Guidelines for UAS operations in the open and specific category – Ref to Regulation (EU) 2019/947

Issue no.: 3

Date: 17.07.2025

Revision record

Issue	Date of issue	Summary of changes
01	31.01.2024	Initial issue
02	04.10.2024	Introduction of the conditions to operate UAS in the open category over railways
03	17.07.2025	Amended version of Part B: Specific category

Change revision summary of latest issue

Paragraph no.	Description of change
Part A.I	Introduction of the table summarising the condition to overfly a railway
Part A.I.4	Addition of the paragraph for the best practices for the overflight of railways
Part B	Amendment of the entire Part B.I specific category (additional information regarding BVLOS operations)

Abbreviations

Please refer to the list of abbreviation included in the easy access rule on UAS.

Introduction and purpose of these Guidelines

Since 2021, when Regulations (EU) No 2019/945 and No 2019/947 became applicable, Europe became one of the first region in the world regulating drone operations. To allow the use of new technology, the regulations were developed following a performance-based, flexible approach, identifying the minimum safety performance required, and leaving to UAS operators the possibility to define the 'how' to reach it. This has the benefit of not slowing down the evolution of the drone market, that is continuously evolving at a fast pace; however, sometimes it may be more difficult for UAS operators to identify solutions that may reach the minimum safety performance while being compliant with the regulation.

To support application of Regulations (EU) No 2019/945[1] and No 2019/947[2], EASA is developing, with the support of NAAs and of the industry, acceptable means of compliance (AMC) and guidance material (GM) (see easy access rule on UAS). Nevertheless, the UAS community is asking to share additional material based on lessons learned and best practices resulting from the experience gained in the last 2 years of implementation of both regulations.

The purpose of the guidelines here is to share such additional material with the UAS Community, so that both industry and Member States may use it as a reference to support application of Regulations (EU) No 2019/945 and No 2019/947. EASA will continue to collect feedback from the community and, once the material contained in these guidelines is considered sufficiently mature, will apply the rulemaking process, transferring them in AMC and GM that are regularly integrated in the easy access rule on UAS.

These guidelines are therefore not to be construed as Guidance Material adopted under Article 76 (3) of Regulation (EU) 2018/1139. They are not legally binding and shall be considered as a working document only, which summarises and disseminates the experience of application of the drone regulatory framework to facilitate of application by the competent authorities, operators and addressees of Regulations (EU) No. 2019/945 and No. 2019/947. The content of these guidelines shall not be interpreted or used to contradict or modify the requirements of Regulations (EU) No 2019/945 and No 2019/947 and shall not be in and of themselves, be used to justify the opening of findings of non-compliance during oversight and standardisation activities, conducted by either the Agency or by national competent authorities.

[1] Commission Delegated Regulation (EU) 2019/945 of 12 March 2019 on unmanned aircraft systems and on third-country operators of unmanned aircraft systems, OJ L 152, 11.06.2019.

[2] Commission Implementing Regulation (EU) 2019/947 of 24 May 2019 on the rules and procedures for the operation of unmanned aircraft, OJ L 152, 11.06.2019.

European Union Aviation Safety Agency

Contents

European Union Aviation Safety Agency

Guidelines applicable to operations in both open and specific category

I. Calculation of the VLOS distance (ref. Article 2 point (7))

Operating a UA in VLOS means that the remote pilot is able to clearly scan the sky for presence of other aircraft, be able to clearly see the UA and avoid that it gets close to other aircraft (manned or unmanned) or obstacles or people that may be endangered.

The VLOS distance is affected by a range of factors such as:

— visibility: the operational area and meteorological conditions should allow to maintain unaided visual contact with the UA and the be able to detect the presence of other aircraft in the volume where the UA is operating. A recommended minimum visibility is at least 5km;

— size of the UA;

— UA characteristics such as: UA colour (in relation to how different it is from the background colour) and brightness of UA lights.

When planning a VLOS operation, the VLOS distance should be measured as the air-line distance between the remote pilot and the UA.

Different methods and formulas providing a quantitative assessment of the VLOS distance exist. Here below a formula is proposed, for fixed-wing and multirotor UA. It is based on evaluating two parameters and setting the VLOS at the smallest value between the two:

— maximum distance at which the remote pilot may be able to detect the position and orientation of the UA, based on its size, called 'attitude line of sight' (ALOS); and

— distance up to which other aircraft can be visually detected, and sufficient time is available for an avoidance manoeuvre, called 'detection line of sight' (DLOS).

In order to determine an acceptable VLOS distance the following procedure may be used:

(a) Calculate the ALOS:

— for rotorcraft and multirotor UA:

$$ALOS\ [m] = 327 \times CD\ [m] + 20m$$

— for fixed-wing UA:

$$ALOS\ [m] = 490 \times CD\ [m] + 30m$$

where CD is the characteristic dimension of the UA (i.e. the maximum dimension).

(b) Calculate the (DLOS):

$$DLOS\ [m] = 0.3 \times GV$$

where GV is the ground visibility, which minimum value should be at least 5 km and depends on the operational area conditions.

(c) Define the VLOS distance as the smaller value among ALOS and DLOS[3].

[3] Additional information for the computation of the VLOS distance may be found using the following link: https://www.lba.de/SharedDocs/Downloads/DE/B/B5_UAS/Leitfaden_FG_CV_GRB_eng.html?nn=2996768

Part A: Open category

II. Overflight of moving vehicles in the open category (Ref. UAS.OPEN.060 point (1)(c))

UAS CLASSES	TRANSIT OVER HIGHWAYS	CONDITIONS (risk mitigations)
Category A1 - Until 31/12/23: all UAS < 500g - From 01/12/24: C0, C1 or privately built <250g	III. **Crossing allowed if needed (ref to conditions)** IV. **No hovering** V. **No sustained flights above or along the infrastructure**	- Minimum height 20 meters AGL and obstacles; - Always keep an unobstructed view of the UA; - No distractions caused to drivers (e.g. banners behind the drone, laser lights etc)
Category A2 - Until 31/12/23: 500g < UAS < 2kg - From 01/12/24: C2 (or C0, C1 or privately build <250g)		- No vehicles are present during highway crossing (ref. Chapter 2, point 3(b)); - Minimum height 20 meters AGL and obstacles; - Always keep an unobstructed view of the UA; - No distractions caused to drivers (e.g. banners behind the drone, laser lights etc)
Category A3 - Until 31/12/23: 2kg < UAS < 25kg - From 01/12/24: C3 or privately build (<25kg) (or C0, C1 or privately build <250g)	VI. **No operation (never)**	- Not applicable, no operations should be conducted

Note: for operations in close proximity of highways, use the 1:1 rule

European Union Aviation Safety Agency

<table>
<tr><th>UAS CLASSES</th><th>TRANSIT OVER <u>RAILWAYS</u></th><th>CONDITIONS (risk mitigations)</th></tr>
<tr><td>Category A1
- Until 31/12/23:
all UAS < 500g
- From 01/12/24: C0, C1 or privately built <250g</td><td rowspan="3">1. Crossing allowed if needed (ref to conditions)
2. No hovering (*)
3. No sustained flights above or along (*)</td><td rowspan="3">- No moving trains are present;
- Minimum height 20 meters AGL and obstacles;
- Always keep an unobstructed view of the UA;</td></tr>
<tr><td>Category A2
- Until 31/12/23:
500g < UAS < 2kg
- From 01/12/24: C2 (or C0, C1 or privately build <250g)</td></tr>
<tr><td>Category A3
- Until 31/12/23:
2kg < UAS < 25kg
- From 01/12/24: C3 or privately build (<25kg) (or C0, C1 or privately build <250g)</td></tr>
</table>

(*) = hovering or flying along railways is possible provided that the operation is performed in coordination with railway operator(s)

Note: for operations in close proximity of railways, use the 1:1 rule (see AMC1 UAS.OPEN.030(1) for a description of the 1:1 rule)

UAS CLASSES	TRANSIT OVER OTHER ROADS	CONDITIONS (risk mitigations)
Category A1 - Until 31/12/23: all UAS < 500g - From 01/12/24: C0, C1 or privately built <250g	VII. Crossing allowed if needed (ref to conditions) VIII. No hovering (*) IX. No sustained flights above or along (*)	- No moving vehicles should be present; - Minimum height 20 meters AGL and obstacles; - Always keep an unobstructed view of the UA; - Using a trajectory that minimise the time flying over the road
Category A2 - Until 31/12/23: 500g < UAS < 2kg - From 01/12/24: C2 (or C0, C1 or privately build <250g)		
Category A3 - Until 31/12/23: 2kg < UAS < 25kg - From 01/12/24: C3 or privately build (<25kg) (or C0, C1 or privately build <250g)		

Note: for operations in close proximity of roads, use the 1:1 rule

1. Introduction on the risk of overflying moving vehicles

Regulation (EU) 2019/947 does not discuss explicitly the risks associated to the overflight of moving vehicles in the open category. However, the regulation contains some generic safety objectives to ensure that safety margins are always kept during UAS operations.

