GM1 AMC1 Article 11 Rules for conducting an operational risk assessment

ED Decision 2023/012/R

GENERAL

The operational risk assessment required by Article 11 of the UAS Regulation may be conducted using the methodology described in AMC1 Article 11. This methodology is basically the specific operations risk assessment (SORA) developed by JARUS. Other methodologies might be used by the UAS operator as alternative means of compliance.

Unmanned free balloons are unmanned aircraft and shall thus comply with Regulation (EU) 2019/947. For this type of aircraft, compliance with Appendix 2 to Regulation (EU) No 923/2012 is considered an acceptable means of compliance with Article 11.

Aspects other than safety, such as security, privacy, environmental protection, the use of the radio frequency (RF) spectrum, etc., should be assessed in accordance with the applicable requirements established by the Member State in which the operation is intended to take place, or by other EU regulations.

For some UAS operations that are classified as being in the 'specific' category, alternatives to carrying out a full risk assessment are offered to UAS operators:

(a) for UAS operations with lower intrinsic risks, a declaration may be submitted when the operations comply with the standard scenarios (STSs) listed in Appendix 1 to the UAS Regulation. Table 1 provides a summary of the STSs; and

(b) for other UAS operations, a request for authorisation may be submitted based on the mitigations and provisions described in the predefined risk assessment (PDRA) when the UAS operation meets the operational characterisation described in AMC2 et seq. Article 11 to the UAS Regulation. Table 2 below provides a summary of the PDRAs that have been published so far.

While the STSs are described in a detailed way, the provisions and mitigations in the PDRAs 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. Two types of PDRAs are provided:

— those derived from an STS, which allow the UAS operator to conduct similar operations, but using, for example, UAS without the class label that is mandated by the STS (e.g. privately built UAS); and

— more generic PDRAs.

The codification of a PDRA includes the letter 'G' or 'S' (e.g. PDRA-G01 or PDRA-S01):

— 'G' is used for generic PDRAs.

— 'S' is used for PDRAs that are derived from an STS whose level of prescriptiveness is the same as of the corresponding STS. Therefore, those PDRAs, although they address UAS operations that are subject to operational authorisations (to allow the use of UAS without a class label), are expected to provide an even more simplified authorisation process compared to other (non-STS-related) PDRAs. Ideally, for UAS operations that are performed based on those PDRAs, the competent authorities may implement expedited operational-authorisation processes. Those processes may be based on the review of the documentation that is submitted by the UAS operator to support the declaration of compliance with the PDRA provisions.

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, and the SORA (AMC1 Article 11 of the UAS Regulation) 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.

PDRAs 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.).

STS#	Edition/date	UAS characteristics	BVLOS/VLOS	Overflown area	Maximum range from remote pilot	Maximum height	Airspace	Notes
STS-01	June 2020	Bearing a C5 class marking (maximum characteristic dimension of up to 3 m and MTOM of up to 25 kg)	VLOS	Controlled ground area that might be located in a populated area	VLOS	120 m	Controlled or uncontrolled, with low risk of encounter with manned aircraft	
STS-02	June 2020	Bearing a C6 class marking (maximum characteristic dimension of up to 3 m and MTOM of up to 25 kg)	BVLOS	Controlled ground area that is entirely located in a sparsely populated area	2 km with an AO 1 km, if no AO	120 m	Controlled or uncontrolled, with low risk of encounter with manned aircraft	

Table 1 — List of STSs published as 'Appendix 1 for standard scenarios supporting a declaration' to the Annex to the UAS Regulation

When UAS operators intend to conduct an operation covered by a PDRA, they should fill in the last two columns of the table related to the selected PDRA, named 'integrity' and 'proof'. In the column 'integrity' they should explain how the level of integrity is met, and in the column 'proof' how the level of integrity is demonstrated. To support UAS operators, the two columns are already prefilled; however, the UAS operator may adapt the text to their needs.

If the UAS operation does not fit completely within the limits of the PDRA, the UAS operator is required to conduct a full risk assessment and submit it to the competent authority. Changes to the PDRA should not be done, unless the competent authority accepts that minor changes should be made.

PDRA#	Edition/date	UAS characteristics	BVLOS/VLOS	Overflown area	Maximum range from remote pilot	Maximum height	Airspace	AMC# to Article 11	Notes
PDRA-S01	1.1 / January 2022	Maximum characteristic dimension of up to 3 m and take-off mass of up to 25 kg	VLOS	Controlled ground area that might be located in a populated area	VLOS	150 m	Controlled or uncontrolled, with low risk of encounter with manned aircraft	AMC4	
PDRA-S02	1.1 / January 2022	Maximum characteristic dimension of up to 3 m and take-off mass of up to 25 kg	BVLOS	Controlled ground area that is entirely located in a sparsely populated area	2 km with an AO or with AOs 1 km, if no AO	150 m	Controlled or uncontrolled, with low risk of encounter with manned aircraft	AMC5	
PDRA-G01	1.2 / January 2022	Maximum characteristic dimension of up to 3 m and typical kinetic energy of up to 34 kJ	BVLOS	Sparsely populated area	If no AO, up to 1 km	150 m (operational volume)	Uncontrolled, with low risk of encounter with manned aircraft	AMC2	
PDRA-G02	1.1 / January 2022	Maximum characteristic dimension of up to 3 m and typical kinetic energy of up to 34 kJ	BVLOS	Sparsely populated area	n/a (direct C2 link)	As established for the	Reserved or segregated	AMC3	

PDRA#	Edition/date	UAS characteristics	BVLOS/VLOS	Overflown area	Maximum range from remote pilot	Maximum height	Airspace	AMC# to Article 11	Notes
						reserved or segregated airspace	for the UAS operation		
PDRA-G03	1.0 / January 2022	Maximum characteristic dimension of up to 3 m and typical kinetic energy of up to 34 kJ	BVLOS	Sparsely populated areas	n/a (direct C2 link)	50 m from ground unless in reserved or segregated airspace	Controlled or uncontrolled airspace if height is below 50 m, otherwise reserved or segregated airspace	AMC6	

Table 2 — List of PDRAs published as AMC to Article 11 of the UAS Regulation

For the purposes of the SORA, the following definitions should apply:

— 'populated area' should be understood as 'congested area', as defined in Regulation (EU) No 965/2012 (the 'Air Operations Regulation'): 'in relation to a city, town or settlement, any area which is substantially used for residential, commercial or recreational purposes'; and

— 'rural area' is used in the context of the air risk and it means the volume outside a populated area and not within the aerodrome traffic zone (ATZ) of an aerodrome.

AMC1 Article 11 Rules for conducting an operational risk assessment

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SPECIFIC OPERATIONS RISK ASSESSMENT (SORA) (SOURCE JARUS SORA V2.0)

EDITION December 2020

1. Introduction

1.1 Preface

(a) This SORA is based on the document developed by JARUS, providing a vision on how to safely create, evaluate and conduct an unmanned aircraft system (UAS) operation. The SORA provides a methodology to guide both the UAS operator and the competent authority in determining whether a UAS operation can be conducted in a safe manner. The document should not be used as a checklist, nor be expected to provide answers to all the challenges related to the integration of the UAS in the airspace. The SORA is a tailoring guide that allows a UAS operator to find a best fit mitigation means, and hence reduce the risk to an acceptable level. For this reason, it does not contain prescriptive requirements, but rather safety objectives to be met at various levels of robustness, commensurate with the risk.

(b) The SORA is meant to inspire UAS operators and competent authorities and highlight the benefits of a harmonised risk assessment methodology. The feedback collected from real-life UAS operations will form the backbone of the updates in the upcoming revisions of the document.

1.2 Purpose of the document

(a) The purpose of the SORA is to propose a 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.

(b) Due to the operational differences and the expanded level of risk, the 'specific' category cannot automatically take credit for the safety and performance data demonstrated with the large number of UA operating in the 'open[1]' category. Therefore, the SORA provides a consistent approach to assess the additional risks associated with the expanded and new UAS operations that are not covered by the 'open' category.

(c) The SORA is not intended as a one-stop-shop for the full integration of all types of UAS in all classes of airspace.

(d) This methodology may be applied where the traditional approach to aircraft certification (approving the design, issuing an airworthiness approval and type certificate) may not be appropriate due to an applicant's desire to operate a UAS in a limited or restricted manner. This methodology may also support the activities necessary to determine the associated airworthiness requirements. This assumes that the safety objectives set forth in, or derived from, those applicable for the

[1] As defined by Article 4 of the UAS Regulation.

'certified'[1] category, are consistent with the ones set forth or derived for the 'specific' category.

(e) The methodology is based on the principle of a holistic/total system safety risk-based assessment model used to evaluate the risks related to a given UAS operation. The model considers the nature of all the threats associated with a specified hazard, the relevant design, and the proposed operational mitigations for a specific UAS operation. The SORA then helps to evaluate the risks systematically, and determine the boundaries required for a safe operation. This method allows the applicant to determine the acceptable risk levels, and to validate that those levels are complied with by the proposed operations. The competent authority may also apply this methodology to gain confidence that the UAS operator can conduct the operation safely.

(f) To avoid repetitive individual approvals, EASA will apply the methodology to define 'standard scenarios' or 'predefined risk assessments' for the identified types of ConOps with known hazards and acceptable risk mitigations.

(g) The methodology, related processes, and values proposed in this document are intended to guide the UAS operator when performing a risk assessment in accordance with Article 11 of the UAS Regulation.

1.3 Applicability

(a) The methodology presented in this document is aimed at evaluating the safety risks involved with the operation of UAS of any class, size or type of operation (including military, experimental, research and development and prototyping). It is particularly suited, but not limited to, 'specific' operations for which a hazard and a risk assessment are required.

(b) The safety risks associated with collisions between UA and manned aircraft are in the scope of the methodology. The risk of a collision between two UA or between a UA and a UA carrying people will be addressed in future revisions of the document.

(c) In the event of a mishap, the carriage of people or payloads on board the UAS (e.g. weapons) that present additional hazards is explicitly excluded from the scope of this methodology.

(d) Security aspects are excluded from the applicability of this methodology when they are not limited to those confined by the airworthiness of the systems (e.g. the aspects relevant to protection from unlawful electromagnetic interference.)

(e) Privacy and financial aspects are excluded from the applicability of this methodology.

(f) The SORA can be used to support waiving the regulatory requirements applicable to the operation if it can be demonstrated that the operation can be conducted with an acceptable level of safety.

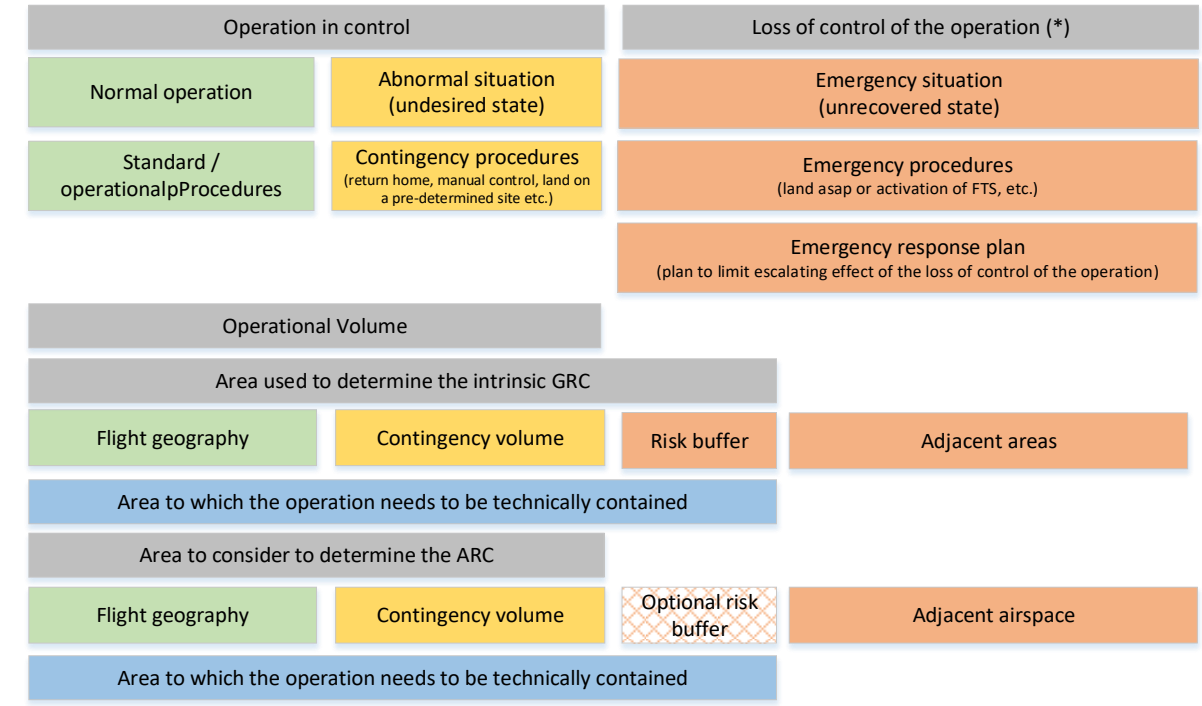
(g) In addition to performing a SORA in accordance with the UAS Regulation, the UAS operator must also ensure compliance with all the other regulatory requirements applicable to the operation that are not necessarily addressed by the SORA.

[1] As defined by Article 6 of the UAS Regulation.

1.4 Key concepts and definitions

1.4.1 Semantic model

(a) To facilitate effective communication of all aspects of the SORA, the methodology requires the standardised use of terminology for the phases of operation, procedures, and operational volumes. The semantic model shown in Figure 1 provides a consistent use of the terms for all SORA users. Figure 2 provides a graphical representation of the model and a visual reference to further aid the reader in understanding the SORA terminology.



(*) The Loss of control of operation corresponds to situations:
- where the outcome of the situation highly relies on providence; or
- which could not be handled by a contingency procedure; or
- when there is grave and imminent danger of fatalities.

Figure 1 — SORA semantic model

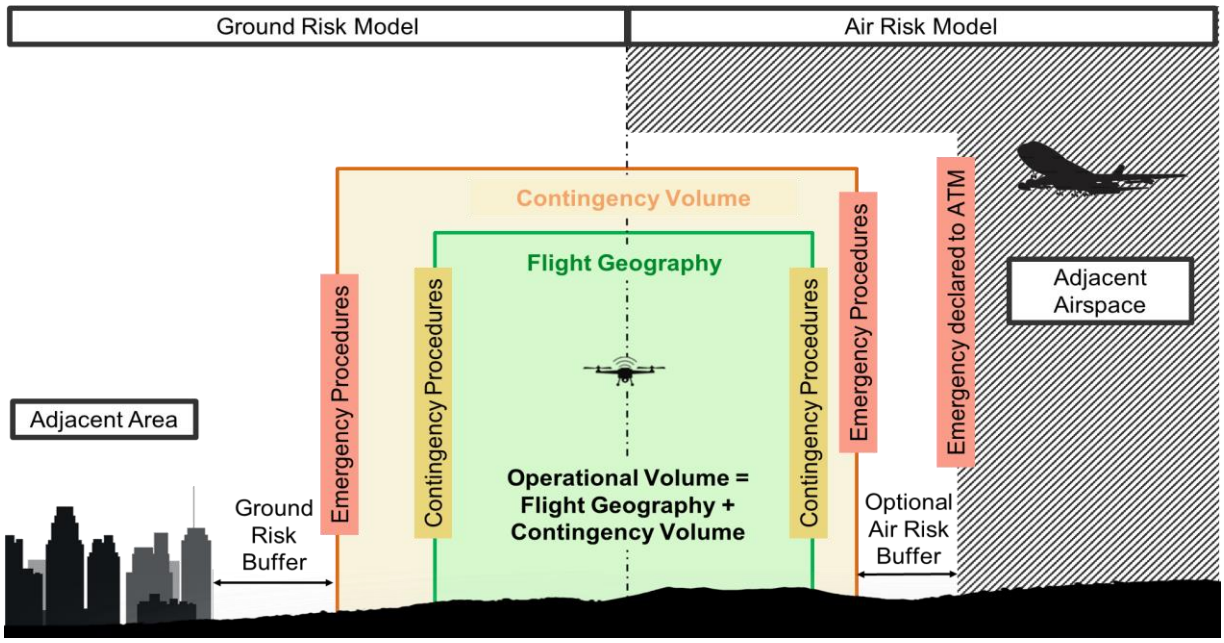


Figure 2 — Graphical representation of the SORA semantic model

1.4.2 Introduction to robustness

(a) To properly understand the SORA process, it is important to introduce the key concept of robustness. Any given risk mitigation or operational safety objective (OSO) can be demonstrated at differing levels of robustness. The SORA process proposes three different levels of robustness: low, medium and high, commensurate with the risk.

(b) The **robustness** designation is achieved using both the **level of integrity** (i.e. safety gain) provided by each mitigation, and the **level of assurance** (i.e. method of proof) that the claimed safety gain has been achieved. These are both risk-based.

(c) The activities used to substantiate the level of integrity are detailed in Annexes B, C, D and E. Those annexes provide either guidance material or reference industry standards and practices where applicable.

(d) General guidance for the level of assurance is provided below:

(1) A **low** level of assurance is where the applicant simply declares that the required level of integrity has been achieved.

(2) A **medium** level of assurance is where the applicant provides supporting evidence that the required level of integrity has been achieved. This is typically achieved by means of testing (e.g. for technical mitigations) or by proof of experience (e.g. for human-related mitigations).

(3) A **high** level of assurance is where the achieved integrity has been found to be acceptable by a competent third party.

(e) The specific criteria defined in the Annexes take precedence over the criteria defined in paragraph d.

(f) Table 1 provides guidance to determine the level of robustness based on the level of integrity and the level of assurance:

	Low assurance	Medium assurance	High assurance
Low integrity	Low robustness	Low robustness	Low robustness
Medium integrity	Low robustness	Medium robustness	Medium robustness
High integrity	Low robustness	Medium robustness	High robustness

Table 1 — Determination of robustness level

(g) For example, if an applicant demonstrates a medium level of integrity with a low level of assurance, the overall robustness will be considered to be low. In other words, the robustness will always be equal to the lowest level of either the integrity or the assurance.

1.5 Roles and responsibilities

(a) While performing a SORA process and assessment, several key actors might be required to interact in different phases of the process. The main actors applicable to the SORA are described in this section.

(b) UAS operator — The UAS operator is responsible for the safe operation of the UAS, and hence the safety risk analysis. In accordance with Article 5 of the UAS Regulation, the UAS operator must substantiate the safety of the operation by performing the specific operational and risk assessment, except for the cases defined by the same Article 5. Supporting material for the assessment may be provided by third parties (e.g. the manufacturer of the UAS or equipment, U-space service providers, etc.). The UAS operator obtains an operational authorisation from the competent authority/ANSP. A UAS operator having a LUC cannot be granted the privilege to assess compliance with the design requirements when a UAS with a design verification report[1] (DVR) or a (restricted) type certificate ((R)TC) is required.

(c) Applicant — The applicant is the party seeking operational approval. The applicant becomes the UAS operator once the operation has been approved.

