstanding the above, the applicant should have a documented VLOS de-confliction scheme, in which the applicant explains which methods will be used for detection, and defines the associated criteria applied for the decision to avoid incoming traffic. If the remote pilot relies on detection by observers, the use of phraseology will have to be described as well.
- For VLOS operations, it is assumed that an observer is not able to detect traffic beyond 2 NM. Since our operations are maximum up to 1 km, UAS operator have already adjusted the operation and/or the procedures accordingly.

6. **Step #7 — SAIL determination**

Considering that for the ground risk, the final GRC is 2, and for the air risk, the final ARC is not more than ARC-b, and the resulting SAIL is SAIL II.

SAIL determination				
	Residual ARC			
Final GRC	a	b	c	d
≤2	I	II	IV	VI
3	II	II	IV	VI
4	III	III	IV	VI
5	IV	IV	IV	VI
6	V	V	V	VI
7	VI	VI	VI	VI
>7	Category C operation			

Figure 20 SAIL determination

7. Step #8 — identification of operational safety objectives (OSOs)

The purpose of this step is to evaluate the defenses within the UAS operation in the form of OSOs and the associated level of robustness depending on SAIL. Following table provides a qualitative methodology to make this determination. In this table, 'O' means optional, 'L' means recommended with low robustness, 'M' means recommended with medium robustness, and 'H' means recommended with high robustness.

SAIL II corresponding to this operation is highlighted in yellow in order to show the required level of robustness for the different OSOs.

OSO number (in line with Annex E to SORA)		SAIL					
		I	II	III	IV	V	VI
	Technical issue with the UAS						
OSO#01	Ensure that the operator is competent and/or proven	O	L	M	H	H	H
OSO#02	UAS manufactured by competent and/or proven entity	O	O	L	M	H	H
OSO#03	UAS maintained by competent and/or proven entity	L	L	M	M	H	H

OSO number (in line with Annex E to SORA)		SAIL					
		I	II	III	IV	V	VI
OSO#04	UAS developed to authority-recognised design standards	O	O	O	L	M	H
OSO#05	UAS is designed considering system safety and reliability	O	O	L	M	H	H
OSO#06	C3 link performance is appropriate for the operation	O	L	L	M	H	H
OSO#07	Inspection of the UAS (product inspection) to ensure consistency with the ConOps	L	L	M	M	H	H
OSO#08	Operational procedures are defined, validated and adhered to	L	M	H	H	H	H
OSO#09	Remote crew is trained, current and able to control the abnormal situation	L	L	M	M	H	H
OSO#10	Safe recovery from technical issues	L	L	M	M	H	H
	Deterioration of external systems supporting UAS operations						
OSO#11	Procedures are in place to handle the deterioration of external systems supporting UAS operations	L	M	H	H	H	H
OSO#12	The UAS is designed to manage the deterioration of external systems supporting UAS operations	L	L	M	M	H	H
OSO#13	External services supporting UAS operations are adequate for the operation	L	L	M	H	H	H
	Human error						
OSO#14	Operational procedures are defined, validated and adhered to	L	M	H	H	H	H
OSO#15	Remote crew is trained, current and able to control the abnormal situation	L	L	M	M	H	H
OSO#16	Multi-crew coordination	L	L	M	M	H	H
OSO#17	Remote crew is fit to operate	L	L	M	M	H	H
OSO#18	Automatic protection of the flight envelope from human error	O	O	L	M	H	H
OSO#19	Safe recovery from human error	O	O	L	M	M	H
OSO#20	A human factors evaluation has been performed and the HMI has been found appropriate for the mission	O	L	L	M	M	H
	Adverse operating conditions						

OSO number (in line with Annex E to SORA)		SAIL					
		I	II	III	IV	V	VI
OSO#21	Operational procedures are defined, validated and adhered to	L	M	H	H	H	H
OSO#22	The remote crew is trained to identify critical environmental conditions and to avoid them	L	L	M	M	M	H
OSO#23	Environmental conditions for safe operations are defined, measurable and adhered to	L	L	M	M	H	H
OSO#24	UAS is designed and qualified for adverse environmental conditions	O	O	M	H	H	H

Figure 21 All OSOs with level of robustness

8. Step #9 — Adjacent area/airspace considerations

The objective of this section is to address the risk posed by a loss of control of the operation, resulting in an infringement of the adjacent areas on the ground and/or adjacent airspace. These areas may vary with different flight phases.

Since this operation will be performed over a controlled ground area and in a populated environment, the following three requirements apply:

I. The probability of leaving the operational volume should be less than 10-4/FH.

This requirement shall be covered while designing hardware and software of UAS. Safety cases provided by manufacturer and/or operator should be able to prove these requirements. Therefore, these requirements will be transformed into the technical requirements of the UAS used in proposed operation. The technical requirements proposed for the UAS used in the proposed operation shall be sufficient to bring that likelihood down to a tolerable level in the order indicated by SORA.

II. No single failure of the UAS or any external system supporting the operation should lead to operation outside the ground risk buffer.

III. Software (SW) and airborne electronic hardware (AEH) whose development error(s) could directly lead to operations outside the ground risk buffer should be developed to an industry standard or methodology recognized as adequate by the competent authority.

Requirements #2 and #3 are considered to be met through the mandate to use a UA equipped with a means to terminate the flight, with its activation independent from the on-board automatic flight control and guidance system. This may be incorporated into the system into order to get compliance. Operators and/or manufacturer may find another means to get compliance with these requirements.

9. Step #10 — Comprehensive safety portfolio

This step is required by the operator to present an operational risk assessment to its competent authority. As per SORA, this will include detailed description of

- Mitigations used to modify the intrinsic GRC.
- Strategic mitigations for the initial ARC.
- Tactical mitigations for the residual ARC.
- Adjacent area/airspace consideration.
- Operational safety objectives.

All these points are defined in this safety analysis.

Operators are requested to add any additional requirements not identified by SORA process (e.g., security, environment protection, etc.) and identify the relevant stakeholders.

4.2.1.4.4 OSO compliance based on SAIL level

The SORA analysis of proposed operation described in section 4.2.1.4.3 resulted into SAIL II. Based on SORA methodology SAIL II operations required fourteen numbers of OSOs at low level of robustness, four numbers of OSOs at medium level of robustness, and six numbers of OSOs as optional. There are no OSOs at high level of robustness.

In the following section, proposed methodology to get compliance with requirements of low and medium level of robustness OSOs are described. The OSOs at optional level are not taken into account.

OSO		SAIL expected level of robustness	Criteria as per SORA V2	Proposed AMC
OSO #01 Ensure that the operator is competent and/or proven	Level of integrity	Low	The applicant is knowledgeable about the UAS being used and as a minimum has the following relevant operational procedures: checklists, maintenance, training, responsibilities, and associated duties.	The point UAS.SPEC.050 of the commission-implemented regulation (EU) 2019/947 requires the UAS operator to 'Establish procedures and limitations adapted to the type of the intended operation and the risk involved'. Operator manual should prepare with all elements described in integrity criteria. Annex A of EASA SORA is a good reference to prepare ConOps. It described minimum elements required (described in integrity criteria) for any ConOps. Furthermore, Appendix 5 to the Annex to the amended IR 2020/639 includes all the aspects to be considered for development of operational manual for standard scenarios, which may be complemented to Annex A of EASA SORA document for compliance of this OSO.
	Level of assurance		The elements delineated in the level of integrity are addressed in the ConOps.	
OSO #03 UAS maintained by competent and/or proven entity (e.g., industry standards)	Level of integrity	Low	• The UAS maintenance instructions are defined and, when applicable, cover the UAS designer's instructions and requirements. • The maintenance staff are competent and have received an authorization to carry out UAS maintenance. • The maintenance staff use the UAS maintenance instructions while performing maintenance	The requirements of this OSO are included in point UAS.SPEC.050(1)(i) that requires 'The UAS operator to maintain the UAS in a suitable condition for safe operation, to define maintenance instructions and employ an adequately trained and qualified maintenance staff'. In addition, the AMC to point UAS.SPEC.050(1)(e)(ii) specifies that 'The UAS operator should ensure that the personnel in charge of duties essential to the UAS operation apply the procedures contained in the operations manual.'
	Level of assurance		Criterion #1 (Procedure): • The maintenance instructions are documented. • The maintenance conducted on the UAS is recorded in a maintenance log system. • A list of the maintenance staff authorized to carry out maintenance is established and kept up to date. Criterion #2 (Training): A record of all the relevant qualifications, experience and/or training completed by the maintenance staff is established and kept up to date.	Criterion#1: The proposed Appendix 5 to the Annex to the IR requires the UAS operator to include in the Operator Manual the maintenance instructions required to keep the UAS in safe condition. Additionally, section A.1.2.4 , Annex A of EASA SORA also describe necessary instructions to define maintenance Criterion#2: The proposed amendment to point UAS.SPEC.050 of the IR requires the UAS operator to keep and maintain up to date, for a minimum of 3 years, a record of all relevant qualifications, experience and/or training completed by the maintenance staff and a record of the maintenance activities conducted on the UAS.

				Moreover, the proposed amendment to point UAS.SPEC.050 of the IR requires the UAS operator to establish and keep up to date a list of maintenance staff authorized by the operator to carry out maintenance activities.
OSO #06 C3 link performance is appropriate for the operation	Level of integrity	Low	The applicant determines that performance, RF spectrum usage[1] and environmental conditions for C3 links are adequate to safely conduct the intended operation. The UAS remote pilot has the means to continuously monitor the C3 performance and ensure that the performance continues to meet the operational requirements2. *1 For a low level of integrity, unlicensed frequency bands might be acceptable under certain conditions, e.g.:* • *the applicant demonstrates compliance with other RF spectrum usage requirements (e.g., Directive 2014/53/EU), by showing that the UAS equipment is compliant with these requirements, and* • *the use of mechanisms to protect against interference (e.g., FHSS, frequency de-confliction by procedure).* *2 The remote pilot has continual and timely access to the relevant C3 information that could affect the safety of flight. For operations with a low level of integrity for this OSO, this could be achieved by monitoring the C2 link signal strength and receiving an alert from the UAS HMI if the signal becomes too low.*	Point UAS.SPEC.050(1)(c) of the IR requires the UAS operator to *'ensure that all operations effectively use and support the efficient use of radio spectrum in order to avoid harmful interference'* The compliance with the following requirements of CE class CE3 are helpful to get compliance with this level of integrity: • 'be safely controllable with regard to stability, manoeuvrability and the command-and-control link performance, by a remote pilot with adequate competency as defined in Implementing Regulation (EU) 2019/947 and following the manufacturer's instructions, as necessary under all anticipated operating conditions including following the failure of one or, if appropriate, more systems'; and • 'unless tethered, be equipped with a command-and-control link protected against unauthorized access to the command-and-control functions'. It is proposed to comply with this requirement to partially comply with this OSO. Furthermore, a requirement to provide information on the health of the command-and-control link are needed. Regarding the use of 'unlicensed frequency bands', as indicated in recital (8) of the DR, Directive 2014/53/EU applies to UA that are not subject to certification, according to Part 21, and are not intended to be operated only on frequencies allocated by the Radio Regulations of the International Telecommunication Union for protected aeronautical use. Moreover, point UAS.SPEC.060 (2)(b) of the IR requires the remote pilot to '*ensure that the operating environment is compatible with the authorized or declared limitations and conditions'.*