In general terms, the overall risk can be defined as the combination of the frequency (probability) of an occurrence and the associated level of hazard.

With respect to hazards, the following categories have been evaluated:

- **Direct hazards** generated by the crash of a drone into the roof/windshield of a moving vehicle. The severity of this hazard is mainly influenced by the kinetic energy transmitted to the vehicle (=> weight of the drone and speed of the vehicles);
- **Indirect hazards** generated as a consequence of a drone crash. For instance, car accidents occurring in a busy highway as a result of a sudden steering done by a car driver in the attempt to avoid the impact with a drone or with its wreckage. Typically, indirect hazards are more relevant for roads than for other kind of infrastructures and they are mainly influenced by the speed of the vehicles, the mass of the drone, the amount of the traffic volume in the road and

by the presence of fences around the road (as they would not allow the prompt removal of a drone wreckage).

With respect to the probability of a drone crash in the open category, currently there are no quantitative evaluations available, therefore a reference basis could be taken from the draft SORA Annex F[4]. According to that document, the operation failure rate for a drone in SAIL II could be in the order of magnitude of 10^{-2} per flight hour. Although in some specific cases a SAIL II drone could differ significantly from drones in the Open category, it can be assumed with an acceptable level of approximation that the operational failure rate is similar.

The riskiest scenario is represented by operations over highways and busy roads. For this reason, some additional considerations and mitigations are needed.

Operations over railways still deserve some considerations and mitigations.

These additional considerations and mitigations are described in the next paragraphs.

Operations over inland waterways with large traffic density are not considered particularly risky and the already available material is deemed to be sufficient.

While the final goal is to protect vehicles and occupants, it is impractical to introduce provisions based on the intrinsic protection ensured by vehicles because they might move faster than UAS in the open category and because the intrinsic level of protection of vehicles is significantly different considering different types of them (e.g. motorbikes vs vans). As a result, the drafted material is not directly addressing the overflight of vehicles, but it is rather addressing the overflight of infrastructures (e.g. roads and railways).

Finally, EASA MS may use geographical zones (refer to Article 15 of the EU drone regulation) in order to address the risks associated to the overflight of moving vehicles, e.g. by introducing specific limitations or conditions for the operations of UAS over roads and railways. However, it is expected that UAS pilots and operators would benefit from the availability of this guidelines as it will increase their awareness regarding possible risks providing as well hands-on best practices.

It should also be noted that, when a geographical zone exists, the restrictions and conditions introduced by it take the precedence over the contents of this document.

2. Best practices for the overflight of highways

While planning UAS operations in the open category over highways, the following elements should be considered.

1) Hover and sustained flights above, or along, highways are posing the highest risks to uninvolved persons and therefore should always be avoided.

2) Crossing of highways in the subcategory A3 should always be avoided.

[4] Please refer to: http://jarus-rpas.org/jarus-external-consultation-wg-srm-sora

3) Limited to subcategories A1 and A2, in case of operational needs, crossing of highways may be possible under the following conditions:

   a) a minimum height of at least 20 meters above the highway is maintained;

   b) the pilot is positioned in a place that allows to maintain visual line of sight (VLOS) operation especially in case of arrival of vehicles. The pilot should also be able to keep sight of the traffic on the highway;

   c) the remote pilot minimises the risk of distraction to the drivers of vehicles as far as possible (e.g. using a trajectory that minimise the time flying over the road; they should not attach banners behind the UA);

   d) only in case of operations in the A2 subcategory: no moving vehicles is present during the crossing of the highway.

4) Operations in close proximity to (not directly over) highways in the open category could be conducted provided that the UAS is kept at a safe distance from them (e.g. at least respecting the 1:1 rule distance from the highway).

5) For the purpose of this material, highways are considered as any road that satisfies at least one of the following criteria:

   a) The road is listed in the TEN-T network[5]; or,

   b) The road has 4 or more lanes in total and it is intended for motorway traffic only;

Note 1: once this material is transferred in the EU regulatory framework, it is EASA intention to introduce specific provisions allowing competent authorities to classify, for this specific purpose, other roads as highways, if deemed appropriate.

Note 2: in case the highway is already covered by a geographical zone, the prohibitions, conditions or flight authorisations for the geographical zone take precedence.

3. Best practices for the overflight of other roads

While planning UAS operations in the open category over roads other than highways, the following elements should be considered:

1) to reduce potential risks to third parties, the remote pilot should avoid flying over any road with high traffic density when there is no operational need.

2) Motorbikes, bicycles, or other vehicles where occupants are not sheltered, should be considered uninvolved persons that could potentially be affected by the UAS operation and, therefore, the relevant limitations apply.

3) While operating in proximity of roads, the potential risk to third parties should be reduced as much as possible.

[5] https://ec.europa.eu/inea/en/ten-t/ten-t-projects

European Union Aviation Safety Agency

Examples of good practices are:

1) no hover or fly along the road when vehicles are present;

2) cross the road under the following conditions:

   a) at a minimum height of at least 20 meters over the road;

   b) when no vehicles are present;

   c) using a trajectory that minimise the time flying over the road. Keep visual line of sight on the UAS and on the roads;

3) when operating close to a road keep the UA at a safe distance from the road by respecting the 1:1 rule distance from it;

4) minimise the risk of distraction to the drivers of vehicles as far as possible (e.g. do not attach banners behind the UAS).

Note: in case the road is already covered by a geographical zone, the prohibitions, conditions or flight authorisations for the geographical zone take precedence.

4. Best practices for the overflight of railways

While planning UAS operations in the open category over railways the following elements should be considered:

- Hovering and sustained flights above, or along, railways are posing high risks for third parties not involved in the UAS operations and therefore should be always avoided unless they are performed in coordination with the railway operator(s).
- Crossing of railways in the open category may be possible under the following conditions:
  - a minimum height of at least 20 meters above the railway is maintained;
  - using a trajectory that minimise the time flying over the railroad (e.g. using a trajectory perpendicular to the railway);
  - the remote pilot is positioned in a place that allows to maintain visual line of sight operation even in case of arrival of a train. The remote pilot should also be able to keep sight of the traffic on the railway;
  - no moving trains are present.
- Operations in close proximity to (not directly over) railways in the open category are possible under the condition the UAS is kept at a safe distance from them (e.g. at least respecting the 1:1 rule distance from the railway).

Note: in case the railway is already covered by a geographical zone, the prohibitions, conditions or flight authorisations for the geographical zone take precedence over this material.

European Union Aviation Safety Agency

Part B: Specific category

I. SORA- Guidelines for the determination of the air risk (ref. Article 11)

1. Introduction

The rapid advancement of Unmanned Aircraft Systems (UAS) technology has opened new frontiers in aviation, offering unprecedented opportunities for various stakeholders, including operators, service providers, external suppliers, and third parties. However, the safe and efficient integration of UAS operations, particularly Beyond Visual Line of Sight (BVLOS), into the EU airspace presents significant challenges. This guide aims to address these challenges by providing best practices and consideration for conducting and approving operations safely across different airspace classes, including traditional airspace and the emerging U-space.

This document is based on Specific Operations Risk Assessment (SORA) 2.0 and aligned with SORA 2.5. It should be noted that as of June 2025 a SORA 3.0 is currently under development in Joint Authorities for Rulemaking on Unmanned Systems (JARUS) group with the objective of improving Annexes C and D on air risk. The present guidelines may have to be revised when this new version is published.

These guidelines are not legally binding and shall be considered as a working document only, which summarises and disseminates the experience of application of the UAS regulatory framework to facilitate of application by the competent authorities, operators and addressees of Regulations (EU) No. 2019/945 and No. 2019/947. The content of these guidelines shall not be interpreted or used to contradict or modify the requirements of Regulations (EU) No 2019/945 and No 2019/947 and shall not be in and of themselves, be used to justify the opening of findings of non-compliance during oversight and standardisation activities, conducted by either the Agency or by national competent authorities.

2. Executive Summary

This document serves as a guide regarding air risk assessment for stakeholders involved in the planning, execution, or approval of BVLOS UAS operations. Key sections of the document include:

- How to conduct an assessment of the airspace where the UAS operation takes place.
- Considerations on usage of strategic and tactical mitigations.
- Annexes: A collection of supplementary materials and resources to support stakeholders and provide educational material.

3. Objectives of the document

This document focuses on BVLOS operations performed outside of U-space airspace. It addresses the various stakeholders providing guidance on air risk assessment and mitigations, while also aiming at supporting the review of applications for BVLOS operations by NAAs. The document also provides information on technical and operational conditions under which BVLOS operations can be performed.

The document focuses on BVLOS operations at Very Low Level (VLL), below 500ft. This could be the case, for instance, of:

— UAS operations in urban areas where it is proven that low level traffic of helicopters is non-existent or very low,
— UAS operations in controlled and uncontrolled airspace.