(d) UAS manufacturer — For the purposes of the SORA, the UAS manufacturer is the party that designs and/or produces the UAS. The UAS manufacturer has unique design evidence (e.g. for the system performance, the system architecture, software/hardware development documentation, test/analysis documentation, etc.) that they may choose to make available to one or many UAS operator(s) or to the competent authority to help to substantiate the UAS operator's safety case. Alternatively, a potential UAS manufacturer may utilise the SORA to target design objectives for specific or generalised operations. To obtain airworthiness approval(s), these design objectives could be complemented by the use of certification specifications (CS) or industry consensus standards if they are found to be acceptable by EASA.

[1] https://www.easa.europa.eu/sites/default/files/dfu/guidelines_design_verification_uas_medium_risk.pdf

(e) Component manufacturer — The component manufacturer is the party that designs and/or produces components for use in UAS operations. The component manufacturer has unique design evidence (e.g. for the system performance, the system architecture, software/hardware development documentation, test/analysis documentation, etc.) that they may choose to make available to one or many UAS operator(s) to substantiate a safety case.

(f) Competent authority — The competent authority that is referred to throughout this AMC is the authority designated by the Member State in accordance with Article 17 of the UAS Regulation to assess the safety case of UAS operations and to issue the operational authorisation in accordance with Article 12 of the UAS Regulation. The competent authority may accept an applicant's SORA submission in whole or in part. Through the SORA process, the applicant may need to consult with the competent authority to ensure the consistent application or interpretation of individual steps. The competent authority must perform oversight of the UAS operator in accordance with paragraphs (i) and (j) of Article 18 of the UAS Regulation. According to Regulation (EU) 2018/1139[1] (the EASA 'Basic Regulation'), EASA is the competent authority in the European Union to verify compliance of the UAS design and its components with the applicable rules, while the authority that is designated by the Member State is the competent authority to verify compliance with the operational requirements and compliance of the personnel's competency with those rules. The following elements are related to the UAS design:

— OSOs #02 (limited to design criteria), #04, #05, #06, #10, #12, #18, #19 (limited to criterion #3), #20, #23 (limited to criterion #1) and #24;

— M2 mitigation for ground risk (criterion #1);

— verification of the system to contain the UAS to avoid an infringement of the adjacent areas on the ground and/or adjacent airspace, in accordance with Step #9 of the SORA process.

If the UAS operation is classified as SAIL V and VI, compliance with the design provisions defined by SORA (i.e. design-related OSOs, mitigation means linked with the design and containment function) should be demonstrated through a type certificate (TC) issued by EASA according to Annex I (Part 21) to Regulation (EU) No 748/2012[2] as defined in Article 40(1)(d) of Regulation (EU) 2019/945[3]. For the other OSOs and mitigation means, the competent authority may verify compliance or may define which entity is able to verify compliance with them as a third party.

(1) If the UAS operation is classified as SAIL IV, compliance with the design-related SORA provisions (i.e. design-related OSOs, mitigation means linked with the design and containment function) should be demonstrated through

[1] Regulation (EU) 2018/1139 of the European Parliament and of the Council of 4 July 2018 on common rules in the field of civil aviation and establishing a European Union Aviation Safety Agency, and amending Regulations (EC) No 2111/2005, (EC) No 1008/2008, (EU) No 996/2010, (EU) No 376/2014 and Directives 2014/30/EU and 2014/53/EU of the European Parliament and of the Council, and repealing Regulations (EC) No 552/2004 and (EC) No 216/2008 of the European Parliament and of the Council and Council Regulation (EEC) No 3922/91 (OJ L 212, 22.8.2018, p. 1) (https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32018R1139).

[2] Commission Regulation (EU) No 748/2012 of 3 August 2012 laying down implementing rules for the airworthiness and environmental certification of aircraft and related products, parts and appliances, as well as for the certification of design and production organisations (OJ L 224, 21.8.2012, p. 1) (https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32012R0748&qid=1622557691925).

[3] 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, 11.6.2019, p. 1) (https://eur-lex.europa.eu/legalcontent/EN/TXT/?uri=CELEX:32019R0945).

a DVR issued by EASA. Evidence of compliance with the other OSOs and mitigations (not related to design) will be provided to the competent authority according to the level of robustness of the OSOs, that will assess them as part of the application for the operational authorisation.

(2) If the UAS operation is classified as SAIL I, II or III, the competent authority may accept a declaration submitted by the UAS operator for the compliance with all OSOs and mitigations related to design. The competent authority may check the statements of the UAS operator, in particular with regard to the claimed level of integrity and robustness of the UAS for the considered SAIL.

(3) Despite the SAIL, when the claimed level of robustness of the mitigation means M2 is high, the competent authority should require the operator to use a UAS with a DVR issued by EASA limited to compliance with those mitigation means[1].

(g) ANSP — The ANSP is the designated provider of air traffic service in a specific area of operation (airspace). The ANSP assesses whether the proposed flight can be safely conducted in the particular airspace that it covers, and if so, authorises the flight.

(h) U-space service provider — U-space service providers are entities that provide services to support the safe and efficient use of airspace.

(i) Remote pilot — The remote pilot is designated by the UAS operator, or, in the case of general aviation, the aircraft owner, as being charged with safely conducting the flight.

2. The SORA process

2.1 Introduction to risk

(a) Many definitions of the word '**risk**' exist in the literature. One of the easiest and most understandable definitions is provided in SAE ARP 4754A / EUROCAE ED-79A: 'the combination of the frequency (probability) of an occurrence and its associated level of severity'. This definition of 'risk' is retained in this document.

(b) The consequence of an occurrence will be designated as **harm** of some type.

(c) Many different categories of harm arise from any given occurrence. Various authors on this topic have collated these categories of harm as supported by the literature. This document will focus on occurrences of harm (e.g. a UAS crash) that are short-lived and usually give rise to a near loss of life. Chronic events (e.g. toxic emissions over a period of time) are explicitly excluded from this assessment. The categories of harm in this document are the potential for:

(1) fatal injuries to third parties on the ground;

(2) fatal injuries to third parties in the air; or

(3) damage to critical infrastructure.

[1] If the UAS has a DVR covering the full design, this may cover also the mitigation means.

(d) It is acknowledged that the competent authorities, when appropriate, may consider additional categories of harm (e.g. the disruption of a community, environmental damage, financial loss, etc.). This methodology could also be used for those categories of harm.

(e) Several studies have shown that the amount of energy needed to cause fatal injuries, in the case of a direct hit, is extremely low (i.e. in the region of few dozen Joules.) The energy levels of operations addressed within this document are likely to be significantly higher, and therefore the retained harm is the potential for fatal injuries. By application of the methodology, the applicant has the opportunity to claim lower lethality either on a case-by-case basis, or systematically if allowed by the competent authorities (e.g. in the 'open' category).

(f) Fatal injury is a well-defined condition and, in most countries, is known by the authorities. Therefore, the risk of under-reporting fatalities is almost non-existent. The quantification of the associated risk of fatality is straightforward. The usual means to measure fatalities is by the number of deaths within a particular time interval (e.g. the fatal accident rate per million flying hours), or the number of deaths for a specified circumstance (e.g. the fatal accident rate per number of take-offs).

(g) Damage to critical infrastructure is a more complex condition. Therefore, the quantification of the associated risks may be difficult and subject to cooperation with the organisation responsible for the infrastructure.

2.2 SORA process outline

(a) The SORA methodology provides a logical process to analyse the proposed ConOps and establish an adequate level of confidence that the operation can be conducted with an acceptable level of risk. There are ten steps that support the SORA methodology and each of these steps is described in the following paragraphs and further detailed, when necessary, in the relevant annexes.

(b) The SORA focuses on the assessment of air and ground risks. In addition to air and ground risks, an additional risk assessment of critical infrastructure should also be performed. This should be done in cooperation with the organisation responsible for the infrastructure, as they are most knowledgeable of those threats. Figure 3 outlines the ten steps of the risk model, while Figure 4 provides an overall understanding of how to arrive at an air risk class (ARC) for a given operation.

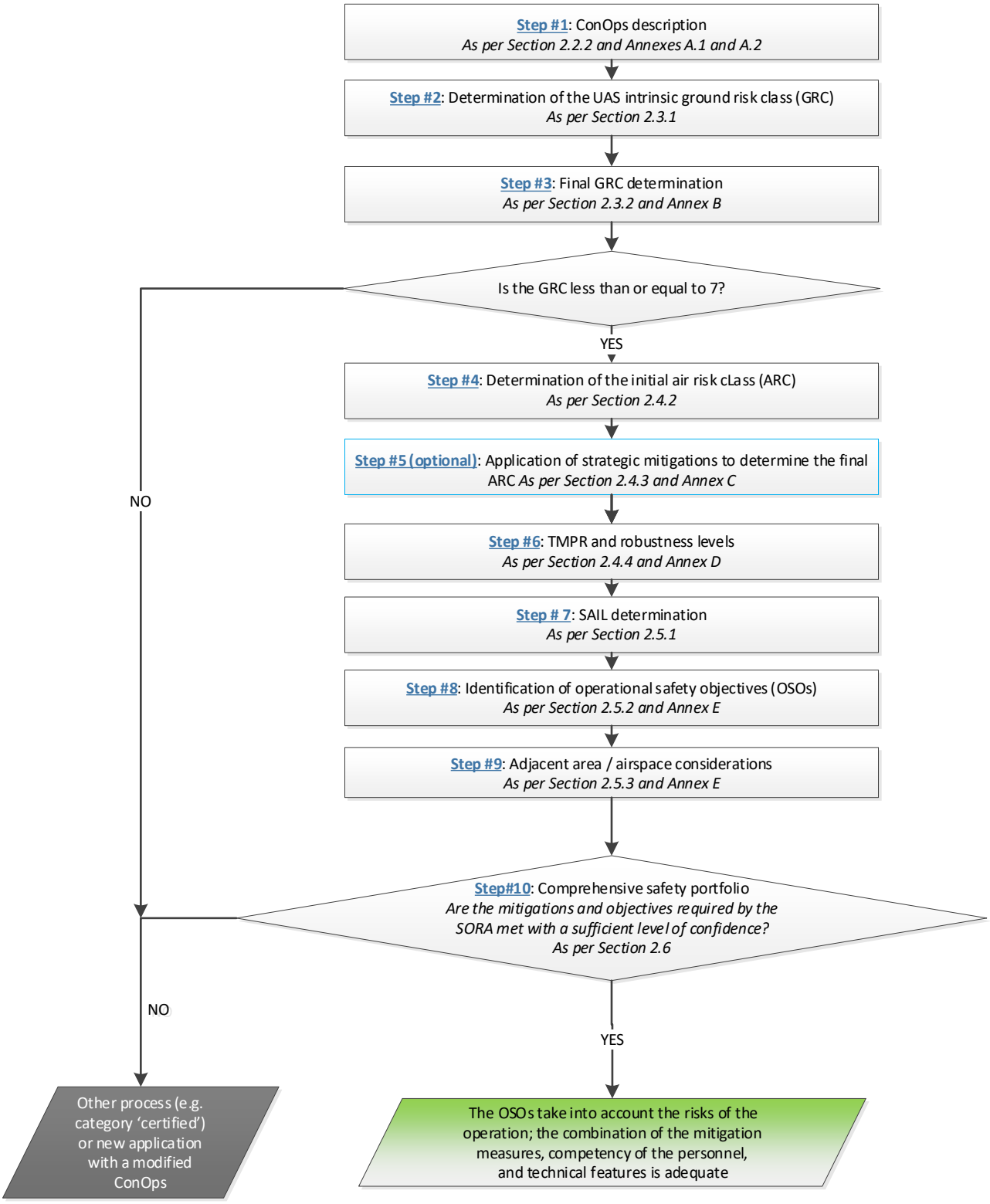


Figure 3 — The SORA process

Note: If operations are conducted across different environments, some steps may need to be repeated for each particular environment.

2.2.1 Pre-application evaluation

(a) Before starting the SORA process, the applicant should verify that the proposed operation is feasible (i.e. not subject to specific exclusions from the competent authority or subject to an STS). Things to verify before beginning the SORA process are whether:

(1) the operation falls under the 'open' category;

(2) the operation is covered by a 'standard scenario' included in the appendix to the UAS Regulation or by a 'predefined risk assessment' published by EASA;

(3) the operation falls under the 'certified' category; or

(4) the operation is subject to a specific NO-GO from the competent authority.

If none of the above cases applies, the SORA process should be applied.

2.2.2 Step #1 — ConOps description

(a) The first step of the SORA requires the applicant to collect and provide the relevant technical, operational and system information needed to assess the risk associated with the intended operation of the UAS. Annex A to this document provides a detailed framework for data collection and presentation. The ConOps description is the foundation for all other activities, and it 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 ANSP. Therefore, when defining the ConOps, the UAS operator should give due consideration to all the steps, mitigations and OSOs provided in Figures 3 and 4.

(b) Developing the ConOps can be an iterative process; therefore, as the SORA process is applied, additional mitigations and limitations may be identified, requiring additional associated technical details, procedures, and other information to be provided/updated in the ConOps. This should culminate in a comprehensive ConOps that fully and accurately describes the proposed operation as envisioned.

2.3 The ground risk process

2.3.1 Step #2 – Determination of the intrinsic UAS ground risk class (GRC)

(a) The intrinsic UAS ground risk relates to the risk of a person being struck by the UAS (in the case of a loss of UAS control with a reasonable assumption of safety).

(b) To establish the intrinsic GRC, the applicant needs the maximum UA characteristic dimension (e.g. the wingspan for a fixed-wing UAS, the blade diameter for rotorcraft, the maximum dimension for multi-copters, etc.) and the knowledge of the intended operational scenario.

(c) The applicant needs to have defined the area at risk when conducting the operation (also called the 'area of operation') including:

(1) the operational volume, which is composed of the flight geography and the contingency volume. To determine the operational volume, the applicant should consider the position-keeping capabilities of the UAS in 4D space (latitude, longitude, height and time). In particular, the accuracy of the navigation solution, the flight technical error[1] of the UAS and the path definition error (e.g. map errors), and latencies should be considered and addressed in this determination;

(2) whether or not the area is a controlled ground area; and

(3) the associated ground risk buffer with at least a 1:1 rule[2], or for rotary wing UA, defined using a ballistic methodology approach acceptable to the competent authority.

(d) Table 2 illustrates how to determine the intrinsic ground risk class (GRC). The intrinsic GRC is found at the intersection of the applicable operational scenario and the maximum UA characteristic dimension that drives the UAS lethal area. If there is a mismatch between the maximum UAS characteristic dimension and the typical kinetic energy expected, the applicant should provide substantiation for the chosen column.

Intrinsic UAS ground risk class				
Max UAS characteristics dimension	1 m / approx. 3 ft	3 m / approx. 10 ft	8 m / approx. 25 ft	>8 m / approx. 25 ft
Typical kinetic energy expected	< 700 J (approx. 529 ft lb)	< 34 kJ (approx. 25 000 ft lb)	< 1 084 kJ (approx. 800 000 ft lb)	> 1 084 kJ (approx. 800 000 ft lb)
Operational scenarios				
VLOS/BVLOS over a controlled ground area[3]	1	2	3	4
VLOS over a sparsely populated area	2	3	4	5
BVLOS over a sparsely populated area	3	4	5	6
VLOS over a populated area	4	5	6	8
BVLOS over a populated area	5	6	8	10
VLOS over an assembly of people	7			
BVLOS over an assembly of people	8			

Table 2 — Determination of the intrinsic GRC

[1] The flight technical error is the error between the actual track and the desired track (sometimes referred to as 'the ability to fly the flight director').

[2] If the UA is planned to operate at 120 m altitude, the ground risk buffer should at least be 120 m.

[3] In line with Figure 1 and point 2.3.1(c), the controlled area should encompass the flight geography, the contingency volume, and the ground risk buffer.

(e) The operational scenarios describe an attempt to provide discrete categorisations of operations with increasing numbers of **people at risk**. In principle, it is possible to use either qualitative criteria (please refer to next point (f)) or quantitative criteria, or consider both criteria, to assess if an operation takes place over sparsely populated areas, populated areas, or assemblies of people.

(f) Qualitative assessment: the volume to be used by the operator to classify the operation includes the operational volume and the ground risk buffer (as defined by a semantic model), which determine the intrinsic GRC.

GM1 Article 2(3) 'Definitions I DEFINITION OF 'ASSEMBLIES OF PEOPLE'' provides guidance on when an operation is classified as taking place over assemblies of people.

An operation should be classified as taking place over a populated area if the volume that is used to determine the intrinsic GRC:

— does not include assemblies of people, and

— includes areas that are substantially used for residential, commercial or recreational purposes.

(g) EVLOS[1] operations are to be considered to be BVLOS for the intrinsic GRC determination.

(h) Controlled ground areas[2] are a way to strategically mitigate the risk on ground (similar to flying in segregated airspace); the UAS operator should ensure, through appropriate procedures, that no uninvolved person is in the area of operation, as defined in Section 2.3.1(c).

(i) An operation occurring in a populated environment cannot be intrinsically classified as being in a sparsely populated environment, even in cases where the footprint of the operation is completely within special risk areas (e.g. rivers, railways, and industrial estates). The applicant can make the claim for a lower density and/or shelter with Step #3 of the SORA process.

(j) Operations that do not have a corresponding intrinsic GRC (i.e. grey cells on the table) are not supported by the SORA methodology.

(k) When evaluating the typical kinetic energy expected for a given operation, the applicant should generally use the airspeed, in particular V_{cruise} for fixed-wing aircraft and the terminal velocity for other aircraft. Specific designs (e.g. gyrocopters) might need additional considerations. Guidance useful in determining the terminal velocity can be found at https://www1.grc.nasa.gov/beginners-guide-to-aeronautics/termvel/.

[1] EVLOS — A UAS operation whereby the remote pilot maintains uninterrupted situational awareness of the airspace in which the UAS operation is being conducted via visual airspace surveillance through one or more human VOs, possibly aided by technological means. The remote pilot has direct control of the UAS at all times.

[2] See the definition in Article 2(21) of the UAS Regulation.

(l) The nominal size of the crash area for most UAS can be anticipated by considering both the size and the energy used in the ground risk determination. There are certain cases or design aspects that are non-typical and will have a significant effect on the lethal area of the UAS, such as the amount of fuel, high-energy rotors/props, frangibility, material, etc. These may not have been considered in the intrinsic GRC determination table. These considerations may lead to a decrease/increase in the intrinsic GRC. The use of industry standards or dedicated research might provide a simplified path for this assessment.

2.3.2 Step #3 – Final GRC determination

(a) The intrinsic risk of a person being struck by the UAS (in case of a loss of control of the operation) can be controlled and reduced by means of mitigation.

(b) The mitigations used to modify the intrinsic GRC have a direct effect on the safety objectives associated with a particular operation, and therefore it is important to ensure their robustness. This has particular relevance for technical mitigations associated with the ground risk (e.g. an emergency parachute).

(c) The final GRC determination (step #three) is based on the availability of these mitigations to the operation. Table 3 provides a list of potential mitigations and the associated relative correction factor. A positive number denotes an increase in the GRC, while a negative number results in a decrease in the GRC. All the mitigations should be applied in numeric sequence to perform the assessment. Annex B provides additional details on how to estimate the robustness of each mitigation. Competent authorities may define additional mitigations and the relative correction factors.