	Level of assurance	Low	The applicant declares that the required level of integrity has been achieved (Refer Section 9 of JAURUS Annex E)	A declaration form the UAS operator will be submitted.
OSO #07 Inspection of the UAS (product inspection) to ensure consistency with the ConOps	Level of integrity	Low	The remote crew ensures that the UAS is in a condition for safe operation and conforms to the approved concept of operations.	Point UAS.SPEC.060(2)(c) of the IR requires the remote pilot to *'ensure that the UAS is in a safe condition to complete the intended flight safely'*. The proposed Appendix 5 to the Annex to the IR to prepare operation manual for standard scenario requires: • in point 4, the UAS operator to describe the concept of operations including the intended operations; • in point 6(c)(i)(H), the UAS operator to include in the Operator Manual the procedures to verify that the UAS is in a condition to safely conduct the intended operation.
	Level of assurance		Criterion #1 (Procedure): Product inspection is documented and accounts for the manufacturer's recommendations if available. Criterion #2 (Training): The remote crew is trained to perform the product inspection, and that training is self-declared (with evidence available).	UAS.SPEC.030 (3) (e) ask to prepare an operations manual when required by the risk and complexity of the operation. The operation manual guide for standard scenarios are described in Appendix 5 of IR. It may act as guidelines to prepare operation manual. Criterion #1: The verification that the UAS is in safe condition for the intended operation is included in the Operator Manual. Criterion #2: Point UAS.SPEC.050 of the IR requires that the UAS operator ensures that remote pilots 'have been informed about the UAS operator's operations manual' and that personnel in charge of duties essential to the UAS operation, other than the remote pilots, 'have completed the on-the-job-training developed by the operator and have been informed about the UAS operator's operations manual'. Standard scenarios- 1 proposed low robustness of this OSOs. The point UAS.STS-01.020(5) of the IR defines the minimum training for the remote pilot. Pre-flight activities are part of the training. Both the theoretical and practical skills training are accredited (with a certificate of remote pilot theoretical knowledge and an accreditation of completion of STS-01

				practical skills training, respectively). Thus, evidence of basic training is available. This training certificate can be used for this operation. All points defined in this section must be checked carefully and documented.
Operational procedures (OSO #08, OSO #11, OSO #14 and OSO #21)	Level of integrity	Medium	**Criterion #1 (Procedure definition):** ✓ Operational procedures[1] appropriate for the proposed operation are defined and as a minimum cover the following elements: • Flight planning, • Pre- and post-flight inspections, • Procedures to evaluate the environmental conditions before and during the mission (i.e., real-time evaluation), • Procedures to cope with unintended adverse operating conditions (e.g., when ice is encountered during an operation not approved for icing conditions), • Normal procedures, • Contingency procedures (to cope with abnormal situations), • Emergency procedures (to cope with emergency situations), and • Occurrence reporting procedures. ✓ Normal, contingencies, and emergency procedures are compiled in an operations manual. ✓ The limitations of the external systems used to support UAS safe operations[2] are defined in an operations manual. 1. *Operational procedures cover the deterioration[3] of the UAS itself and any external system supporting UAS operation.* 2. *In the scope of this assessment, external systems supporting UAS operation are defined as systems that are not already part of the UAS but are used to:* a. *launch/take-off the UA;*	Criterion #1: Point UAS.SPEC.050(1)(a) of the IR requires the UAS operator to '*establish procedures and limitations adapted to the type of the intended operation and the risk involved, including operational procedures to ensure the safety of the operations*'. Besides this UAS.STS-01.030(1) of the IR requires the UAS operator to develop an Operation Manual, which as described in the proposed Appendix 5 to the Annex to the IR, includes all the elements indicated in SORA criterion #1. Therefore, the operator may create operator manual as per the guidance and fulfil this criteria. Criterion #2: Since this is still under JARUS discussion (as indicated in the note), it has not been fully considered in the assessment. However, since in the case of an emergency situation in which the UA may leave the operational volume, there is a requirement for the remote pilot to terminate the flight, and the activation of this flight termination can be considered as a 'manual control' by the remote pilot, then this criterion could also be considered (at least partially) addressed. Criterion #3: The Appendix 5 for standard scenario-1 to the Annex to the IR requires the UAS operator to include in the operational procedures considerations to minimize human errors.

			b. *make pre-flight checks; or* c. *keep the UA within its operational volume (e.g., GNSS, satellite systems, air traffic management, U-Space).* *External systems activated/used after a loss of control of the operation are **excluded** from this definition* 3. *To properly address the deterioration of external systems required for the operation, it is recommended to:* *a. identify these 'external systems';* *b. identify the modes of deterioration of the 'external systems' (e.g., complete loss of GNSS, drift of the GNSS, latency issues, etc.) which would lead to a loss of control of the operation;* *c. describe the means to detect these modes of deterioration of the external systems/facilities; and* *d. describe the procedure(s) used when deterioration is detected (e.g., activation of the emergency recovery capability, switch to manual control, etc.).* **Criterion #2 (Procedural complexity):** Contingency/emergency procedures require manual control by the remote pilot[1] when the UAS is usually automatically controlled. *(1) This is still under discussion since not all UAS have a mode where the pilot could directly control the surfaces; moreover, some people claim it requires significant skill to not make things worse.* **Criterion #3 (Consideration of potential human error):** Operational procedures take human errors into consideration. At a minimum, operational procedures provide:	

			• a clear distribution and assignment of tasks, and • an internal checklist to ensure staff are performing their assigned tasks.	
	Level of assurance		Operational procedures are validated against standards considered adequate by the competent authority and/or in accordance with a means of compliance acceptable to that authority. The adequacy of the contingency and emergency procedures are proved through: • dedicated flight tests, or • simulation, provided the simulation is proven valid for the intended purpose with positive results.	EASA will provide, in future, standards and/ or the means of compliance considered adequate to comply with this OSO. In order to comply with this OSO, the UAS operator will prove the adequacy of the contingency and emergency procedures through dedicated flight tests or simulations.
Remote crew training (OSO #09, OSO #15 and OSO #22)	Level of integrity	**Low**	The competency-based theoretical and practical training ensures knowledge of: a. UAS regulations, b. UAS airspace operating principles, c. Airmanship and aviation safety, d. Human performance limitations; e. Meteorology, f. Navigation/charts, g. UA knowledge, and h. Operating procedures and is adequate for the operation.	Article 8 of the IR lists the competencies required for remote pilots operating UAS in the 'specific' category; Point UAS.SPEC.050(1)(d)(i) of the IR requires the UAS operator to ensure before conducting operations that the remote pilot has the appropriate competency. The proposed amendment to point UAS.SPEC.060(1)(b) of the IR requires the remote pilot to be familiar with the user's manual provided by the manufacturer of the UAS.
	Level of assurance		Training is self-declared (with evidence available)	As per the approach used in subcategory A2 of the 'open' category the remote pilot may be allowed to conduct self-study. However, the examination for the theoretical knowledge is required to be held at an entity recognized by the competent authority. Operator may contact CAA of area of operation for this verification or any other authorities of that state to get the certificate.
Safe design: OSO #10 Safe recovery from technical issue OSO #12 The UAS is designed to manage the deterioration of external systems supporting UAS operations	Level of integrity	Low	The objective of these OSOs is to complement the technical containment safety requirements by addressing the risk of a fatality occurring while operating over populated areas or gatherings of people. External systems supporting the operation are defined as systems that are not already part of the UAS but are used to: • launch/take-off the UAS, • make pre-flight checks, or	Since our operation will not be conducted over populous areas or gathering of people, these OSOs are not applicable.

			• keep the UA within its operational volume (e.g., GNSS, satellite systems, air traffic management, UTM). External systems activated/used after the loss of control of the operation are **excluded** from this definition. When operating over populated areas or gatherings of people, it can be reasonably expected that a fatality will not occur from any probable[1] failure[2] of the UAS or any external system supporting the operation. 1. The term 'probable' needs to be understood in its qualitative interpretation, i.e., 'Anticipated to occur one or more times during the entire system/operational life of an item.' 2. Some structural or mechanical failures may be excluded from the criterion if it can be shown that these mechanical parts were designed according to aviation industry best practices.	
	Level of assurance		A design and installation appraisal is available. In particular, this appraisal shows that: • the design and installation features (independence, separation and redundancy) satisfy the low-integrity criterion; • Particular risks relevant to the ConOps (e.g., hail, ice, snow, electromagnetic interference, etc.) do not violate the independence claims, if any.	Not applicable
OSO #13 **External services supporting UAS operations are adequate for the operation**	Level of integrity	Low	The applicant ensures that the level of performance of any externally provided service necessary for the safety of the flight is adequate for the intended operation. If the externally provided service requires communication between the UAS operator and the service provider, the applicant ensures there is effective communication to support the service provision.	The proposed operation is at very low flight level near to 50 meter in uncontrolled airspace. The encounter with manned aircraft is already very low in this airspace. The operator will ensure proper coordination with ANSP during the operation in order to avoid manned aircraft during the operation.

			Roles and responsibilities between the applicant and the external service provider are defined.	
	Level of assurance		The applicant declares that the requested level of performance for any externally provided service necessary for the safety of the flight is achieved (without evidence necessarily being available).	The operator may submit a declaration as given in standard scenario, Appendix 2 to the Annex to the IR to ensure compliance with this requirement. The applicant may choose other template too subject to fulfilling of the requirements.
OSO #16 **Multi-crew coordination**	Level of integrity	Low	**Criterion #1 (Procedures):** A procedure (or procedures) to ensure coordination between the crew members and to ensure that robust and effective communication channels is (are) available and at a minimum cover: • the assignment of tasks to the crew, and • establishment of step-by-step communications. **Criterion #2 (Training):** Remote crew training covers multi-crew coordination.	**Criterion #1:** Annex A of EASA SORA section A.1.2.5 Crew recommend adding this clause in ConOps. Operator will prepare manual based on this guidelines and hence will include this operational requirements. Additionally, It is already proposed to prepare operational manual as per Appendix 5 to the Annex to the IR. This document requires the UAS operator to include in the OM a clear distribution and assignment of tasks and to define the required communication procedures among remote crew-members and with external parties, when needed. **Criterion #2:** It is proposed to use standard scenario-1 for remote pilot training. The proposed Attachment A to STS-01 includes the subject 'operational procedures', under which the training on multi-crew coordination is addressed.
	Level of assurance		**Criterion #1 (Procedures):** • Procedures are not required to be validated against either a standard or means of compliance considered adequate by the competent authority. • The adequacy of the procedures and checklists is declared. **Criterion #2 (Training):** Training is self-declared (with evidence available).	**Criterion #1:** Multi-crew coordination, when relevant for the operation, is required to be included as part of the OM operational procedures. As indicated above for the related OSOs (OSO #08, OSO #11, OSO #14 and OSO #21), EASA will provide, in the future AMC applicable the standard(s) or means of compliance considered adequate by the Agency. In low level of robustness, competent authority validation is not needed. **Criterion #2:** The operator will submit a declaration regarding this.
OSO #17 **Remote crew is fit to operate**	Level of integrity	Low	a. For the purpose of this assessment, the expression 'fit to operate' should be interpreted as physically and mentally fit to perform their duties and safely discharge their responsibilities. b. Fatigue and stress are contributory factors to human error. Therefore, to	Annex A of EASA SORA section A.1.2.5 Crew recommend adding this clause in ConOps. Operator will prepare manual based on this guidelines and hence will include this operational requirements. It is already proposed to prepare operational manual as per Appendix 5 to the Annex to the IR