4. Context – operations

Performing BVLOS operations[6] usually requires an operational authorization under the conditions provided for in Article 12 of Regulation (EU) 2019/947, unless they are performed in the certified category. This operational authorisation may be issued by the competent authority, based on an operational risk assessment performed by the operator using the SORA methodology or Pre-defined Risk Assessments (PDRAs).

The SORA assesses an operation on the principle of a holistic safety risk-based assessment model, considering the risk posed both on ground and in the air.

In terms of air risk, there exist theoretically three approaches that an operator could take:

1. Operate fully segregated, in an airspace dedicated to the UAS operation. Based on the methodology, it would be the equivalent of an ARC-a. This is how many of the operations are currently being conducted in Europe.
2. Operate fully integrated, similar to how manned aviation operates. This is at the moment not widely possible due to the limitations of operational means and technology available.
3. Operate partially integrated, in airspace of various levels of risk, each with their corresponding performance requirements. These airspace volumes are characterized by the different ARCs, as given by the SORA methodology. These guidelines focus on providing support information for the way an operator can operate and access the various airspaces, as defined by the ARCs. See Figure 1 below.

[6] The BVLOS operations addressed are the ones during which the operator does not have the capability to maintain continuous unaided visual contact with the unmanned aircraft.

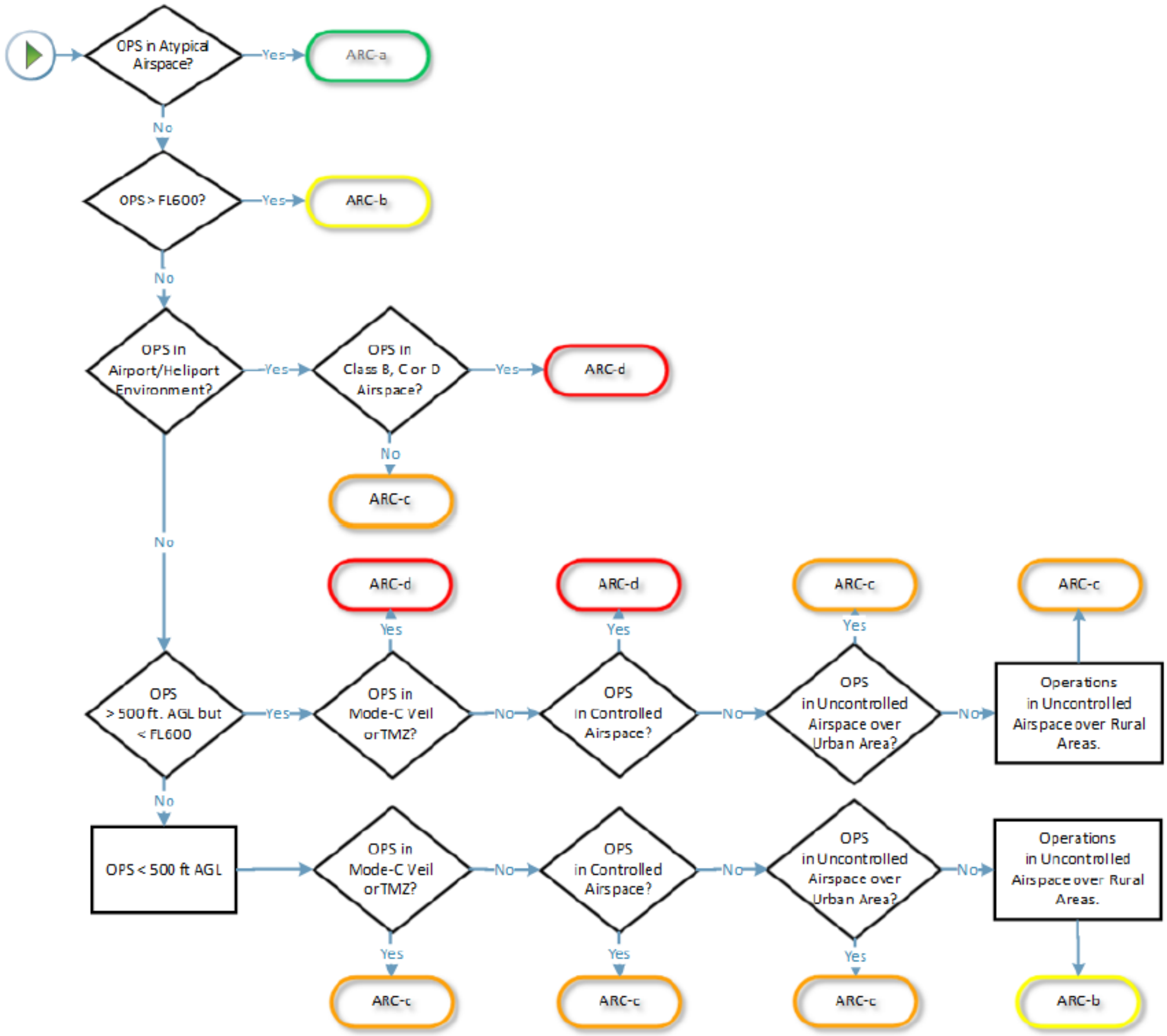

Figure 1 - ARC assignment process (Source: JARUS SORA v2.0)

5. Assessment of the airspace

Step 1: Operator's initial assessment

When intending to perform BVLOS operations in the specific category, operators should consider first if any of the following two air risk mitigation means apply:

— positioning airspace observers (AO) along the trajectory, in charge of monitoring the entry of a manned aircraft into the area of operation and warning the remote pilot to make the appropriate manoeuvre. In this case, the operation would be considered BVLOS with AO from the air risk perspective, which is considered to be an acceptable tactical mitigation for collision risk for all ARC levels (refer to paragraph S.4.6.3 of AMC 1 to Article 11 (SORA 2.5) for additional information).

— operating in airspace that is reserved or segregated for UAS operations. In this case the ARC-a would apply.

If these options are implemented, then no further analysis of the ARCs is required. Both mitigations are widely used, however, they usually require a high level of administrative effort and resources, are partly effective, often burdensome, and also subject to human error. This represents a strong incentive to develop more flexible and easier to implement air risk mitigation measures, that would rely on increased awareness of the actual traffic in the operating volume and adjacent airspaces.

It is of very high importance that an operator has a deep understanding of the airspace where the operation(s) take place. This includes the awareness of the overflown areas, other manned or unmanned traffic to be expected, presence of hotspots, etc.

If none of the 2 options above are considered suitable, then a detailed analysis of the airspace by the operator is needed. The air risk assessment proposed by the operator should consider all manned aircraft operations expected in the UAS area of operations. See section 5.2 below.

Step 2: Operator's analysis of the airspace

The guidance on this subchapter focuses on operations below 500ft. Nevertheless, the approach could be adapted to other airspace volumes as well, noting that some data might not have been included here.

The high-level analysis

The high-level analysis of air traffic needs to consider all types of manned aircraft that can be expected below 500 ft. Information considered should cover:

- Type of activity,
- Environmental constraints (visibility / weather, day / night, etc.),
- Typical locations and height/altitude of operation,
- The ICAO airspace class,
- Conspicuity available and activated, type of equipment, proportion of equipped aircraft.

The high-level analysis should make use of available tools or sources of information that can be used by UAS operators to build the air risk analysis included in the SORA and prepare their missions. Typical tools and sources of information may be:

- UAS geographical zones,
- Aeronautical information, including airspace maps, such as ICAO VFR maps,
- Aggregators of traffic data, such as Flightradar 24, Open Glider Network, etc.,
- Websites and contact of general aviation unions and associations,
- General aviation flight preparation tools or websites, such as maps of activities, hotspots, etc.,
- Weather information services, etc.

The high-level analysis should also consider the proper use and limitations of these tools. For instance:

- Data aggregators do not represent the full traffic but only data provided by conspicuity equipped aircraft,
- Some data on activities that take place below 500 ft (for instance some model aircraft activities) may not be represented on aeronautical maps, because they are not relevant for manned aircraft flights, etc.
- Weather information need to consider the source of the data and the local conditions, as this will provide a different level of confidence (certified vs uncertified sources).

EASA
European Union Aviation Safety Agency

Types of traffic to be expected

This subchapter provides general considerations per type of traffic. Due to the national specific characteristics, other non-listed types of traffic may have to be considered. Competent authorities may identify and include all nationally permitted low-level manned traffic in their airspace descriptions. See also Appendixes 3 and 5 for guidance on hazard identification in a given area of operation.

It should be noted that a different proportion of cooperative aircraft may be expected for each kind of traffic, which may itself depend on the weather, on the time of the day, on the geographical situation, etc.