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

Table 3 — Mitigations for final GRC determination

(d) When applying mitigation M1, the GRC cannot be reduced to a value lower than the lowest value in the applicable column in Table 2. This is because it is not possible to reduce the number of people at risk below that of a controlled area.

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

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

(e) For example, in the case of a 2.5 m UAS (second column in Table 2) flying in visual line-of-sight (VLOS) over a sparsely populated area, the intrinsic GRC is 3. Upon analysis of the ConOps, the applicant claims to reduce the ground risk by first applying M1 at medium robustness (a GRC reduction of 2). In this case, the result of applying M1 is a GRC of 2, because the GRC cannot be reduced any lower than the lowest value for that column. The applicant then applies M2 using a parachute system, resulting in a further reduction of 1 (i.e. a GRC of 1). Finally, M3 (the ERP) has been developed to medium robustness with no further reduction as per Table 3.

(f) The final GRC is established by adding all the correction factors (i.e. -1-1-0=-2) and adapting the GRC by the resulting number (3-2=1).

(g) If the final GRC is greater than 7, the operation is not supported by the SORA process.

(h) In general, a quantitative approach to mitigation means allows to reduce the intrinsic GRC by 1 point if the mitigation means reduce the risk of the operation by a factor of approximately 10 (90 % reduction) compared to the risk that is assessed before the mitigation means are applied. Such quantitative criteria should be used to validate the risk reduction that is claimed when applying Annex B to AMC1 to Article 11.

2.4 The air risk process

2.4.1 Air risk process overview

(a) The SORA uses the operational airspace defined in the ConOps as the baseline to evaluate the intrinsic risk of a mid-air collision, and by determining the air risk category (ARC). The ARC may be modified/lowered by applying strategic and tactical mitigation means. The application of strategic mitigations may lower the ARC level. An example of strategic mitigations to reduce the risk of a collision may be by operating during certain time periods or within certain boundaries. After applying the strategic mitigations, any residual risk of a mid-air collision is addressed by means of tactical mitigations.

(b) Tactical mitigations take the form of detect and avoid (DAA) systems or alternate means, such as ADS-B, FLARM, U-space services or operational procedures. Depending on the residual risk of a mid-air collision, the tactical mitigation performance requirement(s) (TMPR(s)) may vary.

(c) As part of the SORA process, the UAS operator should cooperate with the relevant service provider for the airspace (e.g. the ANSP or U-space service provider) and obtain the necessary authorisations. Additionally, generic local authorisations or local procedures allowing access to a certain portion of controlled airspace may be used if available (e.g. the Low Altitude Authorization and Notification Capability – LAANC – system in the United States).

(d) Irrespective of the results of the risk assessment, the UAS operator should pay particular attention to all the features that may increase the detectability of the UA in the airspace. Therefore, technical solutions that improve the electronic conspicuousness or detectability of the UAS are recommended.

2.4.2 Step #4 - Determination of the initial air risk class (ARC)

(a) The competent authority, ANSP, or U-space service provider, may elect to directly map the airspace collision risks using airspace characterisation studies. These maps would directly show the initial ARC for a particular volume of airspace. If the competent authority, ANSP, or U-space service provides an air collision risk map (static or dynamic), the applicant should use that service to determine the initial ARC, and go directly to Section 2.4.3 'Application of strategic mitigations' to reduce the initial ARC.

(b) As seen in Figure 4, the airspace is categorised into 13 aggregated collision risk categories. These categories were characterised by the altitude, controlled versus uncontrolled airspace, airport/heliport versus non-airport/non-heliport environments, airspace over urban versus rural environments, and lastly atypical (e.g. segregated) versus typical airspace.

(c) To assign the proper ARC for the type of UAS operation, the applicant should use the decision tree found in Figure 4.

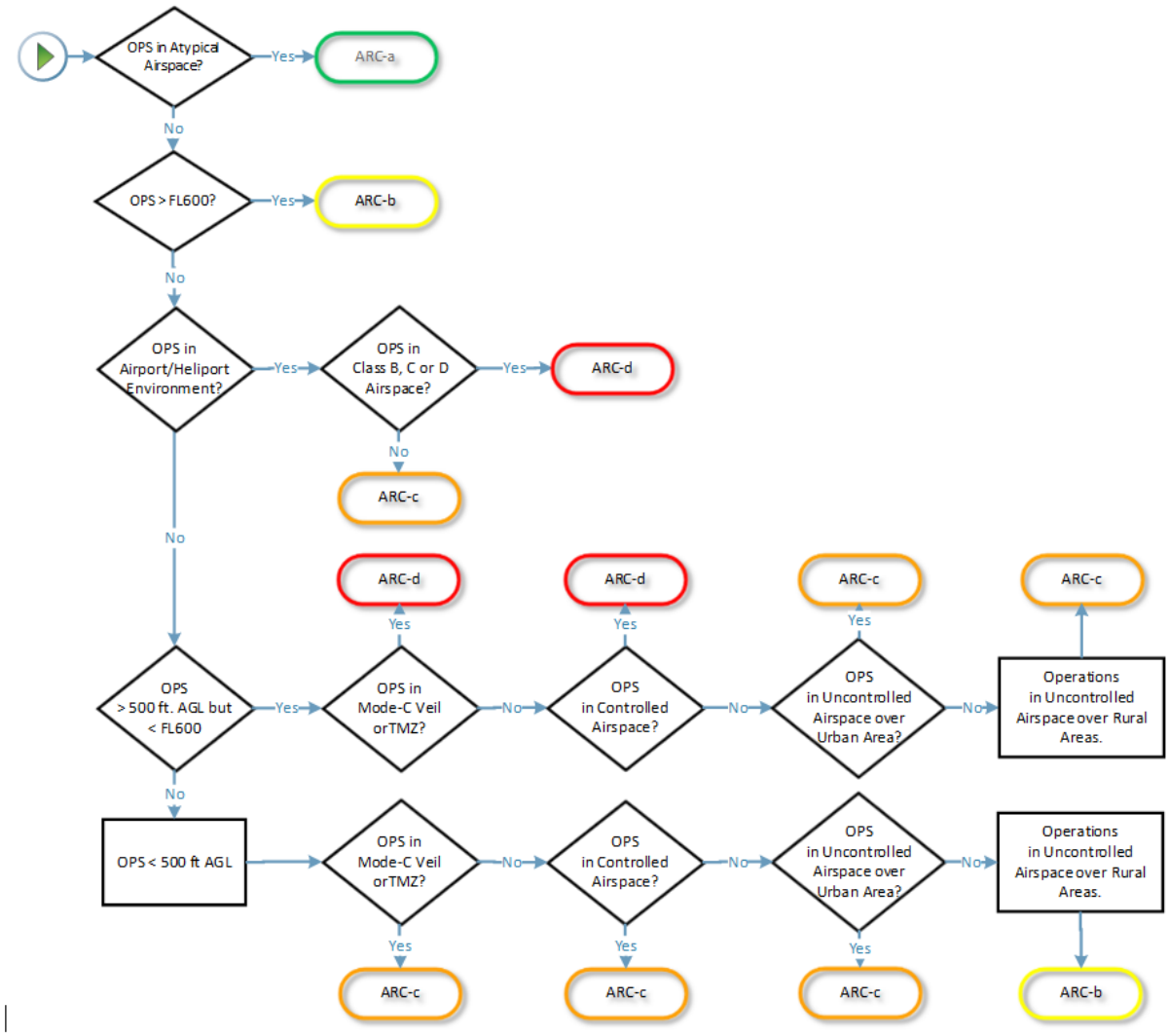


Figure 4 — ARC assignment process

(d) The ARC is a qualitative classification of the rate at which a UAS would encounter a manned aircraft in typical generalised civil airspace. The ARC is an initial assignment of the aggregated collision risk for the airspace, before mitigations are applied. The actual collision risk of a specific local operational volume could be much different, and can be addressed with the application of strategic mitigations to reduce the ARC (this step is optional, see Section 2.4.3, Step #5).

(e) Although the static generalised risk put forward by the ARC is conservative (i.e. it stays on the safe side), there may be situations where that conservative assessment may not suffice. It is important for both the competent authority and the UAS operator to take great care to understand the operational volume and under which circumstances the definitions in Figure 4 could be invalidated. In some situations, the competent authority may raise the operational volume ARC to a level which is greater than that advocated by Figure 4. The ANSP should be consulted to ensure that the assumptions related to the operational volume are accurate.

(f) ARC-a is generally defined as airspace where the risk of a collision between a UAS and a manned aircraft is acceptable without the addition of any tactical mitigation.

(g) ARC-b, ARC-c, ARC-d generally define volumes of airspace with increasing risk of a collision between a UAS and a manned aircraft.

(h) During the UAS operation, the operational volume may span many different airspace environments. The applicant needs to perform an air risk assessment for the entire range of the operational volume. An example scenario of operations in multiple airspace environments is provided at the end of Annex C.

2.4.3 Step #5 — Application of strategic mitigations to determine the residual ARC (optional)

(a) As stated before, the ARC is a generalised qualitative classification of the rate at which a UAS would encounter a manned aircraft in the specific airspace environment. However, it is recognised that the UAS operational volume may have a different collision risk from the one that the generalised initial ARC assigned.

(b) If an applicant considers that the generalised initial ARC assigned is too high for the condition in the local operational volume, then they should refer to Annex C for the ARC reduction process.

(c) If the applicant considers that the generalised initial ARC assignment is correct for the condition in the local operational volume, then that ARC becomes the residual ARC.

2.4.4 Step #6 — TMPR and robustness levels

Tactical mitigations are applied to mitigate any residual risk of a mid-air collision that is needed to achieve the applicable airspace safety objective. Tactical mitigations will take the form of either 'see and avoid' (i.e. operations under VLOS), or they may require a system which provides an alternate means of achieving the applicable airspace safety objective (operation using a DAA, or multiple DAA systems). Annex D provides the method for applying tactical mitigations.

2.4.4.1 Operations under VLOS/EVLOS

(a) 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.

(b) Operational UAS flights under VLOS do not need to meet the TMPR, nor the TMPR robustness requirements. In the case of multiple segments of the flight, those segments conducted under VLOS do not have to meet the TMPR, nor the TMPR robustness requirements, whereas those conducted under BVLOS do need to meet the TMPR and the TMPR robustness requirements.

(c) In general, all VLOS requirements are applicable to EVLOS. EVLOS may have additional requirements over and above those of VLOS. The EVLOS verification and communication latency between the remote pilot and the observers should be less than 15 seconds.

(d) 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.

(e) For VLOS operations, it is assumed that an observer is not able to detect traffic beyond 2 NM. (Note that the 2 NM range is not a fixed value and it may largely depend on the atmospheric conditions, aircraft size, geometry, closing rate, etc.). Therefore, the UAS operator may have to adjust the operation and/or the procedures accordingly.

2.4.4.2 Operations under a DAA system — TMPR

(a) For operations other than VLOS, the applicant will use the residual ARC and Table 4 below to determine the TMPR.

Residual ARC	TMPRs	TMPR level of robustness
ARC-d	High	High
ARC-c	Medium	Medium
ARC-b	Low	Low
ARC-a	No requirement	No requirement

Table 4 — TMPRs and TMPR level of robustness assignment

(b) High TMPR (ARC-d): This is airspace where either the manned aircraft encounter rate is high, and/or the available strategic mitigations are low. Therefore, the resulting residual collision risk is high, and the TMPR is also high. In this airspace, the UAS may be operating in integrated airspace and will have to comply with the operating rules and procedures applicable to that airspace, without reducing the existing capacity, decreasing safety, negatively impacting current operations with manned aircraft, or increasing the risk to airspace users or persons and property on the ground. This is no different from the requirements for the integration of comparable new and novel technologies in manned aviation. The performance level(s) of those tactical mitigations and/or the required variety of tactical mitigations are generally higher than for the other ARCs. If operations in this airspace are conducted more routinely, the competent authority is expected to require the UAS operator to comply with the recognised DAA system standards (e.g. those developed by RTCA SC-228 and/or EUROCAE WG-105).

(c) Medium TMPR (ARC-c): A medium TMPR will be required for operations in airspace where the chance of encountering manned aircraft is reasonable, and/or the strategic mitigations available are medium. Operations with a medium TMPR will likely be supported by the systems currently used in aviation to aid the remote pilot in the detection of other manned aircraft, or by systems designed to support aviation that are built to a corresponding level of robustness. Traffic avoidance manoeuvres could be more advanced than for a low TMPR.

(d) Low TMPR (ARC-b): A low TMPR will be required for operations in airspace where the probability of encountering another manned aircraft is low, but not negligible, and/or where strategic mitigations address most of the risk, and the resulting residual collision risk is low. Operations with a low TMPR are supported by technology that is designed to aid the remote pilot in detecting other traffic, but which may be built to lower standards. For example, for operations below 120 m, the traffic avoidance manoeuvres are expected to mostly be based on a rapid descent to an altitude where manned aircraft are not expected to ever operate.

(e) No performance requirement (ARC-a): This is airspace where the manned aircraft encounter rate is expected to be extremely low, and therefore there is no requirement for a TMPR. It is generally defined as airspace where the risk of a collision between a UAS and a manned aircraft is acceptable without the addition of any tactical mitigation. An example of this may be UAS flight operations in some parts of Alaska or northern Sweden, where the manned aircraft density is so low that the airspace safety threshold could be met without any tactical mitigation.

(f) Annex D provides information on how to satisfy the TMPR based on the available tactical mitigations and the TMPR level of robustness.

2.4.4.3 Consideration of additional airspace/operational requirements

(a) Modifications to the initial and subsequent approvals may be required by the competent authority or the ANSP as safety and operational issues arise.

(b) The UAS operator and the competent authority need to be cognisant that the ARCs are a generalised qualitative classification of the collision risk. Local circumstances could invalidate the aircraft density assumptions of the SORA, for example, due to special events. It is important for both the competent authority and the UAS operator to fully understand the airspace and air-traffic flows, and develop a system which can alert UAS operators to changes to the airspace on a local level. This will allow the UAS operator to safely address the increased risks associated with these events.

(c) There are many airspace, operational and equipment requirements which have a direct impact on the collision risk of all aircraft in the airspace. Some of these requirements are general and apply to all volumes of airspace, while some are local and are required only for a particular volume of airspace. The SORA cannot possibly cover all the possible requirements for all the conditions in which the UAS operator may wish to operate. The applicant and the competent authority need to work closely together to define and address these additional requirements.

(d) The SORA process should not be used to support operations of a UAS in a given airspace without the UAS being equipped with the required equipment for operations in that airspace (e.g. the equipment required to ensure interoperability with other airspace users). In these cases, specific exemptions may be granted by the competent authority. Those exemptions are outside the scope of the SORA.

(e) Operations in controlled airspace, an airport/heliport environment or a Mode-C Veil/transponder mandatory zone (TMZ) will likely require prior approval from the ANSP. The applicant should ensure that they involve the ANSP/authority prior to commencing operations in these environments.

2.5 Final assignment of specific assurance and integrity level (SAIL) and OSO

2.5.1 Step #7 SAIL determination

(a) The SAIL parameter consolidates the ground and air risk analyses, and drives the required activities. The SAIL represents the level of confidence that the UAS operation will remain under control.

(b) After determining the final GRC and the residual ARC, it is then possible to derive the SAIL associated with the proposed ConOps.

(c) The level of confidence that the operation will remain under control is represented by the SAIL. The SAIL is not quantitative, but instead corresponds to:

(1) the OSO to be complied with (see Table 6);

(2) the description of the activities that might support compliance with those objectives; and

(3) the evidence that indicates that the objectives have been satisfied.

(d) The SAIL assigned to a particular ConOps is determined using Table 5:

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			

Table 5 — SAIL determination

2.5.2 Step #8 — Identification of the operational safety objectives (OSOs)

(a) The last step of the SORA process is to use the SAIL to evaluate the defences within the operation in the form of OSOs, and to determine the associated level of robustness. Table 6 provides a qualitative methodology to make this determination. In this table, O is optional, L is recommended with low robustness, M is recommended with medium robustness, and H is recommended with high robustness. The various OSOs are grouped based on the threat they help to mitigate; hence, some OSOs may be repeated in the table.

(b) Table 6 is a consolidated list of the common OSOs that historically have been used to ensure safe UAS operations. It represents the collected experience of many experts, and is therefore a solid starting point to determine the required safety objectives for a specific operation. The competent authorities that issue the operational authorisation may define additional OSOs for a given SAIL and the associated level of robustness.

OSO number (in line with Annex E)		SAIL					
		I	II	III	IV	V	VI
	Technical issue with the UAS						
OSO#01	Ensure the UAS 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#04	UAS developed to authority recognised design standards[1]	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 trained and current and able to control the abnormal situation	L	L	M	M	H	H
OSO#10	Safe recovery from a technical issue	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 trained and 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 human machine interface (HMI) found appropriate for the mission	O	L	L	M	M	H
	Adverse operating conditions						

[1] In the case of experimental flights that investigate new technical solutions, the competent authority may accept that recognised standards are not met.

OSO number (in line with Annex E)		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

Table 6 — Recommended OSOs

2.5.3 Step #9 – Adjacent area/airspace considerations

(a) 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.

(b) Safety requirements for 'basic containment' are:

No probable[1] failure[2] of the UAS or any external system supporting the operation should lead to operation outside the operational volume.

Compliance with the requirement above should be substantiated by a design and installation appraisal and should include at least:

— *the design and installation features (independence, separation and redundancy);*

Note: Independence, separation and redundancy are not necessarily required, but they may be useful to substantiate the robustness of the containment system.

— *any relevant particular risk (e.g. hail, ice, snow, electromagnetic interference, etc.) associated with the ConOps.*

The competent authority may accept a declaration for the claimed integrity. The applicant declares that the required level of integrity has been achieved and supporting evidence is available.

[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] The term 'failure' needs to be understood as an occurrence that affects the operation of a component, part, or element such that it can no longer function as intended. Errors may cause failures, but are not considered to be failures. 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.

(c) The enhanced containment applies to operations conducted:

(1) either where the adjacent areas:

(i) contain assemblies of people[1] unless the UAS is already approved for operations over assemblies of people; or

(ii) are ARC-d unless the residual ARC of the airspace area intended to be flown within the operational volume is already ARC-d;

(2) Or where the operational volume is in a populated area where:

(i) M1 mitigation has been applied to lower the GRC; or

(ii) operating in a controlled ground area.

(d) The enhanced containment consists in the following safety requirements:

(a)	The UAS is designed to standards that are considered adequate by the competent authority and/or in accordance with a means of compliance that is acceptable to that authority such that: (1) the probability of the UA leaving the operational volume should be less than 10^{-4}/FH; and (2) no single failure* of the UAS or any external system supporting the operation should lead to its operation outside the ground risk buffer. Compliance with the requirements above should be substantiated by analysis and/or test data with supporting evidence.
(b)	Software (SW) and airborne electronic hardware (AEH) whose development error(s) could **directly** (refer to Note 2) lead to operations outside the ground risk buffer should be developed to an industry standard or methodology that is recognised as being adequate by EASA.