			ensure that vigilance is maintained at a satisfactory level of safety, consideration may be given to the following: 1. remote crew duty times; 2. regular breaks; 3. rest periods; and 4. (4)handover/takeover procedures. *The applicant has a policy defining **how the remote crew can declare** themselves fit to operate before conducting any operation.*	The proposed Appendix 5 to the Annex to the IA requires the UAS operator to include a policy defining how the remote crew can declare themselves fit to operate before conducting any operation.
	Level of assurance		The policy to define how the remote crew declares themselves fit to operate (before an operation) is documented. The remote crew declaration of fit to operate (before an operation) is based on policy defined by the applicant.	ConOps will include these requirements. Operator may ask for declaration for remote crew as per their policy.
OSO #20 A human factors evaluation has been performed and the HMI has been found appropriate for the mission	Level of integrity	Low	The UAS information and control interfaces are succinctly presented and do not confuse, cause unreasonable fatigue, or contribute to remote crew errors that could adversely affect the safety of the operation. *Comments/notes:* *If an electronic means is used to support potential visual observers in their role to maintain awareness of the position of the unmanned aircraft, its HMI:* • *is sufficient to allow the visual observers to determine the position of the UA during operation;* • *does not degrade the visual observer's ability to:* • *scan the airspace where the unmanned aircraft is operating for any potential collision hazard; and* • *Maintain effective communication with the remote pilot at all times.*	Part 4 of the Annex to the DR includes for UAS in class C3 a requirement for the UAS manufacturers to ensure that the UAS can be safely controlled and maneuvered by a remote pilot with the competency defined in the IR. The same requirement is also applicable to UAS in class C5. This requirement is also in this UAV. No visual observers is needed as range of operation is less than 1 km.
	Level of assurance		The applicant conducts an evaluation of the UAS considering and addressing human factors to determine that the HMI is appropriate for the mission. The HMI	The applicant shall conduct necessary action to ensure compliance with this requirement in technical specification of UAS. (For example, in standard scenarios, this is ensured by CE marking process). The operator may simply declare for compliance with this

			evaluation is based on engineering evaluations or analyses.	OSO but they should have evidence to show to competent authority in case of need.
OSO #23 Environmental conditions for safe operations are defined, measurable and adhered to	Level of integrity	Low	**Criterion #1 (Definition):** Environmental conditions for safe operations are defined and reflected in the flight manual or equivalent document. **Criterion #2 (Procedures):** Procedures to evaluate the environmental conditions before and during the mission (i.e., real-time evaluation) are available and include assessment of the meteorological conditions (METAR, TAFOR, etc.) with a simple recording system. **Criterion #3 (Training):** Training covers assessment of the meteorological conditions.	**Criterion #1:** Part 4 of the Annex to the DR includes for UAS in CE class C3 a requirement for the UAS manufacturers to include in the user's manual the: • 'operational limitations (including but not limited to meteorological conditions and day/night operations)'; and • 'appropriate description of all the risks related to UAS operations'; The same requirements are applicable also to UAS in class C5. This shall be adapted in this case to get compliance with this OSO. **Criterion #2:** Annex A to EASA SORA and Appendix 5 to the Annex to the IR requires the UAS operator to include in the OM the environmental and weather conditions adequate to conduct the UAS operation, as well as contingency procedures to cope with adverse operating conditions. Complying with these documents will ensure this OSO compliance. **Criterion #3:** The proposed Attachment A REMOTE PILOT THEORETICAL KNOWLEDGE AND PRACTICAL SKILL EXAMINATION FOR STS-01 defined commission implementing regulation (EU) 2020/639 includes 'meteorology' as one of the subjects. This can be used as a training guidance for remote pilot in order to get compliance with this OSO requirements.
	Level of assurance		**Criterion #1 (Definition):** The applicant declares that the required level of integrity has been achieved[1] 1. Supporting evidence may or may not be available. **Criterion #2 (Procedures):** • Procedures are not required to be validated against either a standard or means of compliance considered adequate by the competent authority. • The adequacy of the procedures and checklists is declared.	The operator will submit declaration mentioning all the points mentioned in this requirements.

			Criterion #3 (Training): Training is self-declared (with evidence available).	

Table 12 OSOs compliance based on SAIL level

4.2.1.5 Summary of SORA and associated requirements

1	UAS operators shall define a concept of operations (ConOps) as per descriptions given in Annex-A of EASA SORA version and include operator manual into ConOps by incorporating necessary guidelines defined in Appendix 5 to the Annex to the IR 2020/639. As part of the ConOps, the UAS operator shall define the required operational volume and ground risk buffer.
2	Operator may incorporate the means to reduce the effects of ground impact by adding parachute with UAV.
3	The operator will define ERP in ConOps based on ▪ GM1 UAS.SPEC.030(3)(e)(7) of Application for an operational authorization defined Easy Access Rules for Unmanned Aircraft Systems (Regulations (EU) 2019/947 and (EU) 2019/945), ▪ UAS.STS-01.030(4) of the amended implemented regulation (EU) 639/2020 ▪ A1.3.5, Annex 1 of EASA SORA ▪ The remote flight crew training defined in GM1 UAS.SPEC.050(1)(d).
4	The operation will be performed below 120m. It is proposed that the operation will always be performed in uncontrolled airspace class F or class G or in controlled airspace after coordination and individual flight authorization by CAA in accordance with published procedure for the area of operation. This will ensure a low probability of the UA encountering manned aircraft or other airspace users.
5	The operation will be always VLOS.
6	The UAS operator is advised to consider additional means to increase the situational awareness with regard to air traffic operating in the vicinity of the operational volume.
7	The applicant should have a documented VLOS de-confliction scheme, in which the applicant explains which methods will be used for detection, and defines the associated criteria applied for the decision to avoid incoming traffic. If the remote pilot relies on detection by observers, the use of phraseology will have to be described as well.
8	For VLOS operations, it is assumed that an observer is not able to detect traffic beyond 2 NM. Since our operations are maximum up to 1 km, UAS operator have already adjusted the operation and/or the procedures accordingly. Operator should ensure to maintain this constraint.
9	The probability of leaving the operational volume **should be less than 10^{-4}/FH**. Please refer section 8
10	No single failure of the UAS or any external system supporting the operation should lead to operation outside the ground risk buffer. Please refer section 8.
11	Software (SW) and airborne electronic hardware (AEH) whose development error(s) could directly lead to operations outside the ground risk buffer should be developed to an industry standard or methodology recognized as adequate by the competent authority. Please refer section 8.
12	Operator will prepare complete safety portfolio as per section 9. Operators are requested to add any additional requirements not identified by SORA process (e.g., security, environment protection, etc.) and identify the relevant stakeholders.
13	While in operation, UAS operator and remote pilot shall respect: ▪ The right to respect for private and family life set out in Article 7 of the Charter of Fundamental Rights of the European Union ▪ The right to protection of personal data set out in Article 8 of that Charter and in Article 16 TFEU (Treaty on the Functioning of the European Union) and ▪ Above articles regulated by Regulation (EU) 2016/679 also known as GDPR (General Data Protection Regulation) of the European Parliament and of the Council.
14	The requirements to comply with required OSOs based on SAIL II should be complied as described in this document. The detailed description of proposed compliance methodologies are given in section 4.2.1.4.4. The proposed methodologies are based on European implemented regulation (EU) 2019/947, European delegated regulation (EU) 2019/945, and their suggested AMC and GM. If operators found any other means of compliance for any OSOs, they may use it. The overall objectives are to comply with the requirements asked in OSOs based on their level of robustness.
15	Operator should take additional safety measured in order to comply with all requirements based on SAIL level as well as other safety measures needed for operations not covered in current analysis.

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16	It should be noted that SORA is a guide, not a checklist. Additional requirements based on states regulations and other necessary aspects should take into considerations.
17	The analysis performed in this section is resulted by the analysis of different regulations and documents specially related to standard scenarios. It is not documented by competent authorities or published as a means of compliance to OSOs for SAIL II category. Therefore, operator is required to review the document and take decision based on their analysis. This document is only for the support of the operator.

Table 13 : Summary of SORA and associated requirements

4.2.1.6 Conclusion

In this document, three options as per current European regulations are proposed for UC2, Demo-2 operation. The proposed options are based on the minimum parameters supplied by the operator for analysis. It is up to discretion of the operator to choose most applicable option for this demonstrator.

For the operations defined in open category and standard scenario-1, the necessary requirements are given in different regulatory documents. Operators are required to comply with all regulatory and technical requirements proposed for these options in case the operation falls into one of them.

UAS regulations and methodology for doing safety assessment for UAS operations known as SORA are developed in last few years. UAS regulations are still evolving. With the definition of U-space regulations, UAS regulations will evolve further and may need other requirements based on U-space services. Current UAS regulations will be applicable in EU region from 31st December 2020.

It should be noted that there are not enough experienced gained for application of SORA methodology and methods for complying with current UAS regulations. Therefore, the SORA analysis given in this document should not be taken as the perfect analysis for UC2, Demo-2 operation. Additionally, the proposed AMC for OSOs compliance are not approved by competent authority. The AMC to complying with each OSOs are still under development. The proposed AMC in given analysis are based on self-analysis of available documents and based on some examples of SORA analysis given by EASA for operator guidance. Hence, operators may use other ways to comply with necessary requirements.

4.2.2 UC-1 description

This use case demonstrate the technology developed in COMP4DRONES in the Transport domain with the use of drones as sensors and monitoring devices for different transport infrastructures.

The main applications will be:

- Detection and early response to traffic incidents
- Support applications in ports
- Railway infrastructure full-cycle: from inspection phase to maintenance.

Three demonstrators will be deployed in this use case: Traffic Management, port Operations and Railway Infrastructure.

4.2.2.1 OBJECTIVES of UC1

This Use Case will target the following main objectives:

- Secure deployment of drones as monitoring devices of the road traffic conditions and the detection and early response to incidents
- Safe integration of drones into the airspace and daily transport operations
- Automatize the usage of drones in transport infrastructure operations and incident management.

4.2.2.2 UC1-Demonstrator 1

The Use Case 1 Demo-1 focus on the deployment of drones as monitoring devices of the road traffic conditions and the detection and early response to incidents.