Unpowered air sports: hang gliders, paragliders, parachuting

- Typical locations: mountains or rural environment,
- Typical height may be below 500 ft, especially during take-off and landing phase, except for parachuting where humans will be in freefall from 13,000ft to 3000ft.
- Very dependent on weather situation: VFR conditions, thermal lifts,
- Usually low proportion of conspicuous aircraft,
- Source of information: maps of hang glider/paraglider hotspots, paragliding thermal maps, etc.

Unpowered air sports: Gliders

- Typical locations: around airfield, mountains, mostly known areas,
- Typical height may be below 500 ft, especially during landing phase (take-off on identified airfields),
- Very dependent on weather situation: VFR conditions, thermal lifts,
- Large proportion of conspicuous aircraft,
- Source of information: OGN.

Powered air sports: very light aircraft, ultralights, motor gliders, motor paragliders

- Typical locations: rural areas,
- Typical height may be below 500 ft, especially during take-off and landing phase outside airfields,
- Dependent on weather situation: VFR conditions,
- Proportion of conspicuous aircraft varies greatly from one country to another,
- Source of information: OGN

Helicopters (civil, military)

- Typical locations: urban and rural area, could be indicated in the Aeronautical Information Publication (AIP).
- May be allowed to fly below 500 ft outside airfields,
- Dependent on weather situation: VFR conditions, Night VFR possible (most likely at higher heights although Night Vision Googles (NVG) operations and training at VLL should also be considered)
- Conspicuity:
  - State missions may be allowed not to be conspicuous for discretion purpose.
  - SAR/HEMS: usually well-known, conspicuity equipped, sometimes ADS-B,
  - Commercial aircraft: Specialised Operations (SPO),
  - General aviation: transponder data for school flights

European Union Aviation Safety Agency

- Source of information: OGN

Light aircraft (non-pressurized general aviation)

- Typical locations: rural areas (heights > 500 ft in urban areas)
- Typical height: 500 ft or above except during emergency landing exercises or exceptional situations.
- Dependent on weather situation: VFR conditions (IFR always above 500 ft when far from airfields)
- Conspicuity:
  - Usually equipped with radio communication (R/C): but monitoring R/C is not considered an air risk mitigation,
  - Usually equipped with Mode A/C,
- Source of information: OGN, FlightRadar24

Military fixed wing aviation

- Typical locations: rural areas (heights > 500 ft in urban areas),
- Typical height: may descent below 500 ft,
- Dependent on weather situation: VFR conditions (IFR always above 500 ft when far from airfields/air bases),
- Conspicuity: State missions may be allowed not to be conspicuous for discretion purpose, so the aircraft may be equipped but the device may not be activated for security reasons,
- Source of information / tools depends on the country of operation.

Other types of operations with manned aircraft

- High Risk Specialised Operations (SPO HR) such as agricultural, aerial work flights below the minimum safe altitude;
- Non-commercial operations below 500ft.

Considerations on height/altitude

Depending on the location and operation, the high-level analysis may also have to consider traffic that flies at 500 ft or above. The reasons are the following:

- Altimetry systems of non-certified UAS may be imprecise and unreliable,
- Non licensed remote pilot may not be aware of the limitations of their systems or may not correctly calibrate them,
- Manned aircraft use barometric references (altitude), not local height. Especially in high ground areas, they may not always meet the 500ft minimal height,
- UAS are using geometric height (GNSS), which is subject to restrictions for establishment and verification of vertical separation (ref ICAO Doc 4444 8.5.5.1.1 and Part ATS ATS.TR.210(c)(1)).

In such cases, an appropriate buffer between the UAS and manned aviation should be established, which might need to be calculated on a case-by-case basis. In general, a buffer of 30m is considered adequate (same as the open category).

European Union Aviation Safety Agency

6. Overview on airspace and national differences

Due to lack of data on the movement of manned traffic at VLL, UAS operators require a high effort to have a full awareness of the manned traffic situation, especially at very low levels where most aircraft are not equipped with certified positioning equipment such as ADS-B.

The traffic situation at VLL may also be unknown to competent authorities themselves and may greatly differ from one Member States to another, and even from one area to another (mountain areas, proximity of take-off and landing platforms, funnel effect between controlled airspaces, places of interest, etc.). For this reason, it is highly encouraged that the competent authority produces a high-level description of the traffic situation in the considered country, including the relevant sources of information (website of general aviation associations, main aerial work companies, collaborative air traffic maps, etc.). Such preliminary analysis would greatly facilitate the building of the air risk assessment by the operator and ensure that it does not forget or neglect some types of traffic or local specific traffic situations. Furthermore, since operators are not necessarily familiar with the traffic situation outside their country of registration, such a high-level analysis would be especially useful for the determination of local conditions and mitigation measures for operations in another Member State, as required by the cross-border procedure.

Since each airspace and conditions may differ from one Member State to another, there is a high necessity to perform such an analysis in each country (or even at regional level if needed). For instance:

- In some countries, military traffic may fly at very low height, while not in others,
- Some countries have a higher proportion of conspicuity equipped aircraft than others,
- Some areas, such as mountain areas, tend to concentrate more glider/paraglider traffic,
- Consider GA practicing engine failure exercises, presence of hot air balloons, spraying operations, etc.

7. Considerations on strategic mitigations

Air risk strategic mitigations are defined in SORA Main Body and further detailed in Annex C. Their actual implementation and effectiveness can be impacted by local conditions such as weather or areas overflown. The sections below provide general considerations of some of those aspects.

8. Implications of weather and day/night

In uncontrolled airspace, flying UAS at night or during adverse weather conditions may provide an air risk mitigation by operational restriction. This is a commonly used mitigation.

At night, a UAS operation that takes place below 500 ft may need to fly below the minimal height for VFR at night and IFR in order to be considered a possible mitigation, unless proven safe otherwise. Furthermore, it needs to be considered that most recreational activities are expected to be suspended (except VFR at night), thus possibly making the air risk analysis easier.

The use of sufficiently intense lights should be encouraged to increase the visibility of the UAS, thus making “see and avoid” more effective for manned aircraft crews.

Certain environmental conditions — such as poor visibility or adverse weather — may reduce the likelihood of conflict with manned aviation due to lower traffic density and could therefore be considered as part of an air risk mitigation strategy. However, these same conditions may pose operational risks to the UAS itself (e.g., icing), and must therefore be carefully assessed to ensure the overall safety of the flight. It needs to be noted that weather may change at very short notice, therefore this needs to be considered during the assessment.

However, it should be stressed that special operations may take place below 500 ft, even at night and/or below VMC limits. Specific considerations of such operations may be needed.

9. Considerations on environment

Urban areas

The initial ARC-c classification of urban areas in the current version of SORA is seen to be applicable for urban areas where intense traffic, such as taxi helicopters, HEMS and/or public protection operations, take place. In Europe, such cities are quite rare so in several cases, an argumentation for a residual ARC-b classification might be considered appropriate by the competent authority.

When traffic is expected above or nearby urban areas, the air risk classification may be refined considering VFR charts, reporting/entry points to aerodromes in the vicinity of cities and recommended or mandatory VFR routes.

Airport and heliport surroundings

In the SORA, airport and heliport surroundings are considered as high traffic hotspots, thus entailing an increased ARC level (ARC-c or ARC-d). The proposed classifications make sense for most uncontrolled aerodromes. For controlled aerodromes, further considerations may also apply, depending on local ATC procedures.

The geography of the area that should be considered as the “surrounding” of a given aerodrome may differ from one country to another.

10. Considerations on tactical mitigations

This section addresses known technical solutions that may be used to improve the mutual awareness of UAS and manned aircraft traffic.

Tactical mitigations will be implemented by the operator to reduce the residual risk of a mid-air collision. When considering operations under VLOS/BVLOS with AO, the “see and avoid” is considered to be an acceptable tactical mitigation for all ARC levels. However, it is generally recommended to consider additional means to increase the situational awareness concerning the air traffic operating in the vicinity, if possible.

When considering BVLOS operations, the tactical mitigations require a higher assurance of obtaining the safety objective/criteria in that airspace. Current traffic situation, electronic flight information services or notification to manned a/c about the intended operation may be considered.

The following sections detail different information tools and surveillance technologies that can increase the situational awareness and may be used as tactical mitigations for the UAS operation (in full or partial).

11. Considerations on information distribution

Aeronautical information

Regarding information for manned aircraft, the only standard that is recognized at international level is the aeronautical information (NOTAM and Sup AIP). Although satisfactory from a regulatory and liability point of view (all crews are supposed to read aeronautical information), this solution is usually not considered sufficient from a safety point of view:

- the presentation of the information (WGS84 coordinates) makes it complex to apprehend,
- the high number of NOTAMs is often overwhelming for pilots,
- a significant proportion of general aviation users do not properly prepare their flights,
- emergency operators may not have the time to take full knowledge of aeronautical information.