For UA with maximum characteristic dimensions not greater than 3 m, operated up to SAIL II operations, the competent authority may accept a declaration from the applicant for the compliance with the MoC to Light-UAS.2511[2]. For UAS configurations exceeding the applicability of such MoC[3], the competent authority may decide to still accept declarations based on such MoC with evidence available, or to accept appropriate MoC proposed by the applicant. Otherwise, the competent authority may request the applicant to use a UAS for which EASA has verified the claimed integrity.

As it is not possible to anticipate all local situations, the UAS operator, the competent authority and the ANSP should use sound judgement with regard to the definition of the

[1] See the definition in Article 2(3) of the UAS Regulation.

* The term 'failure' needs to be understood as an occurrence that affects the operation of a component, part, or element such that it can no longer function as intended. Errors may cause failures, but are not considered to be failures. 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.

[2] Final Means of Compliance with Light-UAS.2511 MOC Light-UAS.2511-01 - Issue 01 | EASA (europa.eu)

[3] EASA is developing MoC applicable to different UAS configurations. Until these are available, the competent authority may define means of compliance for special configurations (e.g. tethered drones) where a DVR may not be appropriate.

'adjacent airspace' as well as the 'adjacent areas'. For example, for a small UAS with a limited range, these definitions are not intended to include busy airport/heliport environments 30 kilometres away. The airspace bordering the UAS volume of operation should be the starting point of the determination of the adjacent airspace. In exceptional cases, the airspace beyond those volumes that border the UAS volume of operation may also have to be considered.

Note 1: The safety requirements as proposed in this section cover both the integrity and assurance levels.

Note 2: The third safety requirement in Section 2.5.3(c) does not imply a systematic need to develop the SW and AEH according to an industry standard or methodology recognised as adequate by the competent authority. The use of the term 'directly' means that a development error in a software or an airborne electronic hardware would lead the UA outside the ground risk buffer without the possibility for another system to prevent the UA from exiting the operational volume.

2.6 Step #10 — comprehensive safety portfolio

(a) The SORA process provides the applicant, the competent authority and the ANSP with a methodology which includes a series of mitigations and safety objectives to be considered to ensure an adequate level of confidence that the operation can be safely conducted. These are:

(1) mitigations used to modify the intrinsic GRC;

(2) strategic mitigations for the initial ARC;

(3) tactical mitigations for the residual ARC;

(4) adjacent area/airspace considerations; and

(5) OSOs.

(b) The satisfactory substantiation of the mitigations and objectives required by the SORA process provides a sufficient level of confidence that the proposed operation can be safely conducted.

(c) The UAS operator should be sure to address any additional requirements that were not identified by the SORA process (e.g. for security, environmental protection, etc.) and identify the relevant stakeholders (e.g. environmental protection agencies, national security bodies, etc.). The activities performed within the SORA process will likely address those additional needs, but they may not be considered to be sufficient at all times.

(d) The UAS operator should ensure the consistency between the SORA safety case and the actual operational conditions (i.e. at the time of the flight).

Annex A to AMC1 to Article 11

ED Decision 2019/021/R

CONOPS: GUIDELINES ON COLLECTING AND PRESENTING SYSTEM AND OPERATIONAL INFORMATION FOR SPECIFIC UAS OPERATIONS

A.0 General guidelines

This document must be original work completed and understood by the applicant (operator). Applicants must take responsibility for their own safety cases, whether the material originates from this template or otherwise.

A.0.1 Document control

Applicants should include an amendment record at the beginning of the document to record changes and show how that the document is controlled.

Amendment/ Revision/ Issue Number	Date	Amended by	Signed
a, b, c or 1, 2, 3 etc.	DDMMYYYY	Name of the person carrying out the amendment/ revision/ issue number	Signature of person carrying out the amendment/ revision/ issue number

This section is critical to ensure appropriate document control.

Any significant changes to the ConOps may require further assessment and approval by the competent authority prior to further operations being conducted.

A.0.2 References

(a) List all references (documents, URL, manuals, appendices) mentioned in the ConOps:

#	Title	Description	Amendment/ Revision/ Issue Number
[1]			
[2]			

A.1 Guidance for the collection and presentation of operationally relevant information

The template below provides section headings detailing the subject areas that should be addressed when producing the ConOps, for the purposes of demonstrating that a UAS operation can be conducted safely. The template layouts as presented are not prescriptive, but the subject areas detailed should be included in the ConOps documentation as required for the particular operation(s), in order to provide the minimum required information and evidence to perform the SORA.

A.1.1 Reserved

A.1.2 Organisation overview

(a) This section describes how the organisation is defined, to support safe operations. It should include:

(1) the structure of the organisation and its management, and

(2) the responsibilities and duties of the UAS operator.

A.1.2.1 Safety

(a) The 'specific' category covers operations where the operational risks are higher and therefore the management of safety is particularly important. The applicant should describe how safety is integrated in the organisation, and the safety management system that is in place, if applicable.

(b) Any additional safety-related information should be provided.

A.1.2.2 Design and production

(a) If the organisation is responsible for the design and/or production of the UAS, this section should describe the design and/or the production organisation.

(b) It should provide information on the manufacturer of the UAS to be used if the UAS is not manufactured or produced by the operator, i.e. by a third-party manufacturer.

(c) If required, information on the production organisation of the third-party organisation should be provided as evidence.

A.1.2.3 Training of staff involved in operations

This section should describe the training organisation or entity that qualifies all the staff involved in operations with respect to the ConOps.

A.1.2.4 Maintenance

This section should describe:

(a) the general maintenance philosophy of the UAS;

(b) the maintenance procedures for the UAS; and

(c) the maintenance organisation, if required.

A.1.2.5 Crew

This section should describe:

(a) the responsibilities and duties of personnel, including all the positions and people involved, for functions such as:

(1) the remote pilot (including the composition of the flight team according to the nature of the operation, its complexity, the type of UAS, etc.); and

(2) support personnel (e.g. visual observers (VOs), launch crew, and recovery crew);

(b) the procedure for multi-crew coordination if more than one person is directly involved in the flight operations;

(c) the operation of different types of UAS, including details of any limitations to the types of UAS that a remote pilot may operate, if appropriate; and

(d) details of the operator's policy on crew health requirements, including any procedures, guidance or references to ensure that the flight team are appropriately fit, capable and able to conduct the planned operations.

A.1.2.6 UAS configuration management

This section should describe how the operator manages changes to the UAS configuration.

A.1.2.7 Other position(s) and other information

Any other position defined in the organisation, or any other relevant information, should be provided.

A.1.3 Operations

A.1.3.1 Type of operations

(a) Detailed description of the ConOps: the applicant should describe what types of operations the UAS operator intends to carry out. The detailed description should contain all the information needed to obtain a detailed understanding of how, where and under which limitations or conditions the operations shall be performed. The operational volume, including the ground and air risk buffers, needs to be clearly defined. Relevant charts/diagrams, and any other information helpful to visualise and understand the intended operation(s) should be included in this section.

(b) The applicant should provide specific details on the type of operations (e.g. VLOS, BVLOS), the population density to be overflown (e.g. away from people, sparsely populated, assemblies of people) and the type of airspace to be used (e.g. a segregated area, fully integrated).

(c) The applicant should describe the level of involvement (LoI) of the crew and any automated or autonomous systems during each phase of the flight.

A.1.3.2 Normal operation strategy

(a) The normal operation strategy should contain all the safety measures, such as technical or procedural measures, crew training, etc. that are put in place to ensure that the UAS can fulfil the operation within the approved limitations, and so that the operation remains in control.

(b) Within this section, it should be assumed that all systems are working normally and as intended.

(c) The intent of this chapter is to provide a clear understanding of how the operation takes place within the approved technical, environmental, and procedural limitations.

A.1.3.3 Standard operating procedures

This section should describe the standard operating procedures (SOP) applicable to all operations for which an approval is requested. A reference to the applicable operations manual (OM) is acceptable. Note: Checklists and SOP templates may be provided by the local competent authority or a qualified entity.

A.1.3.3.1 Normal operating procedures

This section should describe the normal operating procedures in place for the intended operations.

A.1.3.3.2 Contingency and emergency procedures

This section should describe the contingency procedures in place for any malfunction or abnormal operation, as well as an emergency.

A.1.3.3.3 Occurrence reporting procedures

UAS, like all aircraft, are subject to accident investigations and occurrence reporting schemes. Mandatory or voluntary reporting should be carried out using the reporting processes provided by the competent authorities. As a minimum, the SOP should contain:

(a) reporting procedures in case of:

(1) damage to property;

(2) a collision with another aircraft; or

(3) a serious or fatal injury (third parties and own personnel); and

(b) documentation and data logging procedures: describe how records and information are stored and made available, if required, to the accident investigation body, competent authority, and other government entities (e.g. police) as applicable.

A.1.3.4 Operational limits

This section should detail the specific operating limitations and conditions appropriate to the proposed operation(s); for example, operating heights, horizontal distances, weather conditions, the applicable flight performance envelope, times of operations (day and/or night) and any limitations for operating within the applicable class(es) of airspace, etc.

A.1.3.5 Emergency response plan (ERP)

The applicant should:

(a) define a response plan for use in the event of a loss of control of the operation;

(b) describe the procedures to limit the escalating effects of a crash; and

(c) describe the procedures for use in the event of a loss of containment.

A.1.4 Remote crew training

A.1.4.1 General information

This section describes the processes and procedures that the UAS operator uses to develop and maintain the necessary competence for the remote crew (i.e. any person involved in the UAS operation).

A.1.4.2 Initial training and qualification

This section describes the processes and procedures that the UAS operator uses to ensure that the remote crew is suitably competent, and how the qualification of the remote crew is carried out.

A.1.4.3 Procedures for maintenance of currency

This section describes the processes and procedures that the UAS operator uses to ensure that the remote crew acquire and maintain the required currency to execute the various types of duties.

A.1.4.4 Flight simulation training devices (FSTDs)

This section:

(a) describes the use of FSTDs for acquiring and maintaining the practical skills of the remote pilots (if applicable); and

(b) describes the conditions and restrictions in connection with such training (if applicable).

A.1.4.5 Training programme

This section provides a reference to the applicable training programme(s) for the remote crew.

A2 Guidance for the collection and presentation of technical relevant information

The aim of this section is to collect all the necessary technical information about the UAS and its supporting systems. This information needs to be sufficient to address the required robustness levels of the mitigations and the OSOs of the SORA.

The list below is suggested guidance for items which may be relevant for this assessment, but the items may differ, depending on the specific UAS utilised in this ConOps.

A.2.1 Reserved

A.2.2 UAS description

A.2.2.1 Unmanned aircraft (UA) segment

A.2.2.1.1 Airframe

This section should include the following:

(a) A detailed description of the physical characteristics of the UA (mass, centre-of-mass, dimensions, etc.), including photos, diagrams and schematics, if appropriate to support the description of the UA.

(1) Dimensions: for fixed-wing UA, the wingspan, fuselage length, body diameter etc.; for a rotorcraft, the length, width and height, propeller diameter, etc.;

(2) Mass: all the relevant masses such as the empty mass, MTOM, etc.; and

(3) Centre of gravity: the centre of gravity and limits if necessary.

(b) Materials: the main materials used and where they are used in the UA, highlighting in particular any new materials (new metal alloys or composites) or combinations of materials (composites ‘tailored’ to designs).

(c) Load limits: the capability of the airframe structure to withstand expected flight load limits.

(d) Sub-systems: any sub-systems such as a hydraulic system, environmental control system, parachute, brakes, etc.

A.2.2.1.2 UA performance characteristics

This section should include the following:

(a) the performance of the UA within the proposed flight envelope, specifically addressing at least the following items:

(1) Performance: the

(i) maximum altitude;

(ii) maximum endurance;

(iii) maximum range;

(iv) maximum rate of climb;

(v) maximum rate of descent;

(vi) maximum bank angle; and

(vii) turn rate limits.

(2) Airspeeds: the

(i) slowest speed attainable;

(ii) stall speed (if applicable);

(iii) nominal cruise speed;

(iv) max cruise speed; and

(v) never-exceed airspeed.

(b) Any performance limitations due to environmental and meteorological conditions, specifically addressing the following items:

(1) wind speed limitations (headwind, crosswind, gusts);

(2) turbulence restrictions;

(3) rain, hail, snow, ash resistance or sensitivities;

(4) the minimum visibility conditions, if applicable;

(5) outside air temperature (OAT) limits; and

(6) in-flight icing:

(i) whether the proposed operating environment includes operations in icing conditions;

(ii) whether the system has an icing detection capability, and if so, what indications, if any, the system provides to the remote pilot, and/or how the system responds; and

(iii) any icing protection capability of the UA, including any test data that demonstrates the performance of the icing protection system.

A.2.2.1.3 Propulsion system

This section should include the following:

(a) Principle

A description of the propulsion system and its ability to provide reliable and sufficient power to take off, climb, and maintain flight at the expected mission altitudes.

(b) Fuel-powered propulsion systems

(1) The type (manufacturer organisation and model) of engine that is used;

(2) How many engines are installed;

(3) The type and the capacity of fuel that is used;

(4) How the engine performance is monitored;

(5) The status indicators, alerts (such as warning, caution and advisory), messages that are provided to the remote pilot;

(6) A description of the most critical propulsion-related failure modes/conditions and their impact on the operation of the system;

(7) How the UA responds, and the safeguards that are in place to mitigate the risk of a loss of engine power for each of the following:

(i) fuel starvation;

(ii) fuel contamination;

(iii) failed signal input from the remote pilot station (RPS); and

(iv) engine controller failure;

(8) The in-flight restart capabilities of the engine, if applicable, and if so, a description of the manual and/or automatic features of this capability;

(9) The fuel system and how it allows for adequate control of the fuel delivery to the engine, and provides for aircrew determination of the fuel remaining. This includes a system level diagram showing the location of the system in the UA and the fuel flow path; and

(10) How the fuel system is designed in terms of safety (fire detection and extinguishing, reduction of risk in case of impact, leak prevention, etc.).

(c) Electric-powered propulsion systems

(1) A high-level description of the electrical distribution architecture, including items such as regulators, switches, buses, and converters, as necessary;

(2) The type of motor that is used;

(3) The number of motors that are installed;

(4) The maximum continuous power output of the motor in watts;

(5) The maximum peak power output of the motor in watts;

(6) The current range of the motor in amps;

(7) Whether the propulsion system has a separate electrical source, and if not, how the power is managed with respect to the other systems of the UA;

(8) A description of the electrical system and how it distributes adequate power to meet the requirements of the receiving systems. This should include a system level diagram showing the electrical power distribution throughout the UA;

(9) How power is generated on board the UA (for example, generators, alternators, batteries).

(10) If a limited life power source such as batteries is used, the useful life of the power source during normal and emergency conditions, and how this was determined;

(11) How information on the battery status and the remaining battery capacity is provided to the remote pilot or the watchdog system;

(12) If available, a description of the source(s) of backup power for use in the event of a loss of the primary power source. This should include:

(i) the systems that are powered during backup power operation;

(ii) a description of any automatic or manual load shedding; and

(iii) how much operational time the backup power source provides, including the assumptions used to make this determination;

(13) How the performance of the propulsion system is monitored;

(14) The status indicators and alert (such as warning, caution and advisory) messages that are provided to the remote pilot;

(15) A description of the most critical propulsion-related failure modes/conditions and their impact on system operation;

(16) How the UA responds, and the safeguards that are in place to mitigate the risk of a propulsion system loss for each of the following:

(i) Low battery charge;

(ii) A failed signal input from the RPS; and

(iii) A motor controller failure;

(17) If the motor has in-flight reset capabilities, a description of the manual and/or automatic features of this capability.

(d) Other propulsion systems

A description of these systems to a level of detail equivalent to the fuel and electrical propulsions sections above.

A.2.2.1.4 Flight control surfaces and actuators

This section should include the following:

(a) A description of the design and operation of the flight control surfaces and servos/actuators, including a diagram showing the location of the control surfaces and the servos/actuators;

(b) A description of any potential failure modes and the corresponding mitigations;

(c) How the system responds to a servo/actuator failure; and

(d) How the remote-pilot or watchdog system is alerted of a servo/actuator malfunction.

A.2.2.1.5 Sensors

This section should describe the non-payload sensor equipment on board the UA and its role.

A.2.2.1.6 Payloads

This section should describe the payload equipment on board the UA, including all the payload configurations that significantly change the weight and balance, electrical loads, or flight dynamics.

A.2.3 UAS control segment

This section should include the following:

A.2.3.1 General

An overall system architecture diagram of the avionics architecture, including the location of all air data sensors, antennas, radios, and navigation equipment. A description of any redundant systems, if available.

A.2.3.2 Navigation

(a) How the UAS determines its location;

(b) How the UAS navigates to its intended destination;

(c) How the remote pilot responds to instructions from:

(1) air traffic control;

(2) UA observers or VOs (if applicable); and

(3) other crew members (if applicable);

(d) The procedures to test the altimeter navigation system (position, altitude);

(e) How the system identifies and responds to a loss of the primary means of navigation;

(f) A description of any backup means of navigation; and

(g) How the system responds to a loss of the secondary means of navigation, if available.

A.2.3.3 Autopilot

(a) How the autopilot system was developed, and the industry or regulatory standards that were used in the development process.

(b) If the autopilot is a commercial off-the-shelf (COTS) product, the type/design and the production organisation, with the criteria that were used in selecting the COTS autopilot.

(c) The procedures used to install the autopilot and how its correct installation is verified, with references to any documents or procedures provided by the manufacturer's organisation and/or developed by the UAS operator's organisation.

(d) If the autopilot employs input limit parameters to keep the aircraft within defined limits (structural, performance, flight envelope, etc.), a list of those limits and a description of how these limits were defined and validated.

(e) The type of testing and validation that was performed (software-in-the-loop (SITL) and hardware-in-the-loop (HITL) simulations).

A.2.3.4 Flight control system

(a) How the control surfaces (if any) respond to commands from the flight control computer/autopilot.

(b) A description of the flight modes (i.e. manual, artificial-stability, automatic, autonomous).

(c) Flight control computer/autopilot:

(1) If there are any auxiliary controls, how the flight control computer interfaces with the auxiliary controls, and how they are protected against unintended activation.

(2) A description of the flight control computer interfaces required to determine the flight status and to issue appropriate commands.

(3) The operating system on which the flight controls are based.

A.2.3.5 Remote pilot station (RPS)

(a) A description or a diagram of the RPS configuration, including screen captures of the control station displays.

(b) How accurately the remote pilot can determine the attitude, altitude (or height) and position of the UA.

(c) The accuracy of the transmission of critical parameters to other airspace users/air traffic control (ATC).

(d) The critical commands that are safeguarded from inadvertent activation and how that is achieved (for example, is there a two-step process to command 'switch the engine off'). The kinds of inadvertent input that the remote pilot could enter to cause an undesirable outcome (for example, accidentally hitting the 'kill engine' control in flight).

(e) Any other programmes that run concurrently on the ground control computer, and if there are any, the precautionary measures that are used to ensure that flight-critical processing will not be adversely affected.

(f) The provisions that are made against an RPS display or interface lock-up.