Present stage of use case Demo 1 will be conducted in **VLOS with MTOM=6,3 kg, speed=20 m/s, max altitude=100 m and maximum range= Up to 500m over controlled ground area. There will be no autonomous operation.**

4.2.2.2.1 Algorithm to choose types of operation

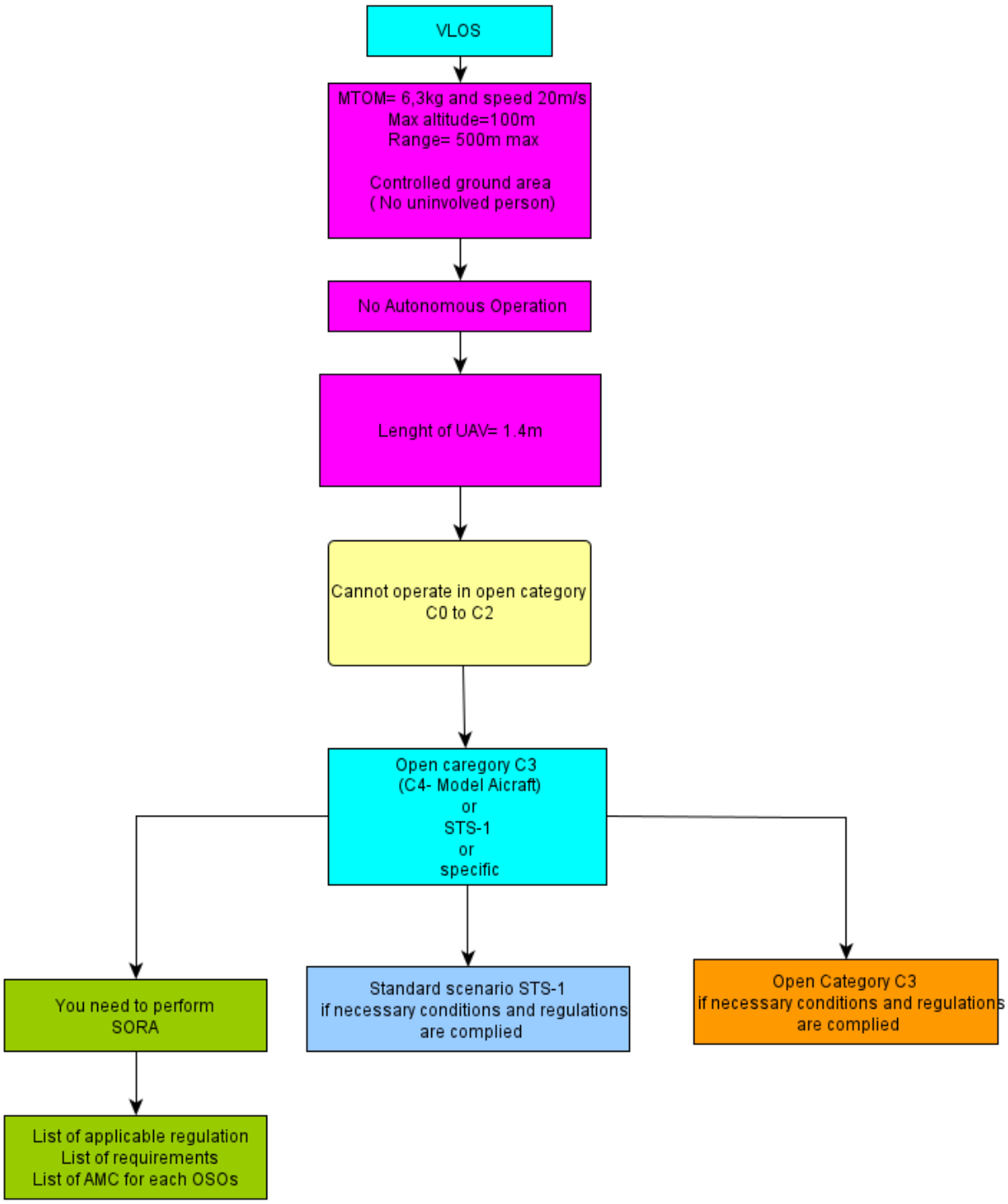

Figure 22 Use of proposed algorithm to choose types of operation

4.2.2.2.2 Proposed Operational Methods

Based on the analysis done by the standard algorithm for this operation, the operator may get operational authorization in three methods.

Open Category C3

The operation can be done in open category, which does not require any types of authorization or declaration. For this conditions, the operations can be performed in open category with CE marking of CE3. Please refer 4.2.1.4.1 for detail description.

Specific category: Standard scenario (STS)-1

This is the scenarios defined by EASA under specific categories of UAS operations by taking into consideration of most frequent types of operations done in different member states in Europe. EASA has published two standard scenarios: STS-1 and STS-2. Definition of other standard scenarios are in developing stage by EASA.

Proposed operation covered most of the aspects of high-level requirements defined in standard scenario-1. However, standard scenarios are prescriptive. In order to comply with standard scenarios, it is necessary to comply with all restrictions and detailed technical descriptions defined in standard scenarios. This option will describe all necessary regulations and restrictions. It will also give references of regulations, where detailed technical descriptions are mentioned. It is to be noted that in case of non-compliance with single requirement, the operations cannot be performed in standard scenarios. There will be needed to apply SORA for the operation in order to get operational authorization and design constraints which results in operational authorization. Please refer section 4.2.1.4.2 for detailed description.

Specific Category by applying SORA methodology

In case of non-compliance of standard scenarios constraints or open categories of operation, the application of SORA will be needed for the operation belongs to specific categories.

The analysis of present operation in three cases are described in next section.

4.2.2.2.3 Description of three options

Open Category C3

The operation can be done in open category, which does not require any types of authorization or declaration. The following conditions need to be meet at all the times.

1. The UAS belongs to C3 class set out in Delegated Regulation (EU) 2019/945 and shall comply with all requirements defined in Part 4 of Annex of (EU) 2019/945.
2. The UAS shall comply with all requirements defined in Part A of Annex of commission implemented regulation (EU) 2019/947 related to A3 categories of operations and other general conditions for open categories of operation.
3. The remote pilot ensures that the unmanned aircraft is kept at a safe distance from people and that it is not flown over assemblies of people.
4. There will not be any uninvolved people during operation.
5. The remote pilot keeps the unmanned aircraft in VLOS at all times except when using an unmanned aircraft observer as specified in Part A of the Annex of (EU) 2019/945.
6. During flight, the unmanned aircraft is maintained within 120 meters from the closest point of the surface of the earth, except when overflying an obstacle.
7. During flight the unmanned aircraft does not carry dangerous goods and does not drop any material.
8. Remote identification system is must for all UA intended to operate below 120m to address security and privacy risk.

9. While in operation, UAS operator and remote pilot shall respect:
    - The right to respect for private and family life set out in Article 7 of the Charter of Fundamental Rights of the European Union
    - The right to protection of personal data set out in Article 8 of that Charter and in Article 16 TFEU (Treaty on the Functioning of the European Union) and
    - Above articles regulated by Regulation (EU) 2016/679 also known as GDPR (General Data Protection Regulation) of the European Parliament and of the Council.
10. Operator should develop guidelines for its remote pilots so that all operations are flown in a manner that minimizes nuisances to people and animals. (Social acceptance 2019/947. Delegated Regulation (EU) 2019/945 includes maximum level of noise for unmanned aircraft operated close to people in the 'open' category for social acceptance).
11. UAS should comply with the relevant essential health and safety requirements set out in Directive 2006/42/EC of the European Parliament and of the Council.
12. Green flashing light shall be illuminated during night operation.

Standard scenario-1

You can fly in STS-1 category subject to compliance with following regulations & restrictions:

1. UAV shall comply with controlled ground area definition based on mass provided in UAS.STS-01.020, Appendix-1 of Commission Implementing Regulation (EU) 2020/639.
2. UAV shall not fly in autonomous mode.
3. UAV shall not be controlled by remote pilot in moving vehicle.
4. Max flight level setting in software shall be set at <120m.
5. UAV operation shall be conducted at a ground speed of less than 5 m/s.
6. Single pilot will fly UAV.
7. No handover of control between control units during flight is allowed.
8. Green flashing light shall be illuminated during night operation.
9. Flight termination function must be enabled.
10. Direct remote identification shall be available and up to date.
11. Unique serial number allowing for its identification.
12. Geo-awareness function may be needed as per member state guidelines. If geo-awareness function is there, it will follow descriptions as per Paragraph 10 of part 4 of commission delegated regulation (EU) 2019/945.
13. During flight, provide the remote pilot with clear and concise information on the height of the UA above the surface or take-off point.
14. Remote pilot should have continuous monitoring of the quality of the command-and-control link, receive an alert when it is likely that the link is going to be lost or degraded to the extent of compromising the safe conduct of the operation, and another alert when the link is lost.
15. The UAV shall have CE-5 marking affixed on UAV as per Article-16 of delegated regulation 2019/945 and complied with all requirements defined in Part 16 of the Annex to amended Delegated Regulation (EU) 2019/945 named commission delegated regulation (EU) 2020/1058.
16. The UAV manufacturer shall submit technical documentation as per article 17 of delegated regulation 2019/945 and carry out the relevant conformity assessment procedure referred to in article 13 of delegated regulation 2019/945.
17. Since UAV will carry sensor used to acquire personal data, operator registration is mandatory considering the risks to privacy and protection of personal data.
18. Operation shall be conducted by remote pilot having certificate of remote pilot theoretical knowledge and holds an accreditation of completion of the STS-01 practical skill training in accordance with Attachment-A of Appendix-1, chapter I of Commission Implementing Regulation (EU) 2020/639 (UAS.STS-01.020).

19. UAS operator will develop operator manual as per UAS.STS-01.030 and Appendix 5 of Commission Implementing Regulation (EU) 2020/639.
20. Remote pilot will ensure compliance of UAS.SPEC.060 and UAS.STS-01.040 of Commission Implementing Regulation (EU) 2020/639.
21. Unmanned aircraft noise and emissions should be minimized as far as possible taking into account the operating conditions and various specific characteristics of individual Member States, such as the population density, where noise and emissions are of concern.
22. UAS operators and remote pilots should ensure that they are adequately informed about applicable Union and national rules relating to the intended operations, in particular with regard to safety, privacy, data protection, liability, insurance, security and environmental protection.
23. While in operation, UAS operator and remote pilot shall respect:
    - The right to respect for private and family life set out in Article 7 of the Charter of Fundamental Rights of the European Union
    - The right to protection of personal data set out in Article 8 of that Charter and in Article 16 TFEU (Treaty on the Functioning of the European Union) and
    - Above articles regulated by Regulation (EU) 2016/679 also known as GDPR (General Data Protection Regulation) of the European Parliament and of the Council.
24. Operator should develop guidelines for its remote pilots so that all operations are flown in a manner that minimizes nuisances to people and animals. (Social acceptance 2019/947. Delegated Regulation (EU) 2019/945 includes maximum level of noise for unmanned aircraft operated close to people in the 'open' category for social acceptance).
25. UAS should comply with the relevant essential health and safety requirements set out in Directive 2006/42/EC of the European Parliament and of the Council.
26. After compliance with all requirements defined above operator may fly by submitting operational declaration in the form given in appendix 2 of Commission Implementing Regulation (EU) 2020/639.

SORA assessment

If operators do not fulfil one or more of the listed regulations and requirements mentioned in standard scenario or open category, they will need to perform SORA for the proposed operation.