Several incidents involving UAS and manned traffic support this safety analysis (penetration of Temporary Segregated Areas (TSA) or loss of separation between manned aircraft and UAS despite adequate aeronautical information).

For these reasons, and although it should not be disregarded, it is often considered that traditional aeronautical information is not sufficient to inform manned aircraft about the presence of an unmanned aircraft.

Digital information

As of January 2025, there exists no commonly accepted shared digital platform to inform manned aircraft crews about UAS traffic. Such technical solutions may be developed locally, with the cooperation of local manned aircraft users, if it can reasonably be considered that no other unknown traffic will enter the area of operations.

Traffic situation awareness

The following tools may be used by UAS operators to improve their awareness of the current traffic situation before and during a flight (non-exhaustive list)

Safesky	Claiming to receive traffic information from many other online services,
Flightradar24[7]	Network of ADS-B receivers. Can in some locations also display Mode S targets using multilateration (MLAT). Coverage is unknown.
ADSb exchange[8]	Network of ADS-B receivers.
Open Glider Network[9]	Network of FLARM and OGN receivers.
Xcontest.org[10]	Online position sharing used by paragliders.

[7] https://www.flightradar24.com/
[8] https://globe.adsbexchange.com/
[9] https://www.glidernet.org/
[10] https://www.xcontest.org/

Air Navigation Pro[11]	Application, also sharing tracking data with Safesky.

Table 1 Tools for situational awareness

It should be noted that the information provided by these tools greatly depends on the types of receivers, and on the proportion of conspicuous aircraft, which may greatly vary. Another consideration is the latency of the data, i.e., the delay between the actual position of an aircraft and the position that is displayed. The high-level analysis conducted initially may provide information to UAS operators about the expected reliability, latency and completeness of the information provided by existing platforms.

12. Surveillance technologies

Surveillance technologies are classified in two main categories: cooperative and non-cooperative systems.

Cooperative systems

The current section only lists the cooperative solutions, based on conspicuity equipment, that may be used by the remote pilot in operations to ensure proper situation awareness of other traffic.

Manned airspace users operating at low level in class G airspace are usually not required to be conspicuous. The systems operated by these users vary a lot (no equipment, various noncertified commercial systems, or certified ADS-B). This could improve in the future as ADS-L becomes a more affordable and standardized option.

Here is a list of commonly used conspicuity equipment, associated with their detection means:

Transmission from manned aviation	Detection on the UAS side
Mode S with extended squitter or ADS-B Out (1090 MHz)	ADS-B In
SRD 860	Devices able to receive SRD 860 transmission[12]
Mode C or Mode S (1090 MHz)	Secondary radar or multilateration (MLAT)
Online traffic sharing services	Online connection to the relevant service

Table 2 Common conspicuity systems

See Appendix 1 for a detailed analysis of surveillance technologies.

Non-cooperative systems

Since manned aircraft operating at low level in class G may not be conspicuous and assessing the proportion of equipped aircraft may be challenging, UAS operators may choose to rely on non-cooperative sensors to detect non conspicuous aircraft. Such systems may be on-board surveillance systems and ground surveillance systems.

[11] https://www.airnavigation.aero/en/

[12] Please check the ADS-L Coalition list of members in the ADS-L chapter in Appendix 1 of this document.

On-board surveillance systems are usually based on image analysis, often supported by artificial intelligence systems. Ground surveillance systems may be based on traditional primary radars or UAS specific detection radars.

Currently there are no awareness systems that have demonstrated a satisfactory level of detection.

Appendix I - Conspicuity devices

ADS-B

ADS-B is the extended surveillance technique of manned aviation. On the ground, specific ground stations are required to work with this type of system in a 1090 MHz surveillance environment. ADS-B must comply with a minimum set of requirements.

Due to the integrity and security requirements that these devices must meet, the cost of ADB-S-In / Out transponder/devices are not suitable for the mass market. Furthermore, the 1090 MHz spectrum limitation intrinsically limits the number of potential users, which is incompatible with the development target of the drone industry.

There are other surveillance options that involve ADS-B receivers and represent much cheaper and more practical options.

All existing ATM/ANS safety systems that use ADS-B information to generate spacing, separation or collision avoidance guidance have required ADS-B validation. It should be determined if for use cases considered here such ADS-B validation is required and what are the performance requirements, if yes.

SRD 860

There are several Short Range Devices using the frequency band of 860 MHZ commercialized as situational awareness technology to prevent collision for general aviation. They broadcast GPS position and altitude along with other parameters.

Mode A/C or Mode S

The aviation transponder interrogation modes are the standard formats of pulsed sequences from an interrogating Secondary Surveillance Radar (SSR). The reply format is usually referred to as a "code" from a transponder, which is used to determine detailed information from a suitably equipped aircraft.

When the transponder receives an interrogation request, it broadcasts the configured transponder code (or "squawk code"). This is referred to as "Mode 3A" or more commonly, Mode A. A separate type of response called "Ident" can be initiated from the airplane by pressing a button on the transponder control panel.

A Mode A transponder code response can be augmented by a pressure altitude response, which is then referred to as Mode C operation. Pressure altitude is obtained from an altitude encoder, either a separate self-contained unit mounted in the aircraft or an integral part of the transponder. The altitude information is passed to the transponder.

Another mode called Mode S (Select) is designed to help avoiding over interrogation of the transponder (having many radars in busy areas) and to allow automatic collision avoidance. Mode S transponders are compatible with Mode A and Mode C Secondary Surveillance Radar (SSR) systems. This is the type of transponder that is used for TCAS or ACAS II (Airborne Collision Avoidance System) functions, and is required to implement the extended squitter broadcast, one means of participating in ADS-B systems. A TCAS-equipped aircraft must have a Mode S transponder, but not all Mode S transponders include TCAS. Likewise, a Mode S transponder is required to implement 1090ES extended squitter ADS-B Out, but there are other ways to implement ADS-B Out (in the U.S. and China.) The format of Mode S messages is documented in ICAO Doc 9688, *Manual on Mode S Specific Services*.

European Union Aviation Safety Agency

ADS-L

ADS-L is a new set of parameters derived from ADS-B Out dataset by EASA, foreseen to be the common data format being used for conspicuity devices, such as the various SRD-860 systems (see ADS-L 4 SRD860 specification[13]) and in the future for mobile communication network as complementary channel. The goal was to provide a standard for inexpensive conspicuity solutions for manned aircraft that could be easily deployed at large scale and compatible with U-space airspace (SERA.6005(c)). These non-certified low-cost devices broadcast a GNSS position (horizontal and vertical) together with a unique identifier and timestamp at low power on the license free band SRD-860 (same band as the FLARM) or using existing mobile telecommunication networks. By July 2025, several ADS-L devices compatible with ADS-L 4 SRD860 specification are available on the market from several manufacturers. There is ongoing work on characterisation of performance of ADS-L using both, the SRD860 frequency band and mobile telecommunication services.

Regarding the ADS-L Coalition, the following members take part in discussing about the common data format:

- Open Collision Avoidance Protocol (CAP);
- AIRMATE;
- Flying Neurons;
- Avionix Software Engineering;
- Air Avionics;
- Dronetag;
- FLARM;
- TRACER;
- TALOSAVIONICS;
- PilotAware;
- NavITer;
- F.u.n.k.e. Avionics;
- SafeSky;
- uAvionix;
- SKYRECON;
- Drone Alliance Europe;
- IAOPA Europe.

All information regarding ADS-L will be documented and stored on the following EASA links:

- https://www.easa.europa.eu/ads-l or
- https://www.easa.europa.eu/iconspicuity .

[13] https://www.easa.europa.eu/sites/default/files/dfu/ads-l_4_srd860_issue_1.pdf

European Union Aviation Safety Agency

Appendix II - Guidance on operational procedures

The current sections provide guidance for operational procedures that may be developed by operators to address the air risk of their operation. They should be considered as guidance and not as mandatory.

1. Preparation of the flight

During the preparation phase, the UAS operator collects information and ensures that strategical and tactical mitigation means used in the risk assessment are properly implemented. Based on the collected information, it also checks that there is no major discrepancy between the current status of traffic and the traffic hypotheses that were made during the strategic air risk assessment. For instance, in the air risk analysis, the UAS operator assumed that there would be no glider. But on the day of the operation, by checking an online source providing the positions of gliders, it observes that there are several in the area of operation.

Airspace map

An ICAO 1:500 000 map should be used. The UAS operator should check for:

- Airspace class,
- Nearby aerodromes,
- Nearby VFR reporting points,
- Other areas, like danger areas or areas for air sporting activities,

When identified, information to relevant stakeholders (aerodrome operators, clubs, HEMS operators, etc.) should be considered.

Aeronautical information

The UAS operator should check for any NOTAMs and Sup AIP around the area of operation.

Additionally, the UAS operator may be required to publish a NOTAM no later than 12 hours before the operation or notify manned aviation by other means acceptable to the competent authority. A phone number to reach the ground control station should be included in the publication.