(g) The alerts (such as warning, caution and advisory) that the system provides to the remote pilot (e.g. low fuel or battery level, failure of critical systems, or operation out of control).

(h) A description of the means to provide power to the RPS, and redundancies, if any.

A.2.3.6 Detect and avoid (DAA) system

(a) Aircraft conflict avoidance

(1) A description of the system/equipment that is installed for collaborative conflict avoidance (e.g. SSR, TCAS, ADS-B, FLARM, etc.).

(2) If the equipment is qualified, details of the detailed qualification to the respective standard.

(3) If the equipment is not qualified, the criteria that were used in selecting the system.

(b) Non-collaborative conflict avoidance:

A description of the equipment that is installed (e.g. vision-based, PSR data, LIDAR, etc.).

(c) Obstacle conflict avoidance

A description of the system/equipment that is installed, if any, for obstacle collision avoidance.

(d) Avoidance of adverse weather conditions

A description of the system/equipment that is installed, if any, for the avoidance of adverse weather conditions.

(e) Standard

(1) If the equipment is qualified, a list of the detailed qualification to the respective standard.

(2) If the equipment is not qualified, the criteria that were used in selecting the system.

(f) A description of any interface between the conflict avoidance system and the flight control computer.

(g) A description of the principles that govern the installed DAA system

(h) A description of the role of the remote pilot or any other remote crew in the DAA system.

(i) A description of the known limitations of the DAA system.

A.2.4 Containment system

(a) A description of the principles of the system/equipment used to perform containment functions for:

(1) avoidance of specific area(s) or volume(s); or

(2) confinement in a given area or volume.

(b) The system information and, if applicable, supporting evidence that demonstrates the reliability of the containment system.

A.2.5 Ground support equipment (GSE) segment

(a) A description of all the support equipment that is used on the ground, such as launch or recovery systems, generators, and power supplies.

(b) A description of the standard equipment available, and the backup or emergency equipment.

(c) A description of how the UAS is transported on the ground.

A.2.6 Command and control (C2) link segment

(a) The standard(s) with which the system is compliant.

(b) A detailed diagram that shows the system architecture of the C2 link, including informational or data flows and the performance of the subsystem, and values for the data rates and latencies, if known.

(c) A description of the control link(s) connecting the UA to the RPS and any other ground systems or infrastructures, if applicable, specifically addressing the following items:

(1) The spectrum that will be used for the control link and how the use of this spectrum has been coordinated. If approval of the spectrum is not required, the regulation that was used to authorise the frequency.

(2) The type of signal processing and/or link security (i.e. encryption) that is employed.

(3) The datalink margin in terms of the overall link bandwidth at the maximum anticipated distance from the RPS, and how it was determined.

(4) If there is a radio signal strength and/or health indicator or similar display to the remote pilot, how the signal strength and health values were determined, and the threshold values that represent a critically degraded signal.

(5) If the system employs redundant and/or independent control links, how different the design is, and the likely common failure modes.

(6) For satellite links, an estimate of the latencies associated with using the satellite link for aircraft control and for air traffic control communications.

(7) The design characteristics that prevent or mitigate the loss of the datalink due to the following:

(i) RF or other interference;

(ii) flight beyond the communications range;

(iii) antenna masking (during turns and/or at high attitude angles);

(iv) a loss of functionality of the RPS;

(v) a loss of functionality of the UA; and

(vi) atmospheric attenuation, including precipitation.

A.2.7 C2 link degradation

A description of the system functions in case of a C2 link degradation:

(a) Whether the C2 link degradation status is available and in what form (e.g. degraded, critical, automatic messages).

(b) How the status of the C2 link degradation is announced to the remote pilot (e.g. visual, haptic, or sound).

A description of the associated contingency procedures.

(c) Other.

A.2.8 C2 link loss

(a) The conditions that could lead to a loss of the C2 link.

(b) The measures in case of a loss of the C2 link.

(c) A description of the clear and distinct aural and visual alerts to the remote pilot for any case of a lost link.

(d) A description of the established lost link strategy presented in the UAS operating manual, taking into account the emergency recovery capability.

(e) A description of how the geo-awareness or geo-fencing system is used in this case, if available.

(f) The lost link strategy, and, if incorporated, the re-acquisition process in order to try to re-establish the link in a reasonably short time.

A.2.9. Safety features

(a) A description of the single failure modes and their recovery mode(s), if any.

(b) A description of the emergency recovery capability to prevent risks to third-parties. This typically consists of:

(1) a flight termination system (FTS), procedure or function that aims to immediately end the flight; or

(2) an automatic recovery system (ARS) that is implemented through UAS crew command or by the on board systems. This may include an automatic pre-programmed course of action to reach a predefined and unpopulated forced landing area; or

(3) any combination of the above, or other methods.

(c) The applicant should provide both a functional and physical diagram of the global UA system with a clear depiction of its constituent components, and, where applicable, an indication of its peculiar features (e.g. independent power supplies, redundancies, etc.)

Annex B to AMC1 to Article 11

ED Decision 2023/012/R

INTEGRITY AND ASSURANCE LEVELS FOR THE MITIGATIONS USED TO REDUCE THE INTRINSIC GROUND RISK CLASS (GRC)

B.1 How to use Annex B

The following Table B-1 provides the basic principles to consider when using SORA Annex B.

	Principle description	Additional information
#1	Annex B provides assessment criteria for the integrity (i.e. safety gain) and assurance (i.e. method of proof) of the applicant's proposed mitigations. The proposed mitigations are intended to reduce the intrinsic ground risk class (GRC) associated with a given operation.	The identification of mitigations is the responsibility of the applicant.
#2	Annex B does not cover the LoI of the competent authority. The LoI is based on the competent authority's assessment of the applicant's ability to perform the given operation.	
#3	A proposed mitigation may or may not have a positive effect in reducing the ground risk associated with a given operation. In the case where a mitigation is available but does not reduce the risk on the ground, its level of integrity should be considered equivalent to 'None'.	
#4	To achieve a given level of integrity/assurance, when more than one criterion exists for that level of integrity/assurance, all the applicable criteria need to be met.	
#5	Annex B intentionally uses non-prescriptive terms (e.g. suitable, reasonably practicable) to provide flexibility to both the applicant and the competent authorities. This does not constrain the applicant in proposing mitigations, nor the competent authority in evaluating what is needed on a case-by-case basis.	
#6	This annex in its entirety also applies to single-person organisations.	

Table B.1 – Basic principles

B.2 M1 — Strategic mitigations for ground risk

M1 mitigations are 'strategic mitigations' intended to reduce the number of people at risk on the ground. To assess the integrity levels of M1 mitigations, the following need to be considered:

(a) the definition of the ground risk buffer and the resulting ground footprint; and

(b) the evaluation of the people at risk.

With the exception of the specific case of a 'tether' provided in the following paragraph (2), the generic criteria to assess the level of integrity (Table B.2) and level of assurance (Table B.3) of the M1 type ground risk mitigations are provided in following paragraph (1).

(1) **Generic criteria**

		Level of integrity		
		Low	**Medium**	**High**
M1 — Strategic mitigations for ground risk	Criterion #1 (Definition of the ground risk buffer)	A ground risk buffer with at least a 1:1 rule[1] or for rotary wing UA defined using a ballistic methodology approach acceptable to the competent authority.	The ground risk buffer takes into consideration: (a) improbable[2] single malfunctions or failures (including the projection of high energy parts such as rotors and propellers) which would lead to an operation outside the operational volume; (b) meteorological conditions (e.g. wind); (c) UAS latencies (e.g. latencies that affect the timely manoeuvrability of the UA); (d) UA behaviour when activating a technical containment measure; and (e) UA performance.	Same as medium[3]
	Comments	*[1] If the UA is planned to operate at an altitude of 150 m, the ground risk buffer should be a minimum of 150 m.*	*[2] For the purpose of this assessment, the term 'improbable' should be interpreted in a qualitative way as 'Unlikely to occur in each UAS during its total life, but which may occur several times when considering the total operational life of a number of UAS of this type'.* *[3] The distinction between a medium and a high level of robustness for this criterion is achieved through the level of assurance (Table 3 below).*	
	Criterion #2 (Evaluation of people at risk)	The applicant evaluates the area of operations by means of on-site inspections or appropriate appraisals to justify lowering the density of the people at risk (e.g. a residential area during daytime when some people may not be present or an industrial area at night time for the same reason).	The applicant evaluates the area of operations by use of authoritative density data (e.g. data from the U-space data service provider) relevant for the proposed area and time of operation to substantiate a lower density of people at risk. If the applicant claims a reduction, due to a sheltered operational environment, the applicant: (a) uses a UA of less than 25 kg and not flying above 174 knots[4], and (b) demonstrates that although the operation is conducted in a populated environment, it is reasonable to consider that most of the non-involved persons will be located within a building[5].	Same as medium.
	Comments	*N/A*	*[4] as per MITRE presentation given during the UAS Technical Analysis and Applications Center (TAAC) conference in 2016 titled 'UAS EXCOM Science and Research Panel (SARP) 2016 TAAC Update' - PR 16-3979* *[5] The consideration of this mitigation may vary based on the local conditions.*	*N/A*

Table B.2 — Level of integrity assessment criteria for ground risk of non-tethered M1 mitigations

		Level of assurance		
		Low	**Medium**	**High**
M1 — Strategic mitigations for ground risk	Criterion #1 (Definition of the ground risk buffer)	The applicant declares that the required level of integrity is achieved[1].	The applicant has supporting evidence to claim that the required level of integrity has been achieved. This is typically done by means of testing, analysis, simulation[2], inspection, design review or through operational experience.	The claimed level of integrity is validated by the competent authority of the MS or by an entity that is designated by the competent authority.
	Comments	*[1] Supporting evidence may or may not be available.*	*[2] When simulation is used, the validity of the targeted environment used in the simulation needs to be justified.*	*N/A*
	Criterion #2 (Evaluation of people at risk)	The applicant declares that the required level of integrity has been achieved[3].	The density data used for the claim of risk reduction is an average density map for the date/time of the operation from a static sourcing (e.g. census data for night time ops). In addition, for localised operations (e.g. intra-city delivery or infrastructure inspection), the applicant submits the proposed route/area of operation to the applicable authority (e.g. city police, office of civil protection, infrastructure owner etc.) to verify the claim of a reduced number of people at risk.	Same as medium; however, the density data used for the claim of risk reduction is a near-real time density map from a dynamic sourcing (e.g. cellular user data) and applicable for the date/time of the operation.
	Comments	*[3] Supporting evidence may or may not be available*	*N/A*	*N/A*

Table B.3 — Level of assurance assessment criteria for ground risk of non-tethered M1 mitigations

(2) **Specific criteria in case of use of a tether to reduce people at risk**

When an applicant wants to take credit for a tether to justify a reduction in the number of people at risk:

(a) the tether needs to be considered part of the UAS and assessed based on the criteria below, and

(b) potential hazards created by the tether itself should be addressed through the OSOs defined in Annex E.

The level of integrity criteria for a tethered mitigation is found in Table B.4. The level of assurance for a tethered mitigation is found in Table B.5.

		Level of integrity		
		Low	**Medium**	**High**
M1 — Tethered operation	Criterion #1 (Technical design)	Does not meet the 'medium' level criteria	(a) The length of the line is adequate to contain the UA in the operational volume and reduce the number of people at risk. (b) The strength of the line is compatible with the ultimate loads[1] expected during the operation. (c) The strength of the attachment points is compatible with the ultimate loads[1] expected during the operation. (d) The tether cannot be cut by the rotating propellers.	Same as medium[2]
	Comments	*N/A*	*[1] Ultimate loads are identified as the maximum loads to be expected in service, including all the possible nominal and failure scenarios multiplied by a 1.5 safety factor.* *[2] The distinction between a medium and a high level of robustness for this criterion is achieved through the level of assurance (Table B.5 below).*	
	Criterion #2 (Procedures)	Does not meet the 'medium' level criteria	The applicant has procedures to install and periodically inspect the condition of the tether.	Same as medium[3]
	Comments	*N/A*	*[3] The distinction between a medium and a high level of robustness for this criterion is achieved through the level of assurance (Table B.5 below).*	

Table B.4 — Level of integrity assessment criteria for ground risk tethered M1 mitigations

		Level of assurance		
		Low	**Medium**	**High**
M1 — Tethered operation	Criterion #1 (Technical design)	Does not meet the 'medium' level criteria	The applicant has supporting evidence (including the specifications of the tether material) to claim that the required level of integrity is achieved. (a) This is typically achieved through testing or operational experience. (b) Tests can be based on simulations; however, the validity of the target environment used in the simulation needs to be justified.	The claimed level of integrity is validated by the competent authority of the MS or by an entity that is designated by the competent authority.
	Comments	*N/A*	*N/A*	*N/A*
	Criterion #2 (Procedures)	(a) Procedures do not require validation against either a standard or a means of compliance considered adequate by the competent	(a) Procedures are validated against standards considered adequate by the competent authority of the MS and/or in accordance with the means of compliance acceptable to that authority[1]. (b) The adequacy of the procedures is proven through:	Same as medium. In addition: (a) Flight tests performed to validate the procedures cover the complete flight envelope or are proven to be conservative.

		authority of the MS. (b) The adequacy of the procedures and checklists is declared.	(1) dedicated flight tests; or (2) simulation, provided that the representativeness of the simulation means is proven to be valid for the intended purpose with positive results; or (3) any other means acceptable to the competent authority of the MS.	(b) The procedures, flight tests and simulations are validated by the competent authority of the MS or by an entity that is designated by the competent authority.
	Comments	*N/A*	[1] *AMC2 UAS.SPEC.030(3)(e) (Operational procedures for medium and high levels of robustness) is considered an acceptable means of compliance.*	*N/A*

Table B.5 — Level of assurance assessment criteria for ground risk tethered M1 mitigations

B.3 M2 — Effects of ground impact are reduced

M2 mitigations are intended to reduce the effect of ground impact once the control of the operation is lost. This is done by reducing the effect of the UA impact dynamics (i.e. the area, energy, impulse, transfer energy, etc.). One example would be the use of a parachute.

		Level of integrity		
		Low/None	**Medium**	**High**
M2 — Effects of UA impact dynamics are reduced (e.g. parachute)	Criterion #1 (Technical design)	Does not meet the 'medium' level criterion	(a) Effects of impact dynamics and post impact hazards[1] are significantly reduced although it can be assumed that a fatality may still occur. (b) When applicable, in case of malfunctions, failures or any combinations thereof that may lead to a crash, the UAS contains all the elements required for the activation of the mitigation. (c) When applicable, any failure or malfunction of the proposed mitigation itself (e.g. inadvertent activation) does not adversely affect the safety of the operation.	Same as medium. In addition: (a) When applicable, the activation of the mitigation is automated[2]. (b) The effects of impact dynamics and post impact hazards are reduced to a level where it can be reasonably assumed that a fatality will not occur[3].
	Comments	*N/A*	[1] *Examples of post impact hazards include fires and the release of high-energy parts.*	[2] *The applicant retains the discretion to implement an additional manual activation function.* [3] *Emerging research and upcoming industry standards will help applicants to substantiate compliance with this integrity criterion.*
	Criterion #2 (Procedures, if applicable)	Any equipment used to reduce the effect of the UA impact dynamics is installed and maintained in accordance with the manufacturer's instructions.[4]		

	Comments / Notes	*[4] The distinction between a low, a medium and a high level of robustness for this criterion is achieved through the level of assurance (Table B.7 below).*
	Criterion #3 (Training, if applicable)	Personnel responsible for the installation and maintenance of the measures proposed to reduce the effect of the UA impact dynamics are identified and trained by the applicant.[5]
	Comments / Notes	*[5] The distinction between a low, a medium and a high level of robustness for this criterion is achieved through the level of assurance (Table B.7 below).*

Table B.6 — Level of integrity assessment criteria for M2 mitigations

		Level of assurance		
		Low/None	**Medium**	**High**
M2 — Effects of UA impact dynamics are reduced (e.g. parachute)	Criterion #1 (Technical design)	The applicant declares that the required level of integrity has been achieved[1].	The applicant has supporting evidence to claim that the required level of integrity is achieved. This is typically[2] done by means of testing, analysis, simulation[3], inspection, design review or through operational experience. The applicant may declare compliance with MoC to Light-UAS.2512[4] providing the supporting evidence defined in it.	The competent authority should request the applicant to use a UAS for which EASA has verified the claimed integrity through a DVR.
	Comments	*[1] Supporting evidence may or may not be available.*	*[2] The use of industry standards is encouraged when developing mitigations used to reduce the effect of ground impact.* *[3] When simulation is used, the validity of the targeted environment used in the simulation needs to be justified.* *[4] https://www.easa.europa.eu/en/document-library/product-certification-consultations/means-compliance-mitigation-means-m2-ref-amc*	
	Criterion #2 (Procedures, if applicable)	(a) Procedures do not require validation against either a standard or a means of compliance considered adequate by the competent authority of the MS. (b) The adequacy of the procedures	(a) Procedures are validated against standards considered adequate by the competent authority of the MS and/or in accordance with the means of compliance acceptable to that authority[1]. (b) The adequacy of the procedures is proven through: (1) dedicated flight tests; or (2) simulation, provided that the representativeness of the simulation means is proven to be valid for the intended	Same as medium. In addition: (a) Flight tests performed to validate the procedures cover the complete flight envelope or are proven to be conservative. (b) The procedures, flight tests and simulations are validated by the competent authority of the MS or by an entity

		and checklists is declared.	purpose with positive results; or (3) any other means acceptable to the competent authority of the MS	that is designated by the competent authority.
	Comments	*N/A*	*[1] AMC2 UAS.SPEC.030(3)(e) (Operational procedures for medium and high levels of robustness) is considered an acceptable means of compliance.*	*N/A*
	Criterion #3 (Training, if applicable)	Training is self-declared (with evidence available)	(a) Training syllabus is available. (b) The UAS operator provides competency-based, theoretical and practical training.	(a) Training syllabus is validated by the competent authority of the MS or by an entity that is designated by the competent authority. (b) Remote crew competencies are verified by the competent authority of the MS or by an entity that is designated by the competent authority.
	Comments	*N/A*	*N/A*	*N/A*

Table B.7 — Level of assurance assessment criteria for M2 mitigations

B.4 M3 — An ERP is in place, UAS operator validated and effective

An ERP should be defined by the applicant in the event of a loss of control of the operation (*). These are emergency situations where the operation is in an unrecoverable state and in which:

(a) the outcome of the situation relies highly on providence; or

(b) it could not be handled by a contingency procedure; or

(c) when there is a grave and imminent danger of fatalities.

The ERP proposed by an applicant is different from the emergency procedures. The ERP is expected to cover:

(1) a plan to limit the escalating effect of a crash (e.g. to notify first responders), and

(2) the conditions to alert ATM.

(*) Refer to the SORA semantic model (Figure 1) in the main body.