4.2.2.3 UC1-Demonstrator 2

This demonstrator focuses on the deployment of a captive drone as a mobile system for security and aerial surveillance in real time, in the port environment.
Present stage of use case Demo 2 will be conducted in **VLOS with MTOM= 8kg, speed=15 m/s, max altitude=25m and maximum range= Up to 500m over controlled ground area. There will be no autonomous operation.**

4.2.2.3.1 Algorithm to choose types of operation

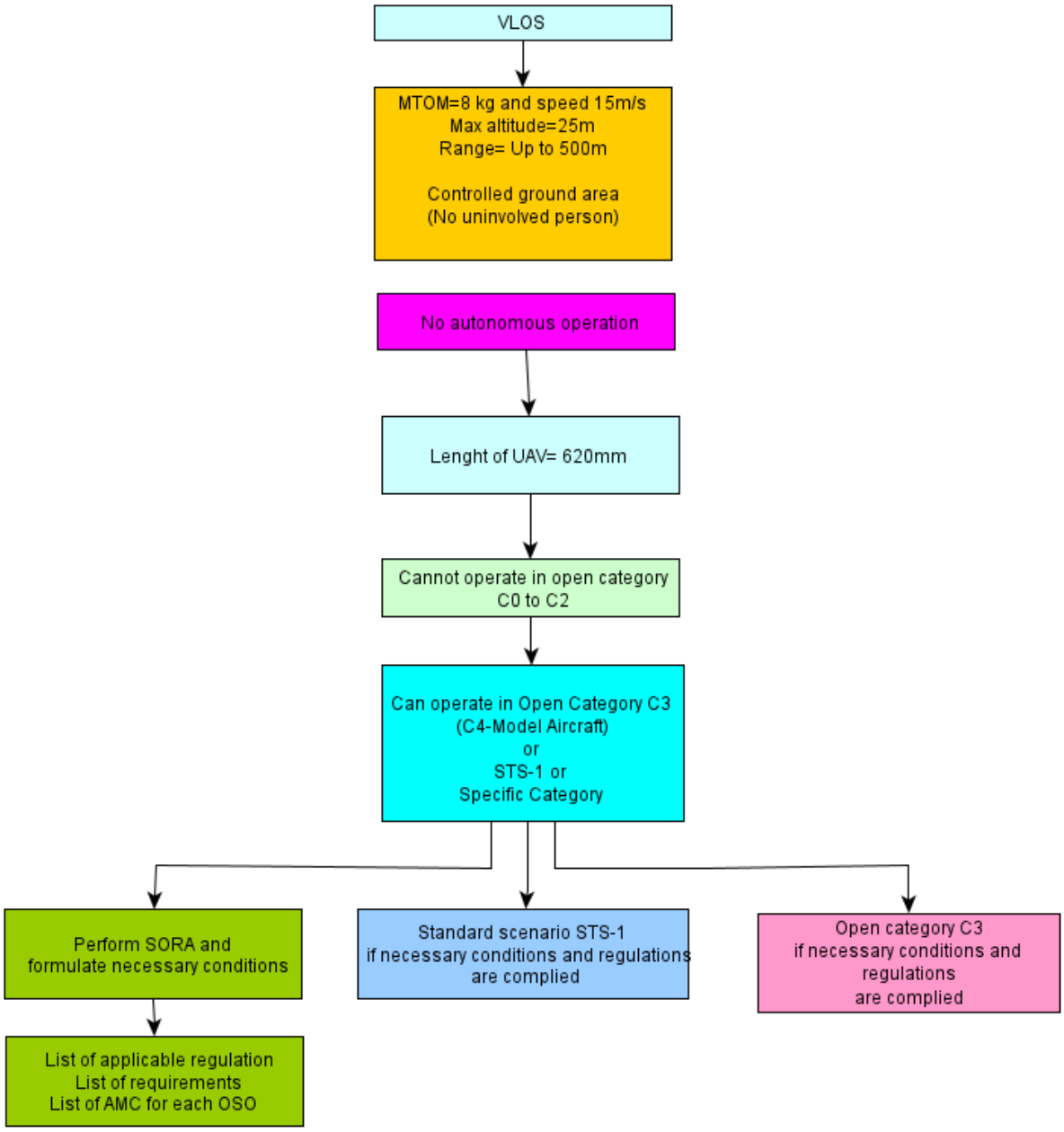

Figure 23 Use of proposed algorithm to choose types of operation

4.2.2.3.2 Proposed Operations methods

Refer section §4.2.2.2.2.

4.2.2.3.3 Description of three options

Refer section §4.2.2.2.3.

4.2.2.4 UC1-Demonstrator 3

This demonstrator focus on deployment of autonomous drone flight command and controlled exclusively through cellular network. A drone as a service concept will be elaborated and demonstrated to be further

incorporated in routine monitoring of Pan European railway infrastructure construction and exploitation stages.
Present stage of use case Demo 3 will be conducted in B**VLOS with MTOM<25kg, speed=15 m/s, max altitude=70m and maximum range= Up to 10km over sparsely populated area. There will be no autonomous operation.**

4.2.2.4.1 Algorithm to choose types of operation

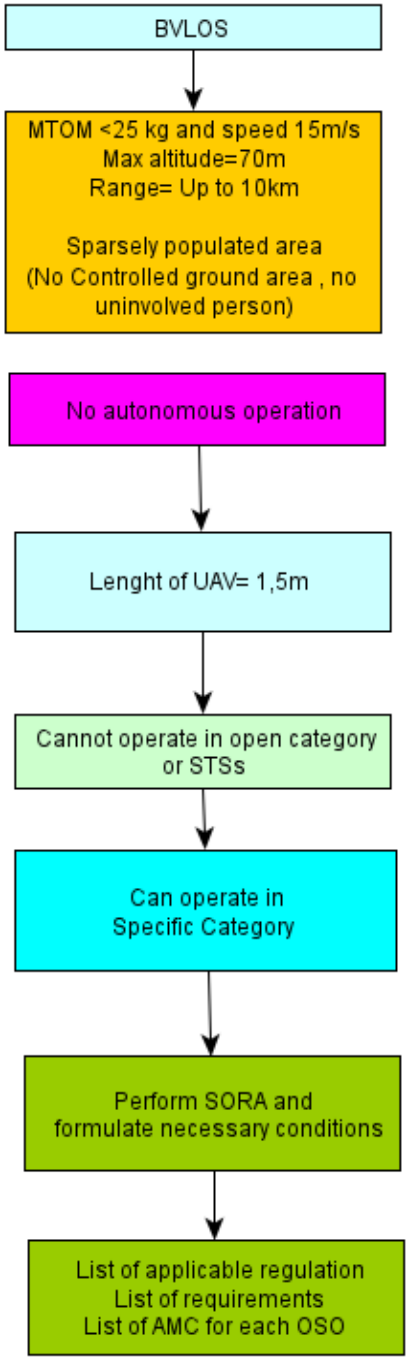

Figure 24 Use of proposed algorithm to choose types of operation

Based on the analysis done by the previous algorithm for this operation, the operator may get operational authorization by applying SORA.

Specific Category by applying SORA methodology: The application of SORA will be needed for this operation. The operator must do SORA assessment and fulfil all the requirements in order to demonstrate to competent authorities about safe operation and hence to receive permit-to-fly.

4.2.3 UC-3 description

UAV can provide features that conventional solutions cannot offer: simultaneous delivery at several location for a reduced price, accessibility to remote areas or areas without infrastructures, overall speed of the delivery.

In order to demonstrate those capabilities, the use case develops two demos: the first one aims ate delivering geophysical sensors using an autonomous fleet of UAVs, the second aims at delivering a parcel in an hospital using ground vehicles to carry it inside buildings and a UAV when outside to achieve fast deliveries.

4.2.3.1 OBJECTIVES of UC3

The use case will focus on 6 main challenges:

- Selecting and Managing a heterogeneous fleet of autonomous vehicles.
- Using a communication infrastructure with redundant, secure, robust, dissimilar and deterministic abilities.
- Navigating and sensing at the landing or dropping zone with a high positioning accuracy and a guarantee of absence of objects, people or animals.
- Detecting and considering dynamically of aircrafts in the mission area and integrating vehicles of the system in air traffic management.
- Reducing risks and complexity on interactions between system operators and autonomous vehicles.
- Exploring some automated situations of logistics requiring multiple automated vehicles to cover the last mile delivery (i.e., UAV and rover collaboration for providing a service impossible by only one of them and reducing risks for people around them).

4.2.3.2 UC3-Demonstrator 1

Present stage of use case Demo 1 will be conducted in **BVLOS with MTOM=35 kg, speed=12 m/s, max altitude=100 m and maximum range= 3km over controlled ground area. There will be autonomous operation.**

4.2.3.2.1 Algorithm to choose types of operation

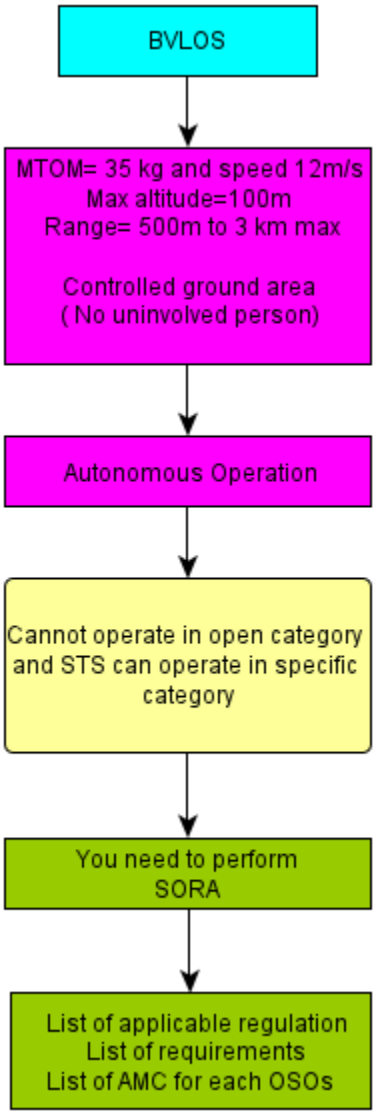

Figure 25 Use of proposed algorithm to choose types of operation

4.2.3.2.2 Proposed Operations method

Based on the analysis done by the previous algorithm for this operation, the operator may get operational authorization by applying SORA.

Specific Category by applying SORA methodology

The application of SORA will be needed for this operation. The operator must do SORA assessment and fulfil all the requirements in order to demonstrate to competent authorities about safe operation and hence to receive permit-to-fly.

4.2.4 UC-5 Description

This use case shows the developments of the COMP4DRONES project in the field of agriculture.

In this Use case two demonstrators will be implemented. The first demonstrator is in the area of wide crop production and deals with the technology requirements for plant monitoring, with a focus on health and growth management, whereby a rover is also used in addition to the drone. On the other hand, the

specific technological needs of viticulture in a remote area with poor infrastructure are illuminated, where the drone serves as a gateway for images and land-bound sensor data.

4.2.4.1 OBJECTIVES of use case-5

The goal of this use case is to use the latest drone and robotic technology for the agricultural domain in order to reduce the costs and times of data collection, human effort and impact on the environment. The main objectives targeted by the Agricultural use case are supporting:

- Dynamic management of energy
- Emergency navigation
- Trusted communication
- Efficient design, integration verification and validation
- Dependability metric based self-adaptability
- Communication security by a Secure element for drones and a cryptography library
- Connect remote areas to ensure drone results upload
- Enable more advanced on-board computations through (but not limiting to) AI
- Extend the impact of this technology by pushing more advanced functionalities on board, without affecting the design time and usability

There are three main scenarios:

Scenario 1: Monitoring and post-processing SHALL enable precise tree crowns definition for water management and harvest forecast;

Scenario 2: Monitoring and online processing SHALL enable to intervene where and when needed, reducing pollution and costs of non-properly sized/defined treatments;

Scenario 3: Cooperation among drone and rover SHALL refine sensing after request, save operator time and effort and allow for prompt/local intervention on nutritional deficiencies, disease or infestations.

4.2.4.2 UC5- Demonstrator 1

This demonstrator is mainly focused on crop monitoring, with special emphasis on health and growth crop management.

Present stage of use case Demo-1 will be conducted in **VLOS.**

Model 1: MTOM=9kg, speed=23 m/s, max altitude= 80m and maximum range= 100m to 300m;

Model 2: MTOM= 6,14kg, speed=17,8 m/s, max altitude= 80 m and maximum range= 100m to 300m;

Model 3: MTOM= 8,2 kg, speed=16 m/s, max altitude= 80 m and maximum range= 100m to 300m;

The operations will be over controlled ground and sparsely populated area. There will be autonomous operations.

The UGV (Unmanned Ground Vehicle) will spray pesticide according to the information provided by the UAV (only for scenario 3).