Geographical zones

The UAS operator should check for any relevant geographical zone in the area of operation.

Additional aerodromes/operating sites

The UAS operator should check for any nearby airstrips/helipads and identify nearby clubs/operators that might use them. It should consider the weather and time of the year (nice weather, weekends and summertime increase the probability of traffic).

Planned events

If the information is available, the UAS operator should check for nearby air sports/air activities events.

Other activities performed at low level

The UAS operator should use available sources to increase the awareness of the current traffic situation. Considering that only a fraction of manned aircraft operating at low level are usually conspicuous, a single detection is an indication that other manned aircraft may fly in the area of operations.

Operations may need to be adapted if expected traffic in the area are:

- Paragliders
- Parachutes
- Hang gliders
- Light aircraft
- Low flying military aircraft
- Balloons

Pre-flight check

Amongst all pre-flight verifications, the UAS operator should check that the conspicuity and detection equipment onboard the aircraft are in operating condition, if available.

2. Surveillance of the traffic situation during the flights

The UAS operator should ensure that the crew has the capacity to perform surveillance of the traffic situation during the flight. Considering the workload generated by the operation of the aircraft itself and with the operation of onboard equipment (sensors, for instance), airspace observers or flight assistants may be required, unless the pilot flying can be alerted of incoming traffic in a user-friendly and manageable way.

In that case the UAS operator shall ensure that the observers/assistant are properly trained, and that communication procedures with the remote pilot are properly defined.

3. Management of conflict situations

The UAS operator should develop procedures for the management of potential conflict with another aircraft and emergency collision avoidance.

Management of separation

When a manned aircraft is detected, the UAS operator should take all necessary actions to give priority to that aircraft and remain well clear from it. The manned aircraft always has priority, and it should be assumed that the manned aircraft crew has no visibility of the UA.

Due to the considerations on height/altitude, and both manned and unmanned aircraft flying in a very narrow layer (500 ft max), vertical separation on its own cannot be considered as a safe and sufficient solution. Horizontal separation should be added.

The procedures should be included in the operational manual and provide clear instructions to the remote pilot on the most efficient manoeuvre to remain at a safe distance from the manned aircraft, depending on the respective heading, speed of both aircraft and distance between them (including no manoeuvre at all if it is expected that both aircraft will remain at a safe distance)

Emergency situations

The SORA defines two elements regarding TMPRs: a «detection volume» and an «alerting threshold».

The detection volume is the volume of airspace (temporal or spatial measurement) which is required to avoid a collision (and remain well clear if required) with manned aircraft. It can be thought of as the last point at which a manned aircraft must be detected, so that the detect and avoid system can performance all the functions. The detection volume in not tied to the sensor(s) Field of View/Field of Regard. The size of the detection volume depends on the aggravated closing speed of traffic that may reasonably be encountered, the time required by the remote pilot to command the avoidance manoeuvre, the time required by the system to respond and the manoeuvrability and performance of the aircraft.

The alerting threshold is the distance at which an alert should be triggered, and an immediate collision avoidance manoeuvre should be performed by the remote pilot.

The detection volume is proportionally larger than the alerting threshold. The distance between the outer border of the detection volume and the alerting threshold on the one hand should be big enough for the remote pilot to detect the incoming traffic and decide if an avoidance manoeuvre is necessary or not. The distance between the alerting threshold and the current position of the UAS on the other hand should be big enough to complete an avoidance manoeuvre after making the decision to avoid.

The most common emergency manoeuvres are quick descent, emergency landing and triggering of the flight termination system.

Emergency landing should be privileged if the local conditions are compatible, in case of low density of population. An onboard camera may be used to check the landing area, ensuring the absence of nearby people or vehicles. In more populated areas, triggering the Flight Termination System (FTS) may be a proper solution if the energy level at impact can be reduced to a non-lethal level (typically below 80J under parachute).

If these conditions cannot be met, a quick descent should be considered. This height should be maintained until the horizontal separation between both aircraft is sufficient.

EASA
European Union Aviation Safety Agency

Appendix III - Airspace Assessment / Hazard Identification

Identification of potential other airspace users in the intended volume of operation and adjacent airspace, and whether they are cooperative.

Based on EUROCONTROL Unmanned Aircraft Systems – ATM Collision Avoidance Requirements [14], §5.4.7, Table 7:

Aerial objects by group			**Hazard Identification**			**Risk Characterization**	
Cat	Group	Description	**Considered as Hazard** [yes / no]	**Equipage** Conspicuity	**Traffic Characteristics** *Rationale to not consider it as Hazard* Hazard characterization within airspace and details on conspicuity requirements	**Strategic Mitigations (included in SORA)** **Soft factors (excluded from the SORA scope)*	**Tactical Mitigations (included in SORA)** **Soft factors (excluded from the SORA scope*
1	F	Fauna. Large Birds	*No*	*None*	*(e.g.) Impact on Ground Risk only*		
	K	Kites and tethered balloons.					
	B	Hot air balloons.	No	MODE-S (a)	• Balloons tend to operate in known weather and areas. • Traffic exposure at low level is limited in airport environment and controlled airspace, • For gas and hot air balloons within airspace C and D, an authorisation is required from the appropriate air traffic control units. • Minimum VFR height (i.e., 500ft/AGL) from VRV-L/SERA are applicable to balloons (except for training) • (a) Transponder MODE-S only required for flights during aeronautical night and dense fog (VRV-L, art. 29)	• Flight planning, identification of the flight time and areas for B Ops • Monitoring of radio communication (1) Soft factors Balloons are identifiable on on-board camera / ground-based webcams due to their size.	• Transponder MODE-S detection through MLAT (2) Soft factors Balloons are identifiable on on-board camera due to their size.

[14] Unmanned Aircraft Systems – ATM Collision Avoidance Requirements ... EUROCONTROL, UAS ATM Integration Activity, version 1.0, November 2008, [online link]

EASA
European Union Aviation Safety Agency

Aerial objects by group			Hazard Identification			Risk Characterization	
Cat	Group	Description	**Considered as Hazard** [yes / no]	**Equipage** Conspicuity	**Traffic Characteristics** *Rationale to not consider it as Hazard* Hazard characterization within airspace and details on conspicuity requirements	**Strategic Mitigations (included in SORA)** **Soft factors (excluded from the SORA scope)*	**Tactical Mitigations (included in SORA)** **Soft factors (excluded from the SORA scope*
	P	Parachutists	Yes	None			
	A	Unpowered air sports: hang gliders, paragliders, etc.					
2	R	Radio controlled model aircraft					
	G	Gliders.					
	S	Powered air sports: very light aircraft, ultralights, motor gliders, motor paragliders, etc					
3	D	Dirigible airships					
4	H-State	Helicopters (VIP, Police, Customs, Civil Protection, Military)					
	H-SAR	Helicopters (emergency and medical services SAR/HEMS)					
	H-CAT	Commercial rotorcraft (CAT) incl. SPO (Aerial Work)					
	H-GAR	General aviation rotorcraft (GAR)					
	L	Light aircraft (i.e. non-pressurised general aviation).					

Aerial objects by group			Hazard Identification			Risk Characterization	
Cat	Group	Description	**Considered as Hazard** [yes / no]	**Equipage** Conspicuity	**Traffic Characteristics** *Rationale to not consider it as Hazard* Hazard characterization within airspace and details on conspicuity requirements	**Strategic Mitigations (included in SORA)** **Soft factors (excluded from the SORA scope)*	**Tactical Mitigations (included in SORA)** **Soft factors (excluded from the SORA scope*
	Q	Pressurised general aviation with MTOM less than 5,700 kg.					
	N	Pressurised pax acft no ACAS					
4,5	T	Pressurised pax acft w/ ACAS					
	C	Cargo aircraft or military air transport.					
	M	Military trainer aircraft and high-performance jets.					
	U	Unmanned Aircraft			*Out of SORA Scope*		

Table 3 Airspace Assessment / Hazard Identification

Appendix IV - Considerations on U-space

As per regulation EU 2021/664, AMC1 Article 3 (4) Member States during the Airspace Risk Assessment (ARA) will define the U-space operational conditions and constraints among which are the residual airspace risk class (ARC) to support the specific operations risk assessment (SORA) as defined per regulation EU 2019/947.

The recommendation, after having applied all the strategic and tactical mitigations, is to apply residual ARC-b for U-space airspace in both controlled and uncontrolled airspace relying on e-conspicuity and the traffic information service, as well as the segregation principle to maintain safe spacing from manned aircraft (e.g. dynamic airspace reconfiguration).

In the U-space airspace the regulation EU 2019/947 is still applicable, therefore, the operational authorization from the competent authority is needed.

It is important to remark that UAS operators will still have to comply with the relevant tactical mitigations performance requirements (TMPRs) required in the operational authorization, however, the U-space airspace is able to provide support in some of them. Additional requirements may be established by the Member State through the definition of the U-space performance requirements.