		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*

Table B.8 — Level of integrity assessment criteria for M3 mitigations

		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 of the MS. (b) The adequacy of the procedures and checklists is declared.	(a) The ERP is developed to standards considered adequate by the competent authority of the MS and/or in accordance with means of compliance acceptable to that authority[1]. (b) The ERP is validated through a representative tabletop exercise[2] 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 the competent authority of the MS or by an entity that is designated by the competent authority. (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 the competent authority of the MS or by an entity that is designated by the competent authority.
	Comments	*N/A*	*[1] AMC3 UAS.SPEC.030(3)(e) (ERP for medium and high*	*N/A*

		Level of assurance		
		Low/None	**Medium**	**High**
			level of robustness) is considered an acceptable means of compliance. *[2] The tabletop exercise may or may not involve all third parties identified in the ERP.*	
	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, the competencies of the relevant staff are verified by the competent authority of the MS or by an entity that is designated by the competent authority.
	Comments	*N/A*	*N/A*	*N/A*

Table B.9 — Level of assurance assessment criteria for M3 mitigations

Annex C to AMC1 to Article 11

ED Decision 2023/012/R

STRATEGIC MITIGATION — COLLISION RISK ASSESSMENT

C.1 Introduction — air risk strategic mitigations

The target audience for Annex C is the UAS operator who wishes to demonstrate to the competent authority that the risk of a mid-air collision in the operational volume is acceptably safe, and to obtain, with concurrence from the ANSP, approval to operate in the particular airspace.

More particularly, this Annex C covers the process of how the UAS operator justifies lowering the initial assessment of the ARC.

The air risk model provides a holistic means to assess the risk of an encounter with manned aircraft. This provides guidance to both the UAS operator and the competent authority on determining whether an operation can be conducted in a safe manner. The model does not provide answers to all the air risk challenges, and should not be used as a checklist. This guidance provides the UAS operator with suitable mitigation means and thereby reduces the air risk to an acceptable level. This guidance does not contain prescriptive requirements, but rather a set of objectives at various levels of robustness.

C.2 Principles

The SORA is only used to establish an initial ARC for an operational volume when the competent authority has not already established one. The initial ARC is a generalised qualitative classification of the rate at which a UAS would encounter a manned aircraft in the operational volume. A residual ARC is the classification after mitigations are applied. The UAS operational volume may have collision risk levels that differ from the generalised initial ARC level. If this is assumed to be the case, this Annex provides a process to help the UAS operator and the competent authority work to lower the initial ARC through the application of strategic mitigations.

C.3 Air risk scope and assumptions

The scope of this air risk assessment is designed to help the UAS operator and the competent authority in determining the risk of a collision with manned aircraft which are operated under the ‘specific’ category. The scope of the air risk assessment does not include:

(a) the probability of UAS on UAS encounters; or

(b) risks due to wake turbulence, adverse weather, controlled flight into terrain, return-to-course functions, a lost link, or an automatic response.

C.3.1 SORA qualitative vs quantitative approach

This air risk assessment is qualitative in nature. Where possible, this assessment will use quantitative data to back up and support the qualitative assumptions. The SORA approach in general provides a balance between qualitative and quantitative approaches, as well as between known prescriptive and non-traditional methodologies.

C.3.2 SORA U-space assumptions

The SORA has used U-space mitigations to a limited extent, because U-space is in the early stages of development. When U-space provides adequate mitigations to limit the risk of UAS encounters with manned aircraft, a UAS operator can apply for, and obtain credit for these mitigations, whether they are tactical or strategic.

C.3.3 SORA flight rules assumptions

Today, UAS flight operations under the 'specific' category cannot fully comply with the IFR and VFR rules as written. Although IFR infrastructures and mitigations are designed for manned aircraft operations (e.g. minimal safe altitudes, equipage requirements, operational restrictions, etc.), it may be possible for a UAS to comply with the IFR requirements. UAS operating at very low levels (e.g. operational volume's ceiling below 150m (~500 ft) AGL) may technically comply with the IFR requirements, but the IFR infrastructure was not designed with that airspace in mind; therefore, mitigations for this airspace would be derived, and would be highly impractical and inefficient. When operating BVLOS, a UAS cannot comply with VFR[1].

Given the above, for the purposes of this risk assessment, it is assumed that the competent authority will address these shortcomings. All aircraft must adhere to specific flight rules to mitigate the collision risk, in accordance with Regulation (EU) No 923/2012[2] (the standardised European rules of the air (SERA) Regulation). The implementation of procedures and guidelines appropriate to the airspace structure reduces the collision risk for all aircraft. For instance, there are equipment requirements established for the airspace requested and requirements associated with day-night operations, pilot training, airworthiness, lighting requirements, altimetry requirements, airspace restrictions, altitude restrictions, etc. These rules must still be addressed by the competent authority.

The Member State is responsible for defining the airspace structures in accordance with Regulation (EU) 2017/373; in addition, as required in Article 15 of the UAS Regulation, the Member State will define the geographical zones for UAS operators. The Member State, when defining the airspace structure, considers the traffic type and complexity and defines the airspace classes and services being provided in accordance with the SERA. This information, which can be published either in the aeronautical information publication (AIP) or any other aeronautical publication, can be used by the UAS operator to identify the initial air risk. The SORA air risk model is a tool to assess the risks associated with UAS operations in a particular volume of airspace, and a method to determine whether those risks are within acceptable safety limits.

C.3.4 Regulatory requirements, safety requirements, and waivers

The SERA Regulation requires all aircraft, manned and UAS, to 'remain well clear from and avoid collisions with' other manned aircraft. The UAS is unable to 'see and avoid', therefore, it must employ an alternate means of compliance to meet the intent of 'see and avoid', which will have to be defined in terms of safety and performance for the UAS operation. When the risk of an encounter with manned aircraft is extremely low (i.e. in atypical/segregated airspace), an alternate means of compliance may not be required. For example, in areas where the manned airspace density is so low, (e.g. in the case of low-level operations in remote parts of Alaska or northern Sweden), the airspace safety threshold could be met with no additional mitigation. UAS operators need to understand that although the airspace may be technically safe to fly in from an air collision risk standpoint, it does not fulfil point SERA.3201 of the SERA Regulation, or the ICAO Annex 2, Section 3.2 'See and Avoid' requirements.

1 A UAS operating under VLOS may be able to comply with VFR.

2 Commission Regulation (EU) No 923/2012 laying 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, OJ L 281, 13.10.2012, p.1.

To operate a UAS in manned airspace, two requirements must be met:

(a) A safety requirement that ensures that the operation is safe to conduct in the operational volume; and

(b) A requirement for compliance with point SERA.3201 of the SERA Regulation to 'see and avoid'.

These requirements must be addressed to the competent authority through either:

(1) demonstration of compliance with both requirements;

(2) demonstration of an alternate means of compliance with the requirements; or

(3) a waiver of the requirement(s) by the competent authority.

The SORA provides a means to assess whether the air risks associated with UAS operations is within acceptable limits.

C.3.5 SORA assumptions on threat aircraft

This air risk assessment does not consider the ability of the threat aircraft to remain well clear from or to avoid collisions with the UAS in any part of the safety assessment.

C.3.6 SORA assumptions on people-carrying UAS

This air risk model does not consider the notion of UAS carrying people, or urban mobility operations. The model and the assessment criteria are limited to the risk of an encounter with manned aircraft, i.e. an aircraft piloted by a human on board.

C.3.7 SORA assumptions on UAS lethality

This air risk assessment assumes that a mid-air collision between a UAS and manned aircraft is catastrophic. Frangibility is not considered.

C.3.8 SORA assertion on tactical mitigations

The SORA model makes no distinction between separation provision and collision avoidance but treats them as one dependent system performing a continuous function, whose goals and objectives change over time. This continuum starts with an encounter and progresses to a near mid-air collision objective as the pilot and/or the detect and avoid system of the UA negotiate(s) the encounter. The use of the term 'tactical mitigation' should therefore not be confused with the provisioning of (tactical) separation services referred to in ICAO Doc 9854.

C.4 General air-SORA mitigation overview

SORA classification of mitigations

The SORA classifies mitigations to suit the operational needs of a UAS in the 'specific' class. These mitigations are classified as:

(a) strategic mitigations by the application of operational restrictions;

(b) strategic mitigations by the application of common structures and rules; and

(c) tactical mitigations.

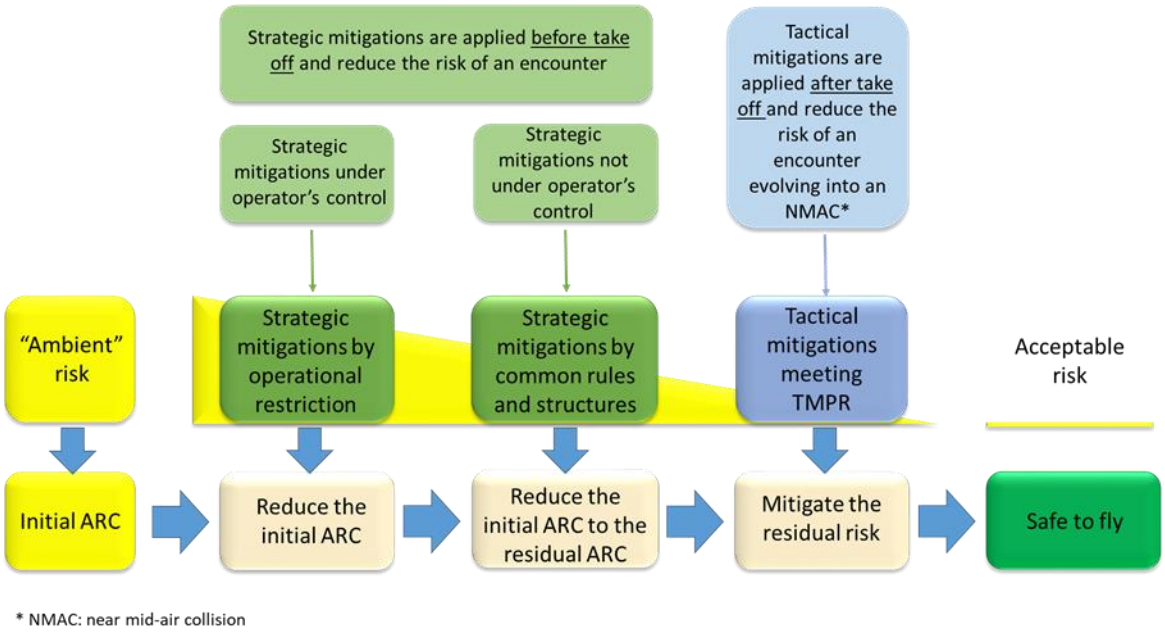


Figure C.5 — SORA air conflict mitigation process

C.5 Air risk strategic mitigation

Strategic mitigation consists of procedures and operational restrictions intended to reduce the UAS encounter rates or the time of exposure, prior to take-off.

Strategic mitigations are further divided into:

(a) mitigations by operational restrictions which are mitigations that are controlled[1] by the UAS operator; and

(b) mitigations by common structures[2] and rules which are mitigations which cannot be controlled by the UAS operator.

C.5.1 Strategic mitigation by operational restrictions

Operational restrictions are controlled by the UAS operator and are intended to mitigate the risk of a collision prior to take-off. This section provides details on operational restrictions, and examples of how these can be applied to UAS operations.

Operational restrictions are the primary means that a UAS operator can apply to reduce the risk of collision using strategic mitigation(s). The most common mitigations by operational restriction are:

(a) mitigation(s) that bound the geographical volume in which the UAS operates (e.g. certain boundaries or airspace volumes); and

(b) mitigation(s) that bound the operational time frame (e.g. restricted to certain times of day, such as flying only at night).

[1] The usage of the word 'controlled' means that the UAS operator is not reliant on the cooperation of other airspace users to implement an effective operational restriction mitigation strategy.

[2] This usage of the word 'structure' means air structure, airways, traffic procedures and the like.

In addition to the above, another approach to limit exposure to risk is to limit the exposure time. This is called 'mitigation by exposure'. Mitigation by exposure simply limits the time of exposure to the operational risk.

Mitigations that limit the flight time or the exposure time to risk may be more difficult to apply. With this said, there is some precedence for this mitigation, which has (in some cases) been accepted by the competent authority. Therefore, even though it is considered to be difficult, this mitigation strategy may be considered.

One example is the minimum equipment list (MEL) system, which allows, in certain situations, a commercial airline to fly for three to ten days with an inoperative traffic collision avoidance system (TCAS). The safety argument is that three days is a very short exposure time compared with the total life-time risk exposure of the aircraft. This short time of elevated risk exposure is justified to allow the aircraft to return to a location where proper equipment maintenance can take place. While appreciating that this may be a difficult argument for the UAS operation to make, the UAS operator is still free to pursue this line of reasoning for a reduction in the risk of collision by applying a time of exposure argument.

C.5.1.1. Example of operational restriction by geographical boundary

The UAS operator intends to fly in a Class B airport airspace. The Class B airspace, as a whole, has a very high encounter rate. However, the UAS operator wishes to operate at a very low altitude and at the very outer reaches of the Class B airspace where manned aircraft do not routinely fly. The UAS operator draws up a new operational volume at the outer edge of the class B airspace and demonstrates that operations within the new Class B volume have very low encounter rates.

The UAS operator may approach this scenario by requesting the competent authority to more precisely define the airport environment from the SORA perspective. The UAS operator then considers the newly defined airport environment, and provides an operational restriction that allows the UAS operation to safely remain inside the class B airspace, but outside the newly defined SORA airport environment.

C.5.1.2 Example of operational restriction by time limitations

The UAS operator wishes to fly in a Class B airport airspace. The Class B airspace, as a whole, has a very high encounter rate. However, the UAS operator wishes to operate at a time of day when manned aircraft do not routinely fly. The UAS operator then restricts the time schedule of the UAS operation and demonstrates that the new time (e.g. 03:00 / 3 AM and still within Class B) has very low encounter rates and is safe for operation.

C.5.1.3 Example of operational restriction by time of exposure

The UAS operator wishes to cut the corner of a Class B airspace for flight efficiency. The UAS operator demonstrates that even though the Class B airspace has a high encounter rate, the UAS is only exposed to that higher rate for a very short amount of time as it transitions the corner.

C.5.2 Strategic mitigation by common structures[1] and rules

Strategic mitigation by common structures and rules requires all aircraft within a certain class of airspace to follow the same structures and rules; these structures and rules work to lower the risk of collision within the airspace. In accordance with the SERA Regulation, all aircraft in that airspace must participate, and only the competent authorities have the authority to set requirements for those aircraft, while the ANSP and ATCO provide instructions. The UAS operator does not have control[2] over the existence or level of participation of the airspace structure or the application of the flight rules. Therefore, strategic mitigation by common structures and rules is applied by the competent authorities. These should be made available to the UAS operator through the geographical zones, defined in accordance with Article 15 of the UAS Regulation.

For example, imagine the situation if individual drivers could create their own driving rules to cover their direction, lanes, boundaries and speed. If the driving rules were different from one driver to another, no safety benefit would be gained, even though they were all following rules (their own), and total chaos would ensue. However, if all drivers were compelled to follow the same set of rules, then the traffic flow would be orderly, with increased safety for all drivers. This is why a UAS operator cannot propose a mitigation schema requiring participation from other airspace users that differs from that required by the competent authority.

Most strategic mitigations by common structures and rules will take the form of:

(a) common flight rules; and

(b) common airspace structures.

Strategic mitigations by common flight rules is accomplished by setting a common set of rules which all airspace users must comply with. These rules reduce air conflicts and/or make conflict resolution easier. Examples of common flight rules that reduce the collision risk include right of way rules, implicit and explicit coordination schemes, conspicuity requirements, cooperative identification system, etc.

Strategic mitigation by using a common airspace structure is accomplished by controlling the airspace infrastructure through physical characteristics, procedures, and techniques that reduce conflicts or make conflict resolution easier. Examples of common flight airspace structures which reduce the risk of collision are airways, departure and approach procedures, airflow management, etc.

In the future, as U-space structures and rules become more readily defined and adopted, they will provide a source for the strategic mitigation of UAS operations by common structures and rules that UAS operators could more easily apply.

[1] This usage of the word ‘structure’ means air structure, airways, traffic procedures and the like.

[2] The usage of the words ‘does not control’ means that the UAS operator does not have control over the implementation of aviation structures and rules and is reliant on the competent authority to implement structures and rules.

C.5.2.1 Example of mitigation by common flight rules

The UAS operator intends to fly in a volume of airspace in which the competent authority requires all UAS to be equipped with an electronic cooperative system[1] and anti-collision lighting. The rules further require the UAS operator to file a flight plan with the designated ANSP/U-space service providers, and check for potential hazards along the whole flight route. The operator complies with these requirements and installs anti-collision lights and a Mode-S Transponder. The operator further agrees to file a flight plan prior to each flight. These rules enhance the safety of the flight in the same way as a notice to airmen (NOTAM). The UAS operator should also have a system in place to check for high airspace usage in the intended operational volume (e.g. a glider competition or a fly-in). In those situations where the UAS operator does not own the airspace in which the operational volume exists, the rules require the UAS operator to request permission prior to entering that airspace.

C.5.2.2. Examples of mitigation by common airspace structure

Example 1: The competent authority establishes a transit corridor through Class B airspace that keeps the UAS separated from other non-UAS airport traffic, and safely separates the corridor traffic in one direction from the traffic in the other direction. The UAS operator intends to fly through this Class B airport airspace, and hence must stay within the established transit corridor and adhere to the transit corridor rules.

Example 2: The UAS operator intends to fly a UAS from one location to another, and files a flight plan with a U-space service provider or the procedural separation system. As the UAS takes off, the U-space service provider then guarantees separation by procedural control of all the aircraft in the airspace. Procedural controls are the take-off windows, reporting points, assigned airways and altitudes, route clearances, etc. required for safe operation.

C.6 Reducing the initial air risk class (ARC) assignment (optional)

This section is intended for an applicant that intends to use strategic mitigations to reduce the collision risk (i.e. ARC). There are two types of ARC:

(a) the initial ARC, which is a qualitative classification of a UAS operational collision risk within an operational volume before strategic mitigations are applied; and

(b) the residual ARC, which is a qualitative classification of a UAS operational collision risk in an operational volume after all strategic mitigations are applied.

If a UAS operator agrees that the (generalised) initial ARC applicable to their operation and operational volume is correct, then this step is not necessary, and the assessment should continue at SORA Step #6 (assigning the DAA tactical performance requirement and robustness levels based on the residual collision risk).

If mitigations to reduce the ARC are relevant and are proposed, this section provides information and examples of how to use strategic mitigation(s) to lower the collision risk within the operational volume, and demonstrate the strategy to a competent authority. The examples within the SORA may or may not be applicable or acceptable to the competent authority;

[1] The installation of an electronic cooperative system would make the UAS a cooperative aircraft in accordance with FAA Interim Operational Approval Guidance 08-01, 'Unmanned Aircraft Systems Operations in the U.S. National Airspace System,' Federal Aviation Administration, FAA/AIR-160, 2008.

however, the SORA encourages an open dialogue between the applicant and the competent authority to determine what is acceptable evidence.

C.6.1 Lowering the initial ARC to the residual ARC-a in any operational volume (optional)

ARC-a is intended for operations in atypical/segregated airspace (see Table C.1). Lowering the initial ARC to residual ARC-a requires a higher level of safety verification because it allows a UAS operator to operate without any tactical mitigation.