4.2.4.2.1 Algorithm to choose types of operation

Model 1 :

Figure 26 Use of proposed algorithm to choose types of operation Model 1

Model 2:

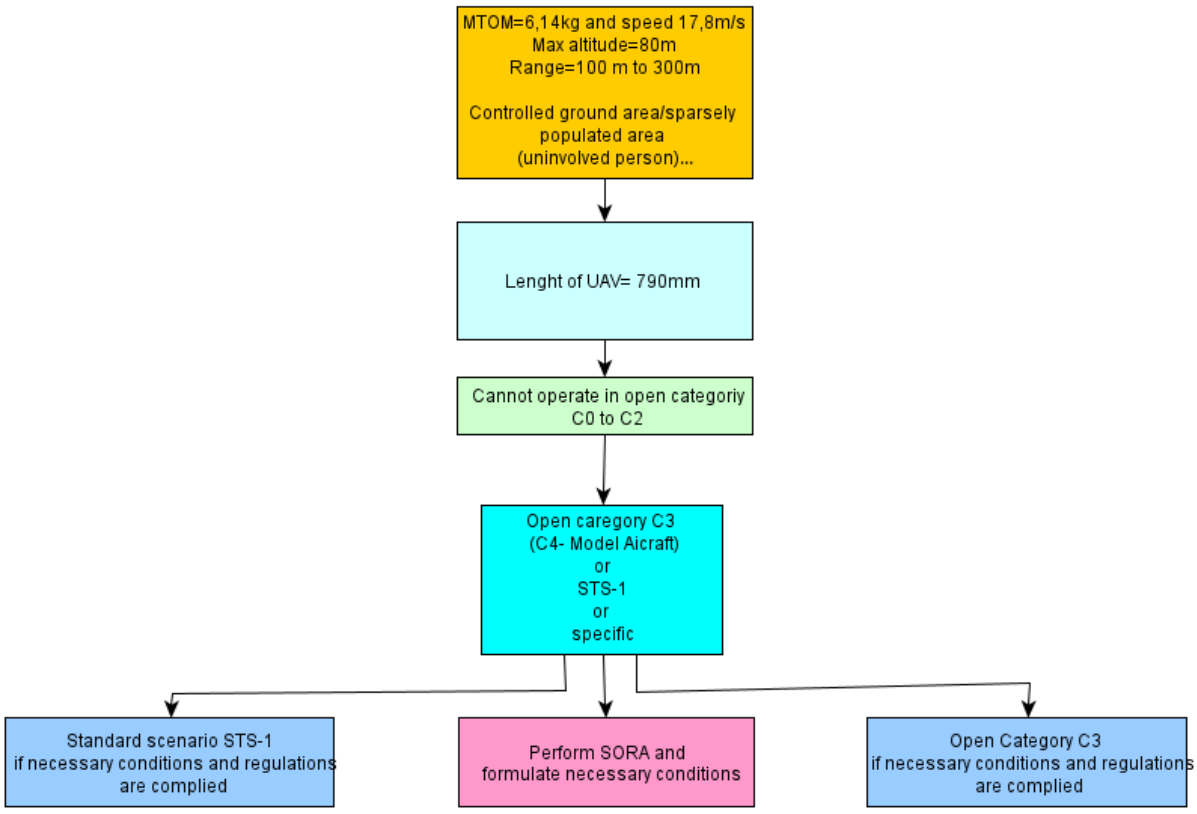

Figure 27 Use of proposed algorithm to choose types of operation Model 2

Model 3:

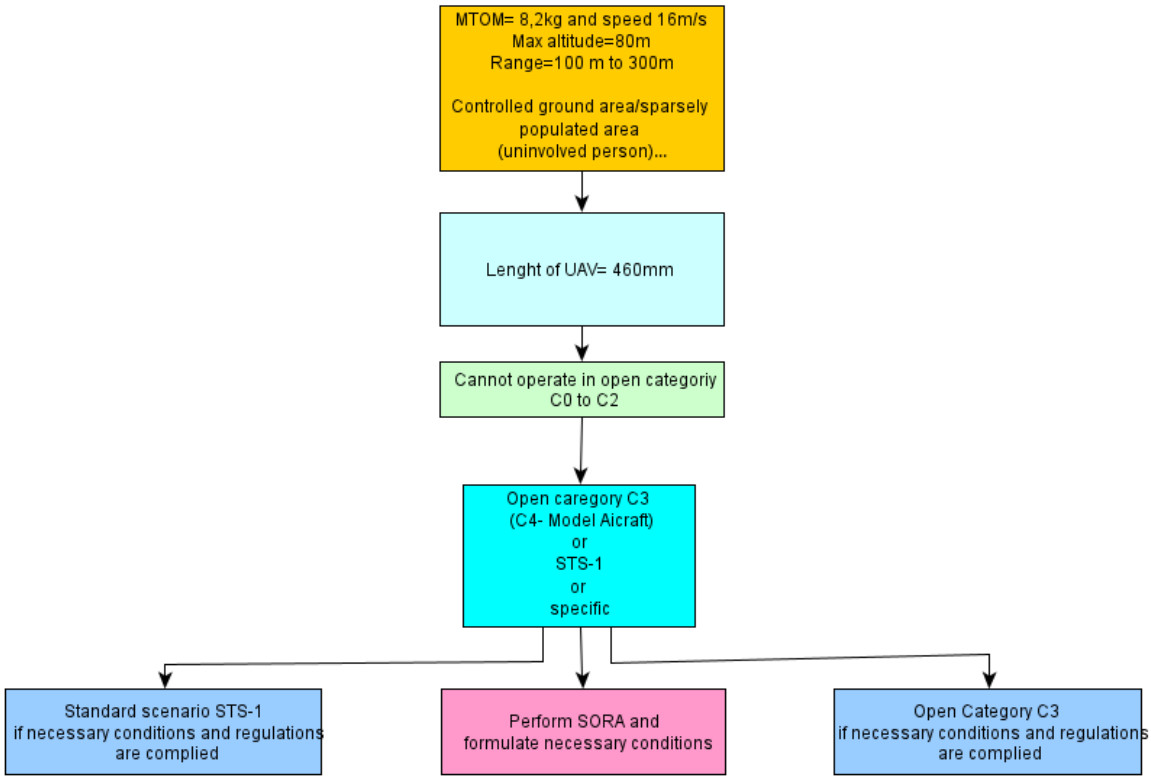

Figure 28 Use of proposed algorithm to choose types of operation Model 3

4.2.4.2.2 Proposed Operations Methods

Based on the analysis done by the standard algorithm for this operation, the operator may get operational authorization in three methods.

Open Category C3

The operation can be done in open category, which does not require any types of authorization or declaration. For this conditions, the operations can be performed in open category with CE marking of CE3. Please refer 4.2.1.4.1 for detail description.

Specific category: Standard scenario (STS)-1

This is the scenarios defined by EASA under specific categories of UAS operations by taking into consideration of most frequent types of operations done in different member states in Europe. EASA has published two standard scenarios: STS-1 and STS-2. Definition of other standard scenarios are in developing stage by EASA.

Proposed operation covered most of the aspects of high-level requirements defined in standard scenario-1. However, standard scenarios are prescriptive. In order to comply with standard scenarios, it is necessary to comply with all restrictions and detailed technical descriptions defined in standard scenarios. This option will describe all necessary regulations and restrictions. It will also give references of regulations, where detailed technical descriptions are mentioned. It is to be noted that in case of non-compliance with single requirement, the operations cannot be performed in standard scenarios. There will be needed to apply SORA for the operation in order to get operational authorization and design constraints which results in operational authorization. Please refer section 4.2.1.4.2 for detailed description.

Specific Category by applying SORA methodology

In case of non-compliance of standard scenarios constraints or open categories of operation, the application of SORA will be needed for the operation belongs to specific categories.

The analysis of present operation in three cases are described in next section.

4.2.4.2.3 Description of three options

Open Category C3

The operation can be done in open category, which does not require any types of authorization or declaration. The following conditions need to be meet at all the times.

1. The UAS belongs to C3 class set out in Delegated Regulation (EU) 2019/945 and shall comply with all requirements defined in Part 4 of Annex of (EU) 2019/945.
2. The UAS shall comply with all requirements defined in Part A of Annex of commission implemented regulation (EU) 2019/947 related to A3 categories of operations and other general conditions for open categories of operation.
3. The remote pilot ensures that the unmanned aircraft is kept at a safe distance from people and that it is not flown over assemblies of people.
4. There will not be any uninvolved people during operation.
5. The remote pilot keeps the unmanned aircraft in VLOS at all times except when using an unmanned aircraft observer as specified in Part A of the Annex of (EU) 2019/945.
6. During flight, the unmanned aircraft is maintained within 120 meters from the closest point of the surface of the earth, except when overflying an obstacle.
7. During flight the unmanned aircraft does not carry dangerous goods and does not drop any material.
8. Remote identification system is must for all UA intended to operate below 120m to address security and privacy risk.
9. While in operation, UAS operator and remote pilot shall respect:
    - The right to respect for private and family life set out in Article 7 of the Charter of Fundamental Rights of the European Union
    - The right to protection of personal data set out in Article 8 of that Charter and in Article 16 TFEU (Treaty on the Functioning of the European Union) and
    - Above articles regulated by Regulation (EU) 2016/679 also known as GDPR (General Data Protection Regulation) of the European Parliament and of the Council.
10. Operator should develop guidelines for its remote pilots so that all operations are flown in a manner that minimizes nuisances to people and animals. (Social acceptance 2019/947. Delegated Regulation (EU) 2019/945 includes maximum level of noise for unmanned aircraft operated close to people in the ‘open’ category for social acceptance).
11. UAS should comply with the relevant essential health and safety requirements set out in Directive 2006/42/EC of the European Parliament and of the Council.
12. Green flashing light shall be illuminated during night operation.

Standard scenario-1

You can fly in STS-1 category subject to compliance with following regulations & restrictions:

1. UAV shall comply with controlled ground area definition based on mass provided in UAS.STS-01.020, Appendix-1 of Commission Implementing Regulation (EU) 2020/639.
2. UAV shall not fly in autonomous mode.
3. UAV shall not be controlled by remote pilot in moving vehicle.
4. Max flight level setting in software shall be set at <120m.