Example of strategic mitigations given by the U-space airspace:

- U-space airspace is considered as a geozone as per regulation EU 2019/947, therefore entry constraints are applicable, such as having a flight authorization approved, airspace classification known, maximum airspace capacity known, schedules known (day/night).
- Flight authorization service pre-flight (strategical 4D volume deconfliction in comparison with other uncrewed flight authorization requests)

Example of tactical mitigations given by the U-space airspace:

- Traffic information service (crewed and uncrewed aircraft position)
- Flight authorization service in flight (update of the approved flight authorization in case of dynamic airspace restrictions)
- Conformance monitoring service if applicable in the U-space airspace

European Union Aviation Safety Agency

Appendix V - Guidelines for identification of an ARC-b airspace

1. Introduction

This section aims to provide guidelines to UAS operators or competent authorities to identify an airspace, classified as ARC-b. An ARC-b airspace is one where the likelihood of encountering another manned aircraft is low but not negligible.

The UAS operator should be able to receive the signals emitted by cooperative manned aircraft and take action to remain well clear and avoid collisions. All means available to acquire information regarding cooperating and uncooperative traffic should be considered.

2. Determination of ARC-b airspace

The UAS operator should:

- determine those areas where the operation should not take place. The minimum distances to any area with known airspace activities that may preclude UAS operations need to be defined. This could include but is not limited to:
  - controlled airspace;
  - any known location used for take-off and landing of all types of aircraft operation (airports, helipads, ULM airfields, paraglider areas, etc.)
  - site of known UAS operations in the framework of model aircraft clubs and associations;
  - area used for en-route operations below 150m (military routes etc.);
- determine the other airspace users that might be present in the volume of the intended UAS operation and in the airspace adjacent to it, and whether at least 50% of manned traffic can be expected to be cooperative. Moreover, the applicant should determine the types of cooperative systems used. The determination may be done using the method defined in subchapter 3 below, up to date surveillance data of the intended volume from a radar or any other source or any method accepted by the competent authority.

In order to reinforce a low probability of encounters (thus, confirming an ARC-b airspace) and to potentially increase the ratio of cooperative aircraft, the UAS operator is expected encouraged to notify in advance the other airspace users (e.g. local aerodromes, flight clubs, RC model associations etc.) about the intended UAS operation so that:

- airspace users potentially avoid the area,
- ATS provides traffic information, when possible,
- pre-flight coordination and/or information is enabled by contacting the UAS operator,
- airspace users become cooperative, if possible.

If deconfliction is required following notification, the competent authority may establish a process to prioritise access to airspace. Furthermore, the competent authority should promote the notification system to maximise the number of informed non-cooperative aircraft operators.

3. Method for estimation of the other airspace

The following airspace users need to be taken into consideration (non-exhaustive list): military aircraft, all helicopters including those operated for emergency and medical services (HEMS), flight training aircraft, gliders, paragliders, hang gliders, parachutes, balloons, aircraft for specialised operations (aerial work), other general aviation aircraft, ultra-light aircraft, unmanned aircraft (including those operated in the framework of model aircraft clubs and associations)[15] , etc.

See also Section 5.2.2 and Appendix 3 of this document for further guidance.

Step 1 - Data gathering

Gather the information needed on a national/regional basis from the competent authority and other relevant stakeholders e.g., aerodrome managing entity. The analysis will provide an average percentage of manned aircraft being cooperative in VLL away from any exclusion area previously defined. This average may have a high degree of variation depending on the local conditions (e.g., gliders do not flight at night, balloons tend to operate in known weather and areas) and hence the analysis is unlikely to be applicable for the intended area of operation. Therefore, the next phase should be performed to adjust the analysis accordingly.

Gather and apply data applicable for the intended volume of operation taking into account all relevant local conditions. This will provide an adjustment to the local conditions of the intended area of operation.

Step 2 - Analysis

Determine all aircraft categories that might be present in the operational volume, in as much details as possible depending upon the data available. Some data will be available from the registry of the competent authority while other data may require engaging in the completion of a surveys with all airspace users (e.g., contacts with national/regional organisations representing airspace users, etc.) Any data subject to judgement should be assessed conservatively to ensure the analysis rather overestimate the number of non-cooperative aircraft operating in the intended volume of operation.

For each aircraft category, determine the following data, as possible:

- category of aircraft in which they fall. If a category of aircraft is utilised for different type of operations in VLL ARC-b airspace, such a category should, if possible, be subdivided in categories for each type of operation. For example, fixed wing GA aircraft used for crop dusting in VLL should be listed separately from other fix wing GA, since they spend a much higher percentage in VLL compared to the other GA aircraft operations;
- number of aircraft;
- yearly flight hours per aircraft;
- type of operation performed in VLL;
- any information which can better define the typical areas where this aircraft category will operate (e.g. paragliders often operate from cliffs);
- any information that can define the areas where this aircraft category unlikely will operate (e.g. hot air balloons very seldom operate over the sea);
- percentage of the time in which this aircraft category operates in VLL away from any exclusion area previously defined;
- percentage of aircraft having cooperative systems like ADS-B, FLARM (a cooperative system should not be considered if the UAS operator cannot directly access to its signals);

[15] UA are included in the types of aircraft that should be taken into account even though the SORA does not address UAS on UAS collision risk in the air risk model. However, if the UAS operations is performed in areas with high density of unmanned aircraft (e.g. area of model flying sites), this will pose an increased ground risk which is undesirable.

- type of cooperative systems.

For each aircraft category, the total number of yearly flights hours in VLL can be calculated as well as the number of yearly flight hours that are performed with a cooperative system.

Once all aircraft categories have been determined and values assigned, the total percentage of cooperative flight hours in VLL can also be calculated.

If needed, steps 1 and 2 may be repeated for the intended area of operation including any further restrictions that may be imposed such as time of day, weather conditions etc.

European Union Aviation Safety Agency

Appendix VI - Example use-cases

1. Introduction

The following use cases cover the traffic situations that are met in most operations. For each use case, a possible residual ARC is indicated. These should be considered as guidelines only and are dependent on the assessment of the operator that shows the SORA conditions are met.

2. Flight in atypical air environment

Flights below 30 meters AGL, far from airports, airfields, and areas where manned air traffic can be reasonably not expected at low altitudes (e.g., designated landing zones for parachutes and paragliders), or below 15m above the maximum height of an artificial obstacle within a horizontal distance of 30 meters, may be considered as taking place in an atypical air environment. However, this is not to be understood as applicable everywhere, so depending on the activity that is expected below 30 meters (landing helicopters or gliders, etc.), the manned activity may not be low enough for the air environment to be considered as atypical. The numbers shown in the pictures below should also be understood as indicative, and not universally applicable.

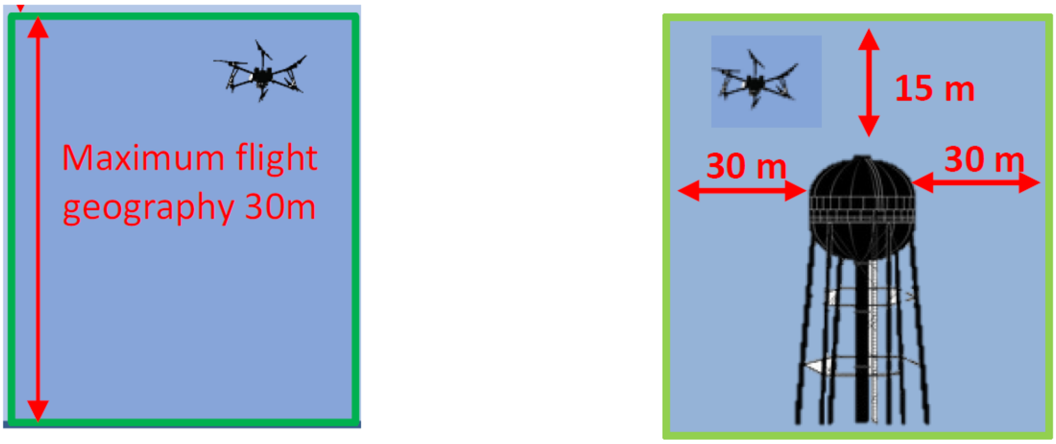

Figure 2 Example atypical air environment (indicative values, not prescriptive)

- Residual ARC: ARC-a.

Note: Volumes could be defined by the Member State to help the operator decide whether the operation can be considered as "far" from airports and airfields. Several types of volumes have already been defined by Member States, such as forbidden airspace at a given horizontal distance from the centre of the airport/airfield, or volumes based on ICAO's Obstacle Limitation Surfaces and standard flight procedures of General Aviation, defining maximum height for UAS operations.