To demonstrate that an operation could be reduced to a residual ARC-a, the UAS operator should demonstrate:

(a) that the operational volume can meet the requirements of SORA atypical/segregated airspace; and

(b) compliance with any other requirements mandated by the competent authority for the intended operational volume.

A residual ARC-a assessment does necessarily exempt the UAS operator from the requirements to 'see and avoid' and to 'remain well clear from' other aircraft. If the designated competent authority allows the UAS operator a residual ARC-a assessment for the operational volume, in order to comply with the SERA Regulation, the UAS operator must either provide a valid means and equipment as an alternate means of compliance for the 'see and avoid' requirement, or the competent authority must waive the requirement to 'see and avoid' and 'remain well clear.'

C.6.2 Lowering the initial ARC using operational restrictions (optional)

There may be many methods by which a UAS operator may wish to demonstrate a suitable air risk and strategic mitigations. The SORA does not dictate how this is achieved, and instead, allows the applicant to propose and demonstrate the suitability and effectiveness of their strategic mitigations. It is important for both the UAS operator and the competent authority to understand that the assessment may be qualitative in nature, and where possible, augmented with quantitative data to support the qualitative assumptions and decisions. The UAS operator and the competent authority should understand there may not be a clear delineation of the decision points, so common sense and the safety of manned aircraft should be of paramount consideration.

The SORA provides a two-step method to reduce the air risk by operational mitigation. The first step is to determine the initial ARC by using the potential air risk encounter rate based on known airspace densities (as per Table C.1). The second step is to reduce the initial risk through UAS operator-provided evidence that demonstrates that the intended operation is more indicative of another airspace volume and an encounter rate that corresponds to a lower risk classification (ARC); hence, reducing the initial ARC to a residual ARC (as per Table C.2). This requires the agreement of the competent authority before the ARC may be reduced.

The SORA used expertise from subject matter experts to rate the airspace encounter category (AEC) and the variables that influence the encounter rates (i.e. proximity, geometry, and dynamics). The variables are not interdependent, nor do they influence the encounter outcome in the same manner. A small increase in one encounter rate variable can have major effects on the collision risk; conversely, a small increase in another variable could have limited effect on the collision risk. Hence, lowering the aircraft density of an AEC airspace does not equate to a direct and equal lowering of the

ARC risk level. There is no direct correlation between an individual AEC variable and the ARC collision risk levels. In summary:

(a) there are three inter-dependent variables that affect the ARC;

(b) the contribution of each variable to the total collision risk is not the same; and

(c) for simplicity, the SORA only allows the manipulation of one of the variables: the proximity, i.e. the aircraft density.

The first step to potentially lowering the ARC is to determine the AEC and the associated density rating using Table C.1. 12 operational/airspace environments were considered for the SORA air risk classification, and they correspond to the 12 scenarios found in Figure 4 of the SORA main body.

Operational environment, AEC and ARC			
Operations in:	**Initial generalised density rating**	**Corresponding AEC**	**Initial ARC**
Airport/heliport environment			
OPS in an airport/heliport environment in class B, C or D airspace	5	AEC 1	ARC-d
OPS in an airport/heliport environment in class E airspace or in class F or G	3	AEC 6	ARC-c
Operations above 150 m (~500 ft) AGL but below flight level 600			
OPS > 150 m (~500 ft) AGL but < FL 600 in a Mode-S Veil or transponder mandatory zone (TMZ)	5	AEC 2	ARC-d
OPS > 150 m (~500 ft) AGL but < FL 600 in controlled airspace	5	AEC 3	ARC-d
OPS > 150 m (~500 ft) AGL but < FL 600 in uncontrolled airspace over an urban area	3	AEC 4	ARC-c
OPS > 150 m (~500 ft) AGL but < FL 600 in uncontrolled airspace over a rural area	2	AEC 5	ARC-c
Operations below 150 m (~500 ft) AGL			
OPS < 150 m (~500 ft) AGL in a Mode-S Veil or TMZ	3	AEC 7	ARC-c
OPS < 150 m (~500 ft) AGL in controlled airspace	3	AEC 8	ARC-c
OPS < 150 m (~500 ft) AGL in uncontrolled airspace over an urban area	2	AEC 9	ARC-c
OPS < 150 m (~500 ft) AGL in uncontrolled airspace over a rural area	1	AEC 10	ARC-b
Operations above flight level 600			
OPS > FL 600	1	AEC 11	ARC-b
Operations in atypical or segregated airspace			
OPS in atypical/segregated airspace	1	AEC 12	ARC-a

Table C.1 — Initial air risk class assessment

After determining the initial risk using Table C.1, an applicant may choose to reduce that risk using Table C.2. To understand Table C.2, the first column shows the AEC in the environment in which the UAS operator wishes to operate. Column A shows the associated airspace density rating for that AEC rated from 5 to 1, with 5 being very high density, and 1 being very low density.

Column B shows the corresponding initial ARC.

Column C is key to lowering the initial ARC. This column shows the relative density ratings that a UAS operator should demonstrate to the competent authority in order to argue and justify that the actual local air density rating of the operational area is lower than the rating associated with the initial AEC (Column A) in Table C.1. If this can be shown and accepted by the competent authority, then the new lower ARC level as shown in column D may be applicable.

As stated earlier, the UAS operator is responsible for collecting and analysing the airspace density and for demonstrating the effectiveness of their proposal for strategic mitigations by operational restrictions to the competent authority. In summary, the UAS operator should demonstrate that the restrictions imposed on the UAS operation can lower the risk of a collision by showing that the local airspace encounter rate, under the operational restrictions, is lower than the generalised AEC assessed encounter rate provided in Table C.1.

The strategic mitigation reduction case should be modelled after a safety case. The size and complexity of the strategic mitigation reduction depends entirely on what the UAS operator is trying to do, and where/when they want to do it. The strategic mitigation case as a safety case has two advantages. Firstly, it provides the UAS operator with a structured approach to describe and capture the operation, the hazards identified, the risk analysed, and the threat(s) mitigated. Secondly, it provides a safety case structure that a competent authority is familiar with, which, in turn, helps the competent authority to understand the UAS operator's intended operation and their reasoning as to why a reduction in the ARC can be safely justified.

As each authority is different, the SORA recommends the applicant to contact the competent authority and/or ANSP to determine the format and presentation of the strategic mitigation reduction case.

The density rating of manned aircraft, assessed on a scale of 1 to 5, with 1 representing a very low density and 5 representing a very high density.				
Column	A	B	C	D
AEC	Initial generalised density rating for the environment	Initial ARC	If the local density can be demonstrated to be similar to:	New lowered (residual) ARC
AEC 1 or; AEC 2	5	ARC-d	4 or 3	ARC-c
			2 or 1[Note 1]	ARC-b
AEC 3	4	ARC-d	3 or 2	ARC-c
			1[Note 1]	ARC-b
AEC 4	3	ARC-c	1[Note 1]	ARC-b
AEC 5	2	ARC-c	1[Note 1]	ARC-b
AEC 6 or; AEC 7 or; AEC 8	3	ARC-c	1[Note 1]	ARC-b

AEC 9	2	ARC-c	1[Note 1]	ARC-b
Note 1: The reference environment for assessing density is AEC 10 (OPS < 400 ft AGL over rural areas).				
AEC10 and AEC 11 are not included in this table, as any ARC 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.				

Table C.2

To fully understand the above, the SORA provides three examples.

Example 1:

A UAS operator intends to operate in an airport/heliport environment, in class C airspace, which corresponds to AEC 1.

The UAS operator enters the initial ARC reduction table at Row AEC 1. Column A shows that the generalised airspace density of this environment is 5. Column B shows the associated initial ARC as ARC-d. Column C indicates that if a UAS operator can demonstrate that the actual, local airspace density corresponds to a generalised density rating of 3 or 4, then the ARC level may be reduced to a residual ARC-c (Column D). If a UAS operator demonstrates that the local airspace density corresponds more to scenarios with a density of 2 or 1, then the ARC level may be lowered to a residual ARC-b (Column D).

Example 2:

A UAS operator intends to operate in an airport/heliport environment, in class G airspace, with a corresponding level of AEC 6.

The UAS operator enters the initial ARC reduction table at Row AEC 6. Column A shows that the generalised airspace density rating that corresponds with this environment is 3. Column B shows the associated initial ARC as ARC-c. Column C indicates that if a UAS operator can demonstrate that the actual, local, airspace density corresponds more to the reference scenario that has a generalised density rating of 1, namely AEC 10, then the residual ARC level may be reduced to ARC-b (Column D).

Example 3:

A UAS operator intends to operate below 150m (~500 ft) AGL, in a class G (uncontrolled) airspace, over an urbanised area, with a corresponding level of AEC 9.

The UAS operator enters the initial ARC reduction table at Row AEC 9. Column A indicates that the generalised airspace density rating corresponding with this environment is 2. Column B shows the associated initial ARC is ARC-c. Column C indicates that if a UAS operator demonstrates that the local airspace density corresponds more to a density rating of 1, namely AEC 10, then the residual ARC level may be reduced to ARC-b (Column D).

C.6.3 Lowering the initial ARC by common structures and rules (optional)

Today, aviation airspace rules and structures mitigate the risk of collision. As the airspace risk increases, more structures and rules are implemented to reduce the risk. In general, the higher the aircraft density, the higher the collision risk, and the more structures and rules are required to reduce the collision risk.

In general, manned aircraft do not use very low level (VLL) airspace, as it is below the minimum safe height to perform an emergency procedure, ‘unless at such a height as will

permit, in the event of an emergency arising, a landing to be made without undue hazard to persons or property on the surface' (Ref. point SERA.3105 of the SERA Regulation). Subject to permission from the competent authority, special flights may be granted permission to use this airspace. Every aircraft will cross VLL airspace in an airport environment for take-off and landing.

With the advent of UAS operations, VLL airspace is expected to soon become more crowded, requiring more common structures and rules to lower the collision risk. It is anticipated that U-space services will provide these risk mitigation measures. This will require mandatory participation by all aircraft in that airspace, similar to how the current flight rules apply to all manned aircraft operating in a particular airspace today.

SORA does not allow the initial ARC to be lowered through strategic mitigation by common structures and rules for all operations in AEC 1, 2, 3, 4, 5, and 11[1]. Outside the scope of SORA, a UAS operator may appeal to the competent authority to lower the ARC by strategic mitigation by using common structures. The determination of acceptability falls under the normal airspace rules, regulations and safety requirements for ATM/ANS providers.

Similarly, SORA does not allow for lowering the initial ARC through strategic mitigation by using common structures and rules for all operations in AEC 10[2].

The maximum amount of ARC reduction through strategic mitigation by using common structures and rules is by one ARC level.

SORA does allow for lowering the initial ARC through strategic mitigation by structures and rules for all operations below 150 m (~500 ft) AGL within VLL airspace (AECs 7, 8, 9 and 10).

To claim an ARC reduction, the UAS operator should show the following:

(a) the UA is equipped with an electronic cooperative system, and navigation and anti-collision lighting[3];

(b) a procedure has been implemented to verify the presence of other traffic during the UAS flight operation (e.g. checking other aircraft's filed flight plans, NOTAMs[4], etc.);

(c) a procedure has been implemented to notify other airspace users of the planned UAS operation (e.g. filing of the UAS flight plan, applying for a NOTAM from the service provider for UAS[5] operations, etc.);

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1 AEC 1, 2, 3, 4, and 5 already have manned airspace rules and structures defined by Regulation (EU) No 923/2012. Any UAS operating in these types of airspace shall comply with the applicable airspace rules, regulations and safety requirements. As such, no lowering of the ARC by common structures and rules is allowed, as those mitigations have already been accounted for in the assessment of those types of airspace. Lowering the ARC for rules and structures in AEC 1, 2, 3, 4, 5, and 11 would amount to double counting of the mitigations.

2 AEC 10: the initial ARC is ARC-b. To lower the ARC in these volumes of airspace (to ARC-a) requires the operational volume to meet one of the requirements of atypical/segregated airspace.

3 Although the SORA takes into account the questionable effects of anti-collision lighting, it also takes into account that the installation of anti-collision lights is often relatively simple and has a net positive effect in preventing collisions.

4 Although NOTAMs are used here as an example, the use of NOTAMs may not be acceptable unless they cover all operations in VLL airspace. It is envisioned that a separate system like that of NOTAMs, which specifically addresses the concerns of VLL airspace, will fulfil this requirement.

5 Although flight plans and posting NOTAMS are used here as examples, the use of flight plans and NOTAMs may not be acceptable unless they cover all operations in VLL airspace. It is envisioned that a separate system, which specifically addresses the concerns of VLL airspace, will fulfil this requirement.

(d) permission has been obtained from the airspace owner to operate in that airspace (if applicable);

(e) compliance with the airspace UAS flight rules, the UAS Regulation, and the policies, etc. applicable to the UAS operational volume and with which all/most aircraft are required to comply (these flight rules, the UAS Regulation, and policies are aimed primarily at UAS operations in VLL airspace);

(f) a UAS airspace structure (e.g. U-space) exists in VLL airspace to help keep UAS separated from manned aircraft. This structure must be complied with by all UAS in accordance with the EU[1] or national regulations;

(g) a UAS airspace procedural separation service has been implemented for VLL airspace. The use of this service must be mandatory for all UAS to keep UAS separated from manned aircraft[2] in accordance with the SERA Regulation; and

(h) all UAS operators can directly communicate with the air traffic controller or flight information services directly or through a U-space service provider in accordance with the SERA Regulation (EU).

C.6.3.1 Demonstration of strategic mitigation by structures and rules

The UAS operator is responsible for collecting and analysing the data required to demonstrate the effectiveness of their strategic mitigations by structures and rules to the competent authority.

C.7 Determination of the residual ARC risk level by the competent authority

As stated before, the UAS operator is responsible for collecting and analysing the data required to demonstrate the effectiveness of all their strategic mitigations to the competent authority.

The competent authority makes the final determination of the airspace residual ARC level.

Caution: As the SORA breaks down collision mitigation into strategic and tactical parts, there can be some overlap between all these mitigations. The UAS operator and the competent authority need to be cognisant and to ensure that mitigations are not counted twice.

Although the static generalised risk (i.e. ARC) is conservative, there may be situations where that conservative assessment may be insufficient. In those situations, the competent authority may raise the ARC to a level that is higher than that advocated by the SORA.

For example, a UAS operator surveys a forest near an airport for beetle infestation, and the airspace was assessed as being ARC-b. The airport is hosting an air show. The competent authority informs the UAS operator that during the week of the air show, the ARC for that local airspace will be ARC-d. The UAS operator can either equip for ARC-d airspace or suspend operations until the air show is over.

[1] The U-space regulation and the relevant adaptation of SERA will apply

[2] This refers to possible future applications of an automated traffic management separation service for unmanned aircraft in a U-space environment. These applications may not exist as such today. A subscription to these services may be required.

Annex D to AMC1 to Article 11

ED Decision 2019/021/R

TACTICAL MITIGATION COLLISION RISK ASSESSMENT

D.1 Introduction-tactical mitigation

The target audience for Annex D is the UAS operator who wishes to apply TMPR, robustness, integrity, and assurance levels for their operation.

Annex D provides the tactical mitigation(s) used to reduce the risk of a mid-air collision. The TMPR is driven by the residual collision risk of the airspace. Some of these tactical mitigations may also provide means of compliance with point SERA.3201 of the SERA Regulation, and the additional requirements of various states.

The air-risk model has been developed to provide a holistic method to assess the risk of an air encounter, and to mitigate the risk that an encounter develops into a mid-air collision. The SORA air-risk model guides the UAS operator, the competent authority, and/or ANSP in determining whether an operation can be conducted in a safe manner. This Annex is not intended to be used as a checklist, nor does it provide answers to all the challenges of DAA. The guidance allows a UAS operator to determine and apply a suitable means of mitigation to reduce the risk of a mid-air collision to an acceptable level. This guidance does not contain prescriptive requirements, but rather objectives to be met at various levels of robustness.

D.2 Principles

The mitigation of the risk that an encounter develops into a mid-air collision is a highly dynamic, variable, and complicated process. To simplify the process, the air-risk model takes a more qualitative approach to arrive at an initial aggregated airspace risk assessment. After an assessment of the initial, unmitigated risk of an encounter, and optional application of strategic mitigations, this Annex assigns a performance requirement on the UAS operation to mitigate the remaining collision hazard (i.e. the residual airspace risk).

D.3 Scope, assumptions and definitions

See Annex C for the scope and assumptions

D.4 Knowledge of terms and definitions

To understand this section, the following SORA definitions need to be understood:

(a) atypical/segregated vs other airspace;

(b) AEC (see Annex C);

(c) initial ARC (see Annex C);

(d) residual ARC (see Annex C);

(e) ICAO conflict management (see ICAO Doc 9854, Section 2.7);

(f) strategic mitigation (see Annex C);

(g) tactical mitigations and feedback loops; and

(h) VLOS and BVLOS.

D.5 TMPR assignment

A tactical mitigation is a mitigation applied after take-off, and for the air risk model, it takes the form of a 'mitigating feedback loop'. This feedback loop is dynamic in that it reduces the rate of collision by modifying the geometry and dynamics of the aircraft in conflict, based on real-time aircraft conflict information.

SORA tactical mitigations are applied to cover the gap between the residual risk of an encounter (the residual ARC) and the airspace safety objectives. The residual risk is the remaining collision risk after all strategic mitigations are applied.

D.5.1 Two classifications of tactical mitigation

There are two classifications of tactical mitigations within the SORA, namely:

(a) VLOS, whereby a pilot and/or observer uses (use) human vision to detect aircraft and take action to remain well clear from and avoid collisions with other aircraft.

(b) BVLOS, whereby an alternate means of mitigation to human vision, as in machine or machine assistance[1], is applied to remain well clear from and avoid collisions with other aircraft (e.g. ATC separation services, TCAS, DAA, U-space, etc.).

D.5.2 TMPR using VLOS

Originally the regulations for 'see and avoid' and 'avoid collisions', defined in point SERA.3201 of the SERA Regulation, assumed that a pilot was on board the aircraft. With UA, this assumption is no longer valid, as the aircraft is piloted remotely.

Under VLOS, the pilot/UAS operator accomplishes 'see and avoid' by keeping the UAS within their VLOS. The UAS remains close enough to the remote pilot/observer to allow them to see and avoid another aircraft with human vision unaided by any device other than, perhaps, corrective lenses. VLOS is generally considered an acceptable means of compliance with the 'remain well clear from' and 'avoiding collisions' requirements of point SERA.3201 of the SERA Regulation.

VLOS generally provides sufficient mitigation for cases where the requirements for tactical mitigations are low, medium, and high. Different states may have other rules and restrictions for VLOS operations (e.g. altitudes, horizontal distances, times for relaying critical flight information, UAS operator/observer training, etc.). In some situations, the competent authority may decide that VLOS does not provide sufficient mitigation for the airspace risk, and may require compliance with additional rules and/or requirements. It is the UAS operators' responsibility to comply with these rules and requirements.