5. UAV operation shall be conducted at a ground speed of less than 5 m/s.
6. Single pilot will fly UAV.
7. No handover of control between control units during flight is allowed.
8. Green flashing light shall be illuminated during night operation.
9. Flight termination function must be enabled.
10. Direct remote identification shall be available and up to date.
11. Unique serial number allowing for its identification.
12. Geo-awareness function may be needed as per member state guidelines. If geo-awareness function is there, it will follow descriptions as per Paragraph 10 of part 4 of commission delegated regulation (EU) 2019/945.
13. During flight, provide the remote pilot with clear and concise information on the height of the UA above the surface or take-off point.
14. Remote pilot should have continuous monitoring of the quality of the command-and-control link, receive an alert when it is likely that the link is going to be lost or degraded to the extent of compromising the safe conduct of the operation, and another alert when the link is lost.
15. The UAV shall have CE-5 marking affixed on UAV as per Article-16 of delegated regulation 2019/945 and complied with all requirements defined in Part 16 of the Annex to amended Delegated Regulation (EU) 2019/945 named commission delegated regulation (EU) 2020/1058.
16. The UAV manufacturer shall submit technical documentation as per article 17 of delegated regulation 2019/945 and carry out the relevant conformity assessment procedure referred to in article 13 of delegated regulation 2019/945.
17. Since UAV will carry sensor used to acquire personal data, operator registration is mandatory considering the risks to privacy and protection of personal data.
18. Operation shall be conducted by remote pilot having certificate of remote pilot theoretical knowledge and holds an accreditation of completion of the STS-01 practical skill training in accordance with Attachment-A of Appendix-1, chapter I of Commission Implementing Regulation (EU) 2020/639 (UAS.STS-01.020).
19. UAS operator will develop operator manual as per UAS.STS-01.030 and Appendix 5 of Commission Implementing Regulation (EU) 2020/639.
20. Remote pilot will ensure compliance of UAS.SPEC.060 and UAS.STS-01.040 of Commission Implementing Regulation (EU) 2020/639.
21. Unmanned aircraft noise and emissions should be minimized as far as possible taking into account the operating conditions and various specific characteristics of individual Member States, such as the population density, where noise and emissions are of concern.
22. UAS operators and remote pilots should ensure that they are adequately informed about applicable Union and national rules relating to the intended operations, in particular with regard to safety, privacy, data protection, liability, insurance, security and environmental protection.
23. While in operation, UAS operator and remote pilot shall respect:
    - The right to respect for private and family life set out in Article 7 of the Charter of Fundamental Rights of the European Union
    - The right to protection of personal data set out in Article 8 of that Charter and in Article 16 TFEU (Treaty on the Functioning of the European Union) and
    - Above articles regulated by Regulation (EU) 2016/679 also known as GDPR (General Data Protection Regulation) of the European Parliament and of the Council.
24. Operator should develop guidelines for its remote pilots so that all operations are flown in a manner that minimizes nuisances to people and animals. (Social acceptance 2019/947. Delegated Regulation (EU) 2019/945 includes maximum level of noise for unmanned aircraft operated close to people in the ‘open’ category for social acceptance).
25. UAS should comply with the relevant essential health and safety requirements set out in Directive 2006/42/EC of the European Parliament and of the Council.

26. After compliance with all requirements defined above operator may fly by submitting operational declaration in the form given in appendix 2 of Commission Implementing Regulation (EU) 2020/639.

SORA assessment

If operators do not fulfil one or more of the listed regulations and requirements mentioned in standard scenario or open category, they will need to perform SORA for the proposed operation.

4.2.4.3 UC5- Demonstrator 2

This demonstrator is designed to assist the winemaker in his work and to minimize the workload and the travel time to remote and poorly connected to the infrastructure vineyards.

The drone flights for Data collection of vineyards to collect multispectral- and RGB images as well as collection data of stationary land bound sensors.

Present stage of use case Demo-2 will be conducted in **VLOS with MTOM=12 kg, speed=6 m/s, max altitude=60 m and maximum range= Up to 400m. It's a semi-autonomous operation; the pilot is able to oversteer autonomous flight.**

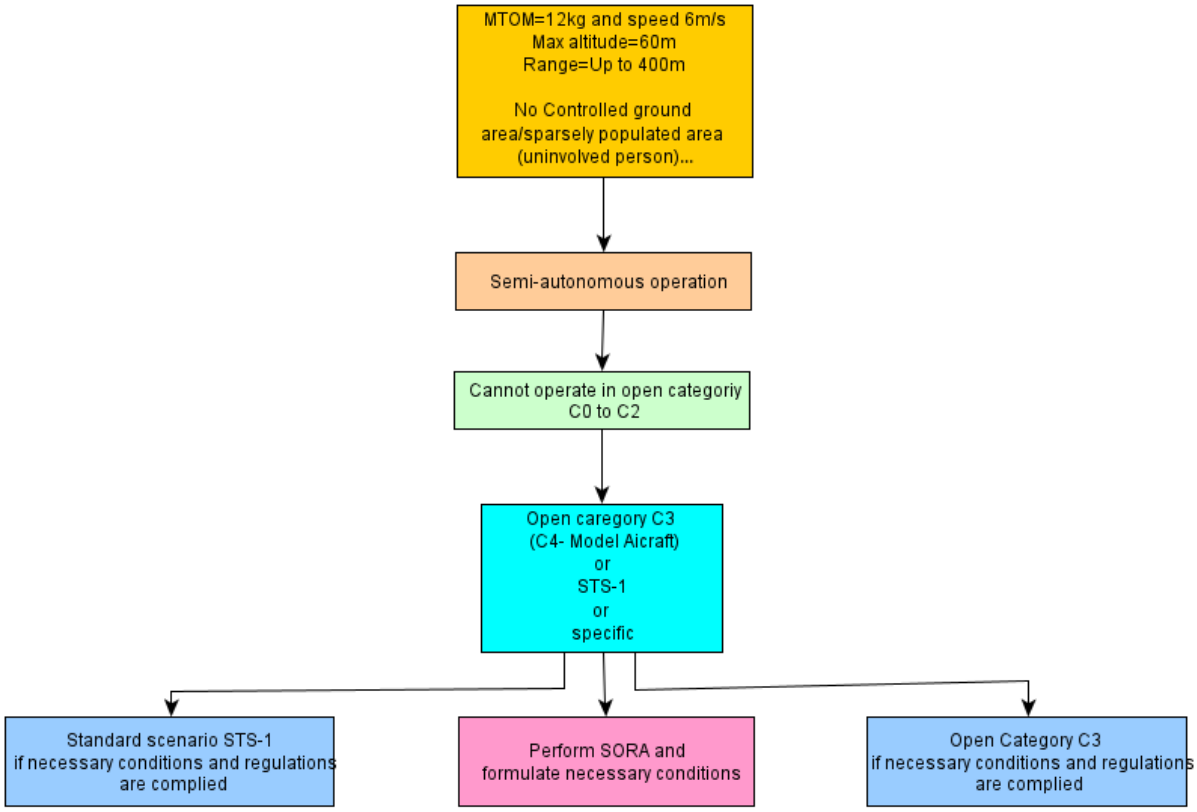

Figure 29 Use of proposed algorithm to choose types of operation

4.2.4.3.1 Proposed Operations methods

Refer to section 0.

4.2.4.3.2 Description of three options

Refer to section §4.2.4.2.2.

4.2.5 Technology analysis

Compliance with Regulatory requirements is very important aspect for development of any technological product in UAS. The certification or approval of any UAS operation depends upon approval of complete system including sub-systems.

As per new UAS regulations, all UAS operations under specific categories having SAIL IV or higher level of robustness require certification of their products. The certification requirements and demonstration varies by robustness levels required for the operation and they are different from strict manned aircraft avionics systems. On 17th December 2020, EASA published Final special condition for Light UAS, which acts as a CS for small UAS, for certification of such UAS having maximum take of mass less than 600 Kg.

AnyWi is developing technology for more reliable communication links between drone and ground (and vice-versa), aimed at scenarios to be approved under SORA. These technologies are known as C2/C3 link. AnyWi were interested to get approval of their technology for high SAIL levels. AnyWi was also interested in looking further into regulatory aspects for their technology development.

After doing research on various available regulatory documents for C2/C3 links development, a summary of applicable regulations and clauses is prepared.

The aim of this section is to present the summary of the regulation and applicable requirements for which the compliance are needed by AnyWi technologies for certification of their products.

SN	Document name	Concerned sections
1	Annex E of SORA V2	OSO#6
2	Special condition for light UAS	Light-UAS.2500, 2510, 2511,2515,2520,2575, subpart-H, Annex I

Compliance with above-mentioned technical regulatory requirements is critical for future acceptance of the product to put into the market. The objective of this analysis was to show importance of regulations and their compliance from the initial development of the product.

4.3 High level recommendations / best practices

This section is dedicated for high level analysis of all use cases and demonstrators of COMP4DRONES project. We provided detailed analysis of one-use case and demonstrators in last section. Users can take example of section **Error! Reference source not found.** to do detailed analysis of their application.

This section will take into consideration of all other use cases of COMP4DRONES project to provide high level recommendations for regulatory compliance. It is very important to understand important recommendations provided by regulatory authorizes for various applications covered by COMP4DRONES project and also to identify what is not covered in current scenarios.

This section will identify the areas not covered by regulations in today's scenarios. We will explain the issues found by this analysis in detail along with proposing solutions in further sections of this chapter.

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6 ANNEXES

6.1 SESAR JU Projects

- In order to assess the maturity of U-space technologies, the SESAR research program created believe that U1 services are available and U2 services can be implemented by the use of various technologies. In order to check various services at various levels, SEASAR JU launched 19 projects. The outcomes of all projects will work as foundations for further research on this topic.
- The summary of all SESAR 19 projects, which were run based on above assumptions, and their outcomes:

1. **CORUS (COncept of opeRations for U-Space)**
   - The CORUS project target was to build U-space Concept of Operations (CONOPS). It was milestones for definition of various new concepts and evolution of new technologies. It provides an initial U-space architecture and detailed definition of the airspace types to be used for very low-level drone operations and the services within them so that operations are safe and efficient. The CONOPS details drone operations in uncontrolled very low-level airspace, and in and around controlled and/or protected airspace such as airfields. It also describes an initial architecture that identifies the airspace types, services and technical development necessary for implementation of the CONOPS, quantifying the levels of safety and performance required. It describes U-space from a user's perspective, showing how it will be organized and detailing the rule-making that is under development.
   - It also proposes solutions for easing social acceptance of drones by examining aspects including safety, privacy, noise and other societal issues. The CORUS CONOPS shows a complete picture of U-space that can be easily understood and that can form a foundation on which U-space implementation throughout Europe can be based. [55]
2. **SECOPS (an integrated SECurity concept for drone OPerationS)**
   - SECOPS defined an integrated security concept for drone operations. It also address resistance of drones against unlawful interference, protection of third parties and integration of geo-fencing technology. The project reviewed technological options for both airborne and ground elements, considered legal, regulatory, and social aspects. An experimental proof of concept integrating common-off the-shelf technologies of the consortium partners was executed in order to prove the feasibility of parts of the integrated security concept and co-operability of the more mature technical solutions, including detection of rogue drones and air defense solutions.
   - SECOPS concluded drone counter measures are likely to be a combination of different technologies and suggests further research to identify appropriate solutions for various applications. It also recommends a legal framework setting out the roles and responsibilities of enforcement agencies. [55]
3. **IMPETUS (Information Management Portal to Enable the inTegration of Unmanned Systems)**
   - IMPETUS researched on the main information needed by drones and how it will be used by drones in very low-level airspace. The project proposed an information management architecture based around micro-services. This is contradiction of legacy monolithic applications which are centralized programs that become more complex as they grow to meet consumer demand. Micro-service-based applications avoid this issue as the entire application is split into small, independent but highly interconnected services.
   - IMPETUS replicated aspects of this architecture and concluded that it can meet relevant U-space challenges. This approach fully supports U-space objectives of flexibility,

availability and scalability, and is an enabler of high-density operations requiring agile responses and adaptability to change. [55]