Competent authorities are likely to publish details of any activity that may take place in such an area, within the AIP (ENR 5.1/5.5, etc.). The determination of whether it is atypical, should consider not just airspace restrictions, but other manned aviation activity that may be hazardous (model aircraft sites, parachuting activity, gliding activity, etc.). The operator would have to demonstrate that the flight is outside these areas.

European Union Aviation Safety Agency

3. Flight in a segregated airspace

A segregated airspace is one dedicated uniquely to a UAS operation, where it can be expected that no other aircraft will be present.

Contingency volumes of SORA operations and the optional air risk buffer should be designed appropriately to meet an actual segregation. These buffers may be defined in coordination with the authority designating the segregated airspace.

- Residual ARC: ARC-a.

Note: restricted or dangerous airspace cannot always be considered as segregated. In some situations, deconfliction scheme and mitigations may be necessary, to deal with HEMS (helicopter emergency medical service) and emergency aircraft, as well as announcement of TSAs (temporary segregated area)/TRAs (temporary reserved area) via NOTAM (notice to airmen), or coordination with ATSP (air traffic service provider) when relevant. In this case, the residual ARC is not ARC-a.

4. Flight in class A/B/C/D airspace outside of airport/heliport environment

An Air Traffic Control (ATC) unit is responsible for a controlled airspace, and it may enable the operation of both manned traffic and the UAS, provided that appropriate coordination procedures are implemented between a UAS operator and ATC. Contrary to the services provided to manned aircraft, ATC may not have to know the position of the UAS at all times and may manage the segregation by allocating a static or dynamic airspace to the UAS operation[16]. ATC will need to know the operation area, to apply the conditions of the protocol between ATC and the UAS operator.

- Residual ARC:
  - ARC-a may be considered when the ATC guarantees that no manned aircraft is allowed to fly within the agreed operational volume reserved for the UA. The agreement between operator and ATC must be handed in when filing for an authorization and using ARC-a.
  - ARC-b or higher may be considered when the ATC cannot guarantee that no manned aircraft is allowed to fly within the agreed operational. If any agreement exists, it should be handed in during the authorization process for mitigation purposes.

Note: the authorisation to fly in a controlled airspace provided by an ATC unit to a UAS operator by itself does not ensure that the ATC unit will actively segregate the manned traffic and the UAS, unless specifically mentioned. The measures to ensure segregation are expected to be agreed before start of the operation.

The ATC coordination should not be understood as the only possible TMPR measure applicable and further options might be available in a specific situation.

5. Flight in class E/F/G airspace outside of airport/heliport environment

The determination of the final ARC will depend on the density of observed traffic. The SORA makes the distinction between rural and urban areas, but a more refined analysis may be needed.
Appendix 1 - Residual ARC:

[16] The geometry of the flight area should be kept as simple as possible for ease of coordination (e.g. small, circular, square, rectangular, elongated corridor).

A2.1. Urban areas: except for cities where a high level of tourist or police helicopter traffic is expected (which is very rarely the case in Europe), the classification in most cases is expected to be ARC-b. ARC-c on the contrary.

A2.2. Rural areas: ARC-b is usually appropriate, but some areas may have a high density of low-height traffic (VFR and glider routes, parachutes, paragliders, etc.). In that case an ARC-c may be considered.

6. Flight in controlled airport/heliport environment

The area around an airport/heliport where it should be considered that the flight takes place in the airport/heliport environment is usually determined by the competent authority. Examples include: 5 km around the centre of the runway or the reference point of the airport, stair-shaped areas around runways, etc.

Appendix 2 - Residual ARC:

A2.1. ARC-a may be considered when the ATC guarantees that no manned aircraft is allowed to fly within the agreed operational volume reserved for the UAS. The agreement between operator and ATC must be handed in when filing for an authorization and using ARC-a.

A2.2. ARC-b may be considered when the ATC does not guarantee that no manned aircraft is allowed to fly within the agreed operational volume but guarantees to provide services between manned and unmanned traffic, that justify the lower encounter rate. This agreement should be handed in during the authorization process for mitigation purposes.

The ATC coordination should not be considered as the only possible TMPR measure and other options, such as VLOS or monitoring conspicuous traffic, might be applicable depending on the local conditions. Additional measures, such as U-space services (flight authorizations, traffic information) may be needed to reach an acceptable level of safety.

Note: the authorisation to fly in a controlled airspace provided by an ATC unit to a UAS operator by itself does not ensure that the ATC unit will actively segregate the manned traffic and the UAS, unless specifically mentioned. The measures to ensure segregation are expected to be agreed before start of the operation

7. Flight in uncontrolled airport/heliport environment

On uncontrolled airport/heliport environment, there can be no ATC-related assurance of strategic nor tactical means between manned traffic and the UAS, even when an AFIS is active and/or the airport operator has issued a flight authorization. A certain level of mitigation can be achieved by coordinating with the airfield manager if the airfield is PPR.

- Residual ARC : ARC-c

II. Operational authorisations with generic vs precise locations (ref UAS.SPEC.030(2))

1. 'Generic' versus 'precise' operational authorisation

According to Article 12 of the UAS Regulation, a competent authority may decide to grant a 'generic' operational authorisation (i.e., an operational authorisation that is taking place in locations generically identified, according to the conditions set in the operational authorisation). Contrary to the 'generic' operational authorisation, an operational authorisation that is limited to locations identified by geographical coordinates will be called 'precise' operational authorisation.

The UAS operator should anyhow check whether the MS where the operation takes place has published a geographical zone in the area of operation according to Article 15 of the UAS Regulation, requiring a flight authorisation (e.g., this may be the case for the areas covered by U-Space). A flight authorisation to enter a geographical zone (as per Article 15(1)) should not be confused with an operational authorisation based on the SORA risk assessment.

2. Conditions for issuing a 'generic' operational authorisation

A 'generic' operational authorisation does not contain any precise location (geographical coordinates) but applies to all locations that meet the approved conditions/limitations (e.g., density of population of the operational and adjacent area, class of airspace of the operational and adjacent area, maximum height, etc.). The UAS operator should develop appropriate procedures described in the operations manual for checking that each flight they conduct:

- meets the mitigations and operational safety objectives derived from the SORA and the requirements listed in the operational authorisation; and
- takes place in an area whose characteristics and local conditions are consistent with the GRC and ARC classification of the SORA as approved by the NAA.

The limitations regarding the operational scenario, the operational volume and the buffers defined in the operational authorisation should be expressed in such a way that it is simple for the UAS operator to ensure compliance with those limitations.

The UAS operator should have a diligent and documented process in the OM to identify/assess that the operational volume complies with the criteria defined in the 'generic' authorisation and with the local conditions.

The UAS operator should train its personnel to assess the operational volume, buffers, and mitigations to prepare for the next operations.

The UAS operator should also document and record the assessment of locations (e.g., in mission files), so that adherence to this process can be verified by the NAA on a regular basis.

3. Conditions for issuing a 'precise' operational authorisation

A 'precise' operational authorisation rather than a 'generic' one should be required when the following conditions occur:

- M1 mitigation at medium or high level of robustness is applied;
- the initial air risk class is iArc-c or higher;
- strategic mitigations are applied to lower the initial ARC (SORA Step #5), except when operating in a U-space airspace.

Up to SAIL II, operations conducted in VLOS should be eligible for a generic authorization independently from the conditions listed above.

4. Example of 'generic' and 'precise' authorisations

A 'generic' operational authorisation may be relevant for operations conducted according to PDRA-S01 and S02, since the conditions are similar to the ones of the declarative STS and it is relatively easy for the UAS operator to ensure compliance with those conditions.

It will usually be easier for the UAS operator to ensure compliance when the conditions are unambiguous and not open to interpretation. This is the case, for instance, when:

- a controlled ground area is required, or the density of population is very low;
- the operation takes place in ARC-a (e.g. segregated airspace).

The following examples may be considered suitable for the scope of a 'generic' authorisation, due to the simplicity to identify suitable operational volumes and apply the mitigation measures:

- agricultural operations conducted at very low level, such as fields spraying;
- swarm light shows over a controlled ground area in ARC-a or ARC-b.

On the contrary, the use of some strategic measure mitigation (M1 for GRC or Step 5 for ARC) often prompt debate between the UAS operator and the NAA regarding the relevance/validity of the data sources (density of population, density/type of traffic in given airspace, etc.), and the efficiency of the proposed strategic mitigation measures. Furthermore, some of these measures are difficult to implement and it is not always possible for the NAA to simply trust the capacity of the UAS operator to do so.

For instance, the following examples show measures that are difficult to implement / open to interpretation and therefore should result in 'precise' authorisations:

- achieving a local reduction of the density of population;
- ensuring the absence of uninvolved persons in very large, controlled ground areas, or reserving large, controlled ground areas in densely populated environments;
- starting an operation in airspace that requires a new protocol with the ANSP/ATSP, etc.

A UAS operator with a LUC may receive the privilege to conduct operations with different locations, even if the operations qualify for 'precise' locations.