4. **DREAMS (Drone European Aeronautical information Management Study)**
   - The DREAMS project objective was to identify the gaps between existing information used by manned aviation and new needs coming from U-space. Unmanned aviation will require a comparable level of information with the same level of integrity and reliability as manned aviation. In this respect, DREAMS assessed the present and future needs of aeronautical information to support the growth of unmanned aviation and ensure the safety of operations. The project concluded aeronautical information available today is insufficient to support U-space operational needs without some extension or tailoring and additional research.
   - It confirmed that several new U-space will be needed such as geo-fencing and geo-caging, geo-vectoring, etc. Several new data formats were also identified as an important enabler for new services. [55]
5. **CLASS (Clear Air Situation for uaS)**
   - The CLASS project examined the potential of ground-based technologies to detect and monitor cooperative and non-cooperative drone traffic in real-time. The project used different means to fused surveillance data obtained by the used of drone identifier and tracker, and holographic radar, to feed a real-time UTM display. Various scenarios were carried out by project to benchmark the surveillance and data fusion technology and achieve the lowest rates of false alarms. As a result of the demonstrations, CLASS was able to define and detail the functional and technical requirements for tracking, monitoring and tactical de-confliction. [55]
6. **TERRA (Technological European Research for RPAS in ATM)**
   - The current communications, navigation and surveillance (CNS) infrastructure is designed to support the needs of manned aviation. The requirements of the emerging drone sector are different and will rely on new and existing technologies to perform effectively. The TERRA project set out to identify relevant ground technologies and to propose a technical ground architecture to support drone operations. TERRA concluded that in environments with a low density of drones and a low level of complexity, the current CNS technologies are sufficient to support U-space services. However, existing technologies present some drawbacks, which limit their application for complex scenarios such as urban environments and high drone densities. To allow full U-space deployment improved technologies are required. These include making use of 5G wireless communications, technologies enabled by Galileo and EGNOS such as augmented satellite positioning data, to cover gaps. Additionally, artificial neural networks modelling has shown the potential benefits of machine learning for use in predicting and classifying drone trajectories in the urban scenarios. Thus, this project demonstrated the used of present CNS technologies for drones domain and identified additional technologies for future need.
7. **PercEvite (Percevoir et Eviter – Detect and Avoid)**
   - The PercEvite project focused on the development of a various sensors for small drones. Main requirement was that proposed solution should be able to detect and avoid ground-based obstacles and flying air vehicles without human intervention. The work started with designing the hardware and software to support these functionalities. Activity then transitioned to live demonstrations using innovative concepts to test the different functionalities. For example, cameras were used to identify objects such as cars, people and obstacles, while embedded microphones were used to differentiate between objects in the airspace and identifying an aeroplane as opposed to a helicopter. The tests looked at different methods of communication ranging from software-defined radio to long term evolution (LTE) 4G wireless broadband. The PercEvite developed two systems: one

designed for extremely small drones weighing as little as 20 grams; and a more comprehensive solution weighing 200 grams suited to drones commonly used in commercial activities like inspection services, photography, surveillance and package delivery. [55]

8. DroC2om (Drone Critical Communications)

- DroC2om project reviewed the capability of the existing cellular and satellite infrastructure that supports C2 datalink communications, using live flight trials and simulations to test availability and performance. The research led to the definition of an integrated communications concept incorporating cellular and satellite datalinks, which is contributing to EUROCAE and 4G/5G standardization work. Based on DroC2om initial investigations, the project partners found that interference management presents a challenge to the reliable operation of the C2 datalink and proposed solutions for further simulation and research. The project provided solid empirical evidence on the drone to cellular networks channel in urban areas and validated dual LTE C2 performance using live trials. It also tested multi-link connectivity and beam switching to ensure drone C2 link quality is maintained in highly loaded cellular networks. It concluded a hybrid cellular satellite architecture, combining low latency and coverage of cellular with reliability of satellite communications, contributes to robust C2 performance. [55]

9. AIRPASS (Advanced Integrated RPAS Avionics Safety Suite)

- AIRPASS defined a high-level architecture for the onboard equipment they will need to carry to safely integrate into airspace. This architecture considers the technologies specific to drone operations such as autopilot and detect and avoid systems. AIRPASS carried out an analysis of available on-board technologies and identified gaps between these systems and technologies necessary to operate drones. The project matched every U-space service to the main avionics components of a drone; specifically, communications, navigation, automated flight control and databases. Due to the variety of drone types and airspaces, AIRPASS defined a general functional architecture which can be applied to multiple applications and which has no implications for hardware. The AIRPASS functional architecture supports the development of U2 services in simple environments and paves the way for the integration of every drone into U-space. [55]

10. DIODE (D-flight Internet Of Drones Environment)

- The DIODE project focused on demonstrating capabilities to safely manage multiple drones flying in very low-level airspace at the same time, while accomplishing multiple tasks and missions. The project worked on the assumption that each aircraft (manned and unmanned) will report its positions. In other words, the whole traffic is cooperative and its complexity is therefore reduced. DIODE demonstrated emerging and mature capabilities on-board drones, which support the deployment of a risk-based and an operation-centric concept of U-space. The project considered a huge range of drones and highlighted opportunities where the drone market can also contribute to development of more advanced U-space services. [55]

11. DOMUS (Demonstration Of Multiple U-space Suppliers)

- The project demonstrate by the use of existing technology that initial and some advanced U-space services, including tactical de-confliction, are possible. DOMUS demonstrated some of the initial services detailed in U1 and U2 definitions of U-space, including e-registration, e-identification, geo-fencing, flight planning, tracking, dynamic flight management and interfaces with air traffic control. Some U3 services, such as tactical de-confliction between two drones, and dynamic geo-fencing in collaboration with air traffic management, were also tested. The project demonstrated the feasibility of connecting U-space operations to the smart city platform. This project add the concept of Ecosystem Manager. The live trials showed an architecture can support multiple

service providers under the management of an Ecosystem Manager for efficient deployment of U-space services. [55]

12. EuroDRONE (A European UTM Testbed for U-space)

- EuroDRONE tested different concepts, technologies and architectures to promote the cooperation of the relevant stakeholders in a U-space environment. By using cloud software and hardware, the research experimented with U-space functionalities ranging from initial services to more advanced services such as automated detect and avoid. The project demonstrated robust end-to-end UTM cloud operations, including beyond visual line of sight medical deliveries over 10km in coordination with air traffic control and commercial operation. It also demonstrated innovative vehicle to infrastructure and vehicle to vehicle (V2V) communications, equipped with operational detect and avoid algorithms. The flights were able to demonstrate high levels of autonomy using cloud-based infrastructure envisaged for an advanced UTM environment. The demonstrations ranged from sea areas to countryside and urban environments, and tested LTE communications links.

13. GEOSAFE (Geo-fencing for safe and autonomous flight in Europe)

- The GEOSAFE project objective was state-of-the-art geo-fencing U-space solutions and to propose improvements and recommendations for future geo-fencing system. The project was based on a one-year long flight-test campaign, which assessed a number of commercially available geo-fencing solutions in order to propose improved geo-fencing systems for tomorrow and technological improvements for drones. The project concluded most drones meet the requirements for pre-tactical geo-fencing and demonstrated that existing technology is ready for initial U-space services even though no one solution is aligned with regulations in different countries. These results are helping to inform the European Commission, EASA and EUROCAE of best practices for integrating drones into European airspace. It suggest that the development of performance requirements will be useful for the ongoing standardization process. [55]

14. GOF-USPACE (Safe drone integration in the Gulf of Finland)

- The GOF-USPACE partners established architecture of FIMS (flight information management system) from three U-space service providers to showcase U-space in all phases of drone operations. The GOF U-SPACE architecture enabled data exchange between two air navigation service providers (in Finland and Estonia), several U-space service providers, eight drone operators and two manned aircraft operators. The GOF U-SPACE architecture integrated U-space service provider micro-services that enabled management of all drone traffic in the same geographical region. The demonstrations showed commercial off-the-shelf UTM components are fit to demonstrate all phases of drone operations. The exercise proved that service providers and operators were able to connect to the open platform to access FIMS and ATM data, while noting the need for additional work to develop tracking solutions and improve resilience to poor mobile network coverage. The project demonstrated the need for resource, where all airspace users can access reliable airspace and aeronautical information and common standards for communication systems. [55]

15. PODIUM (Proving Operations of Drones with initial UTM)

- PODIUM carried out demonstrations at five operational sites in Denmark, France and the Netherlands during 2018 and 2019. The project tested the performance of preflight and in-flight services using different scenarios ranging from airport locations to beyond visual line of sight. The results were used to draw up recommendations on future deployment, regulations and standards. The PODIUM web-based platform enables drone operators and authorities to follow drone operations at VLL in real-time and connect with the pilot where necessary. PODIUM concluded that there is a very strong demand from all stakeholders for U-space solutions that can ease the burden of obtaining flight

authorizations for drone flights, and that increased situational awareness enables safety and efficiency benefits during flight execution. It found that U-space services for the pre-flight phase almost ready for deployment, but significant action is needed to ensure that U-space services can really take off in the flight execution phase. In particular, PODIUM made recommendations relating to tracking, the human machine interface for drone pilots, and the access to trustworthy data with implications for standardization and regulation, and further research and development. [55]

16. SAFEDRONE (Unmanned and manned integration in very low-level airspace)

- The SAFEDRONE project define pre-flight services including electronic registration, electronic identification, planning and flight approval and in-flight services such as geo-fencing, flight tracking, dynamic airspace information and automatic technologies to detect and avoid obstacles. The objective was to accumulate evidence and experience about the required services and procedures necessary to operate drones in a safe, efficient and secure way within U-space. Lessons learned and results from the technologies tested have been passed to EASA and standardization bodies such as EUROCAE. It will help organizations to develop the standards that will enable safe integration of different drone categories under U-space. [55]

17. SAFIR (Safe and Flexible Integration of Initial U-space Services in a Real Environment)

- To safely integrate drones into the airspace, the U-space SAFIR consortium conducted a series of demonstrations to show how technology can support the safe deployment of a multitude of drones in a challenging airspace environment. SAFIR demonstrated full availability of the following services: e-identification; pre-tactical, tactical and dynamic geo-fencing; strategic and tactical de-confliction; tracking and monitoring. The project successfully tested initial, advanced and full U-space services and made recommendations for further research. SAFIR findings will contribute to the EU regulatory process and deployment of interoperable, harmonized and standardized drone services across Europe. [55]

18. USIS (Easy and Safe access to the airspace)

- USIS project validated the services that will be provided by U-space service providers to drone operators and third parties to demonstrate their readiness at a European level. The USIS project considered initial U-space services of e-registration and e-identification, as well as more advanced flight planning, authorization and tracking services necessary for beyond visual line of sight and operations over people. It also looked at scheduling and dynamic airspace management. The project showed that initial U-space services can support multiple numbers of drone operations without creating additional workload for an operator or impacting the safety of the airspace. It highlighted the need for flexibility when carrying out flight planning and approval management processes to cope with different national and local regulations. [55]

19. VUTURA: Validation of U-space by Tests in Urban and Rural Areas

- Demonstrations carried out by VUTURA consortium looked at the new digital smart cities, and how unmanned vehicles can become a part of this interconnected world. VUTURA focused on four major goals. These are: validating the use of shared airspace between existing, manned airspace users and drones; validating more than one U-space service provider providing U-space services in a specific airspace and the procedures needed to support drone flights; ensuring alignment of regulation and standardization between SESAR developments and U-space service providers; and increasing the pace by which European cities and companies exploit emerging technologies related to drones. The goal was to improve the quality of life in cities, create concrete socio-economic outcomes and help European companies to take a leading position in the new smart city market. The work done by VUTURA demonstrated that commercial drone traffic can safely

coexist with traditional air traffic in different kinds of environments and the technology to safely manage drone traffic is feasible, scalable and interoperable. It also suggested the areas in need of further research. Some suggested area were closer alignment of flight planning activity by USSPs and a set of procedures for cross-border flight planning; a common interface for exchanging information and acceptable transmission delay; and reliable detect and avoid capability. Among key findings, VUTURA concluded that airspace users need to be registered in order to share airspace, be identifiable and meet geo-fencing requirements before the industry can move closer to supporting urban air mobility. [55]