The UAS operator should produce a documented VLOS de-confliction scheme, explaining the methods that will be applied for detection and the criteria used to avoid incoming traffic. If the remote pilot relies on detection by observers, the use of communication phraseology, procedures, and protocols should be described. Since the VLOS operation may be sufficiently complex, a requirement to document and approve the VLOS strategy is necessary before approval by the competent authority.

The use of VLOS as a mitigation does not exempt the UAS operator from performing the full SORA risk analysis.

[1] For the purposes of this dissection, systems like ATC separation services would be considered to be machine assisted.

D.5.3 TMPR using BVLOS

Since VLOS has operational limitations, there was a concerted effort to find an alternate means of compliance with the human 'see and avoid' requirements. This alternate means of mitigation is loosely described as 'detect and avoid (DAA)'. DAA can be achieved in several ways, e.g. through ground-based DAA systems, air-based DAA systems, or some combination of the two. DAA may incorporate the use of various sensors, architectures, and even involve many different systems, a human in the loop, on the loop, or no human involvement at all.

TMPR provides tactical mitigations to assist the pilot in detecting and avoiding traffic under BVLOS conditions. The TMPR is the amount of tactical mitigation required to further mitigate the risks that could not be mitigated through strategic mitigation (the residual risk). The amount of residual risk is dependent on the ARC. Hence, the higher the ARC, the greater the residual risk, and the greater the TMPR.

Since the TMPR is the total performance required by all tactical mitigation means, tactical mitigations may be combined. When combining multiple tactical mitigations, it is important to recognise that the mitigation means may interact with each other, depending on the level of interdependency. This may negatively affect the effectiveness of the overall mitigation. Care should be exercised not to underestimate the negative effects of interactions between mitigation systems. Regardless of whether mitigations or systems are dependent or independent, when they act on the same event, unintended consequences may occur.

D.5.3.1 TMPR assignment risk ratio

The SORA TMPR is based on the findings of several studies. These studies provide performance guidance using risk ratios. Table shows the SORA TMPR risk ratio requirements derived from those studies.

Air-Risk Class	TMPR	TMPR system risk ratio objectives
ARC-d	**high performance**	**system risk ratio ≤ 0.1**
ARC-c	medium performance	system risk ratio ≤ 0.33
ARC-b	low performance	system risk ratio ≤ 0.66
ARC-a	No performance requirement	No system risk ratio guidance; although the UAS operator/applicant may still need to show some form of mitigation as deemed necessary by the competent authority

Table D.1 — TMPR risk ration requirements table

Table provides TMPR qualitative criteria as a qualitative means of compliance to help UAS operators translate the risk ratio quantitative values found in Table D.1 into system qualitative functional requirements. Table D.3 provides guidance for the TMPR integrity and assurance objectives for compliance with the objectives of Table C.1.

For the purpose of this assessment, the objectives of Table D.1 take precedence over the guidance provided in Tables D.2 and D.3.

D.5.3.2 TMPR qualitative criterion table

Table D.2, below, shows more qualitative criteria for the different functions and levels of the TMPR. The qualitative criteria are divided into five sub-functions of DAA, namely: detect, decide, command, execute, and the feedback loop. Where reference is made to the detection of a percentage of all aircraft, this should be read as a detection rate of the overall mix of aircraft anticipated to be encountered in the detection volume, and not limited to the detection of just the subset of aircraft in the mix.

	Function	TMPR Level				
		VLOS	No Requirement (ARC-a)	Low (ARC-b)	Medium (ARC-c)	**High (ARC-d)**
Tactical mitigation performance requirements (TMPR)	Detect[1]	No Requirement	No Requirement	The expectation is for the applicant's DAA Plan to enable the operator to detect approximately 50 % of all aircraft in the detection volume[2]. This is the performance requirement in the absence of failures and defaults. It is required that the applicant has awareness of most of the traffic operating in the area in which the operator intends to fly, by relying on one or more of the following: • Use of (web-based) real time aircraft tracking services • Use Low Cost ADS-B In /UAT/FLARM[3]/Pilot Aware[3] aircraft trackers • Use of UTM/U-space Dynamic Geofencing[4] • Monitoring aeronautical radio communications (e.g. use of a scanner)[5]	The expectation is for the applicant's DAA Plan to enable the operator to detect approximately 90 % of all aircraft in the detection volume[2]. To accomplish this, the applicant will have to rely on one or a combination of the following systems or services: • Ground based DAA /RADAR • FLARM [3/6] • Pilot Aware [3/6] • ADS-B In/ UAT In Receiver[6] • ATC Separation Services[7] • UTM/U-space Surveillance Service[4] • UTM/U-space Early Conflict Detection and Resolution Service[4] • Active communication with ATC and other airspace users[5]. The operator provides an assessment of the effectiveness of the detection tools/methods chosen.	A system meeting RTCA SC-228 or EUROCAE WG-105 MOPS/MASPS (or similar) and installed in accordance with applicable requirements.

[1]For an in-depth understanding of the derivation, please see Annex G. Detection should be done with adequate precision for the avoidance manoeuvre to be effective.

[2]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 DAA system can performance all the DAA 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 detection volume is proportionally larger than the alerting threshold.

[3]FLARM and PilotAware are commercially available (trademarked) products/brands. They are referenced here only as example technologies. The references do not imply an endorsement by the approval authority for the use of these products. Other products offering similar functions may also be used.

[4]These refer to possible future applications of automated traffic management systems for unmanned aircraft in an UTM/U-space environment. These applications may not exist as such today.

[5]If permitted by the authority. May require a Radio-License or Permit.

[6]The selection of systems to aid in electronic detection of traffic should be made considering the average equipment of the majority of aircraft operating in the area. For example: in areas where many gliders are known to operate, the use of FLARM or similar systems should be considered whereas for operations in the vicinity of large commercially operated aircraft, ADS-B IN is probably more appropriate. These refer to possible future applications of automated traffic management systems for unmanned aircraft in an UTM/U-space environment. These applications may not exist as such today. A subscription to these services may be required.

[7]The selection of systems to aid in electronic detection of traffic should be made considering the average equipment of the majority of aircraft operating in the area.

	Function	TMPR Level				
		VLOS	No Requirement (ARC-a)	Low (ARC-b)	Medium (ARC-c)	**High (ARC-d)**
Tactical mitigation performance requirements (TMPR)	Decide	No Requirement	No Requirement	The UAS operator should have a documented de-confliction scheme, in which the UAS operator explains which tools or methods will be used for detection and what the criteria are that will be applied for the decision to avoid incoming traffic. In case the remote pilot relies on detection by someone else, the use of phraseology will have to be described as well. Examples: • The operator will initiate a rapid descend if traffic is crossing an alert boundary and operating at less than 1000ft. • The observer monitoring traffic uses the phrase: 'DESCEND!, DESCEND!, DESCEND!'.	All requirements of ARC-b and in addition: 1. The operator provides an assessment of the human/machine interface factors that may affect the remote pilot's ability to make a timely and appropriate decision. 2. The UAS operator provides an assessment of the effectiveness of the tools and methods utilised for the timely detection and avoidance of traffic. In this context timely is defined as enabling the remote pilot to decide within 5 seconds after the indication of incoming traffic is provided. The UAS operator provides an assessment of the failure rate or availability of any tool or service the UAS operator intends to use.	A system meeting RTCA SC-228 or EUROCAE WG-105 MOPS/MASPS (or similar) and installed in accordance with applicable requirements.

	Function	TMPR Level				
		VLOS	No Requirement (ARC-a)	Low (ARC-b)	Medium (ARC-c)	**High (ARC-d)**
Tactical mitigation performance requirements (TMPR)	Command	No Requirement	No Requirement	The latency of the whole command (C2) link, i.e. the time between the moment that the remote pilot gives the command and the airplane executes the command should not exceed 5 seconds.	The latency of the whole command (C2) link, i.e. the time between the moment that the remote pilot gives the command and the airplane executes the command should not exceed 3 seconds.	A system meeting RTCA SC-228 or EUROCAE WG-105 MOPS/MASPS (or similar) and installed in accordance with applicable requirements.

	Function	TMPR Level				
		VLOS	No Requirement (ARC-a)	Low (ARC-b)	Medium (ARC-c)	**High (ARC-d)**
Tactical mitigation performance requirements (TMPR)	Execute	No Requirement	No Requirement	UAS descending to an altitude not higher than the nearest trees, buildings or infrastructure or ≤ 60 feet AGL is considered sufficient. The aircraft should be able to descend from its operating altitude to the 'safe altitude' in less than a minute.	Avoidance may rely on vertical and horizontal avoidance manoeuvring and is defined in standard procedures. Where horizontal manoeuvring is applied, the aircraft shall be demonstrated to have adequate performance, such as airspeed, acceleration rates, climb/descend rates and turn rates. The following are suggested minimum performance criteria:[10] • Airspeed: ≥ 50 knots • Rate of climb/descend: ≥ 500 ft/min • Turn rate: ≥ 3 degrees per second	A system meeting RTCA SC-228 or EUROCAE WG-105 MOPS/MASPS (or similar) and installed in accordance with applicable requirements.

[10] Low End Performance Representative (LEPR) performance requirments for RTCA SC-228 Study 5

	Function	TMPR Level				
		VLOS	No Requirement (ARC-a)	Low (ARC-b)	Medium (ARC-c)	High (ARC-d)
Tactical mitigation performance requirements (TMPR)	Feedback Loop	No Requirement	No Requirement	Where electronic means assist the remote pilot in detecting traffic, the information is provided with a latency and update rate for intruder data (e.g. position, speed, altitude, track) that support the decision criteria. For an assumed 3 NM threshold, a 5 second update rate and a latency of 10 seconds is considered adequate (see example below).	The information is provided to the remote pilot with a latency and update rate that support the decision criteria. The applicant provides an assessment of the aggravated closure rates considering traffic that could reasonably be expected to operate in the area, traffic information update rate and latency, C2 Link latency, aircraft manoeuvrability and performance and sets the detection thresholds accordingly. The following are suggested minimum criteria: • Intruder and ownship vector data update rates: ≤ 3 seconds.	A system meeting RTCA SC-228 or EUROCAE WG-105 MOPS/MASPS (or similar) and installed in accordance with applicable airworthiness requirements.

Table D.2 — TMPR qualitative criteria table

D.5.3.3 Effects of aircraft equipment on tactical system performance

The performance of a tactical mitigation is affected by the equipment of both the UAS and threat aircraft, on an encounter-by-encounter basis. A tactical mitigation mitigates the encounter risk by using a set of sub-functions of the DAA routine, namely see/detect, decide, command, execute, and feedback loop. Equipment that aids these sub-functions increases the overall performance of the tactical mitigation system.

The following example illustrates how the equipment of both the UAS and threat aircraft affects the overall tactical performance. Given a threat aircraft equipped with a transponder, it is easier for other aircraft to detect and track the threat aircraft. In this case, the UAS can be equipped with a system that is able to detect and track transponders. However, a UAS that mitigates the risk by locating the threat aircraft by detecting their transponder (e.g. through ACAS-II V. 7.1) cannot use the same approach to mitigate the risks posed by an aircraft without a transponder.

Tactical mitigation equipment is not homogeneous within the airspace. Different classes of airspace have different mixes of equipment. General aviation aircraft tend to be less well-equipped than commercial aircraft. There will be differences in the mix of general aviation/commercial aircraft from one location/airspace to another. Based on the aircraft equipment, a specific tactical system (e.g. FLARM, ACAS, etc.) could mitigate the risk of a collision in some classes of airspace and not in others.

Therefore, the UAS operator needs to understand the effectiveness of their tactical mitigation systems within the context of the airspace in which they intend to operate, and select systems used for tactical mitigation accordingly. A TCAS II 7.1/ACAS-II equipped UAS will not mitigate all the encounter risks in an area where sailplanes equipped with FLARM are known to operate.

D.5.4. TMPR robustness (integrity and assurance) assignment

Table D.3, below, lists the recommended requirements to comply with the TMPR integrity and assurance assignment.

		TMPR: N/A (ARC-a)	TMPR: Low (ARC-b)	TMPR: Medium (ARC-c)	TMPR: High (ARC-d)
Level of integrity	Criteria	Allowable loss of function and performance of the Tactical Mitigation System: < 1 per 100 Flight Hours (1E-2 Loss/FH)	Allowable loss of function and performance of the Tactical Mitigation System: < 1 per 100 Flight Hours (1E-2 Loss/FH)	Allowable loss of function and performance of the Tactical Mitigation System: < 1 per 1 000 Flight Hours (1E-3 Loss/FH)	Allowable loss of function and performance of the Tactical Mitigation System: < 1 per 100 000 Flight Hours (1E-5 Loss/FH)
	Comments / Notes	*The requirement is considered to be met by commercially available products. No quantitative analysis is required.*	*The requirement is considered to be met by commercially available products. No quantitative analysis is required.*	*This rate is commensurate with a probable failure condition. These failure conditions are anticipated to occur one or more times during the entire operational life of each aircraft.*	*A quantitative analysis is required.*
		TMPR: N/A (ARC-a)	**TMPR: Low (ARC-b)**	**TMPR: Medium (ARC-c)**	**TMPR: High (ARC-d)**
Level of assurance	Criteria	N/A	The operator declares that the tactical mitigation system and procedures will mitigate the risk of collisions with manned aircraft to an acceptable level.	The operator provides evidence that the tactical mitigation system will mitigate the risk of collisions with manned aircraft to an acceptable level.	The evidence that the tactical mitigation system will mitigate the risk of collisions with manned aircraft to an acceptable level is verified by a competent third party.
	Comments / Notes	*N/A*	*N/A*	*N/A*	*N/A*

Table D.3 — TMPR integrity and assurance objectives

D.6 Maintenance and continued airworthiness

The DAA maintenance and continued airworthiness requirements are addressed in the SAIL requirements; please refer to Annex E.

Annex E to AMC1 to Article 11

ED Decision 2023/012/R

INTEGRITY AND ASSURANCE LEVELS FOR THE OPERATIONAL SAFETY OBJECTIVES (OSOs)

E.1 How to use SORA Annex E

The following Table E.1 provides the basic principles to consider when using SORA Annex E.

	Principle description	Additional information
#1	Annex E provides assessment criteria for the integrity (i.e. safety gain) and assurance (i.e. method of proof) of OSOs proposed by an applicant.	The identification of OSOs for a given operation is the responsibility of the applicant.
#2	Annex E does not cover the LoI of the competent authority. LoI is based on the competent authority's assessment of the applicant's ability to perform the given operation.	
#3	To achieve a given level of integrity/assurance, when more than one criterion exists for that level of integrity/assurance, all applicable criteria need to be met.	
#4	'Optional' cases defined in SORA main body Table 6 do not need to be defined in terms of integrity and assurance levels in Annex E.	All robustness levels are acceptable for OSOs for which an 'optional' level of robustness is defined in Table 6 'Recommended OSOs' of the SORA main body.
#5	When the criteria to assess the level of integrity or assurance of an OSO rely on 'standards' that are not yet available, the OSO needs to be developed in a manner acceptable to the competent authority.	
#6	Annex E intentionally uses non-prescriptive terms (e.g. suitable, reasonably practicable) to provide flexibility to both the applicant and the competent authorities. This does not constrain the applicant in proposing mitigations, nor the competent authority in evaluating what is needed on a case-by-case basis.	
#7	This annex in its entirety also applies to single-person organisations.	

Table E.1 – Basic principles to consider when using SORA Annex E

E.2 OSOs related to technical issues with the UAS

OSO #01 — Ensure that the UAS operator is competent and/or proven

TECHNICAL ISSUE WITH THE UAS		Level of integrity		
		Low	**Medium**	**High**
OSO #01 Ensure that the UAS operator is competent and/or proven	Criteria	The applicant is knowledgeable of the UAS being used and as a minimum has the following relevant operational procedures: checklists, maintenance, training, responsibilities, and associated duties.	Same as low. In addition, the applicant has an organisation appropriate[1] for the intended operation. Also, the applicant has a method to identify, assess, and mitigate the risks associated with flight operations. These should be consistent with the nature and extent of the operations specified.	Same as medium.
	Comments	*N/A*	*[1] For the purpose of this assessment, 'appropriate' should be interpreted as commensurate with/proportionate to the size of the organisation and the complexity of the operation.*	*N/A*

TECHNICAL ISSUE WITH THE UAS		Level of assurance		
		Low	**Medium**	**High**
OSO #01 Ensure that the UAS operator is competent and/or proven	Criteria	The elements delineated in the level of integrity are addressed in the ConOps.	Prior to the first operation, the competent authority of the MS or an entity that is designated by the competent authority performs an audit of the organisation.	The applicant holds an organisational operating certificate (e.g LUC) or has a recognised flight test organisation. In addition, the competent authority of the MS or an entity that is designated by the competent authority verifies the UAS operator's competencies.
	Comments	*N/A*	*N/A*	*N/A*

OSO #02 — UAS designed and produced by a competent and/or proven entity

TECHNICAL ISSUE WITH THE UAS		Level of integrity		
		Low	**Medium**	**High**
OSO #02 UAS designed and produced by a competent and/or proven entity	Criteria for design	As a minimum, design documentation covers: (a) the specification of the materials; and (b) the suitability and durability of the materials used.	Same as low. In addition, design documentation also covers: (a) the configuration control; and (b) identification and traceability.	The design organisation complies with Subpart J of Annex I (Part 21) to Regulation (EU) No 748/2012.
	Criteria for production	As a minimum,production procedures cover the processes necessary to allow for repeatability in manufacturing, and conformity within acceptable tolerances.	Same as low. In addition, production procedures also cover: (a) the configuration control; (b) the verification of incoming products, parts, materials, and equipment; (c) identification and traceability; (d) in-process and final inspections & testing; (e) the control and calibration of tools; (f) handling and storage; and (g) the control of non-conforming items.	The production organisation complies with the organisational requirements that are defined in Subpart F or G of Annex I (Part 21) to Regulation (EU) No 748/2012.
	Comments	*N/A*	*N/A*	*N/A*

TECHNICAL ISSUE WITH THE UAS		Level of assurance		
		Low	**Medium**	**High**
OSO #02 UAS designed and produced by a competent and/or proven entity	Criteria for design	The specifications, suitability and durability of the materials are declared against a standard recognised by the competent authority and/or in accordance with means of compliance acceptable to the competent authority.	Same as low. In addition, evidence is available that the UAS has been designed in accordance with design procedures. The competent authority should request the applicant to use a UAS for which EASA	Same as medium. In addition, the competent authority should request the applicant to operate a UAS designed by an organisation approved by EASA according to Subpart J of Annex I

			has verified the claimed integrity through a DVR.	(Part 21) to Regulation (EU) No 748/2012.
	Criteria for production	The declared production procedures are developed to a standard that is considered adequate by the competent authority that issues the operational authorisation and/or in accordance with a means of compliance acceptable to that authority.	Same as low. In addition, evidence is available that the UAS has been produced in conformance with its design.	Same as medium. In addition~~:~~, the competent authority of the MS or an entity that is designated by the competent authority validates compliance with the production organisational requirements that are defined in Subpart F or G of Annex I (Part 21) to Regulation (EU) No 748/2012.
	Comments	*N/A*	*N/A*	*N/A*

OSO #03 — UAS maintained by competent and/or proven entity

TECHNICAL ISSUE WITH THE UAS		**Level of integrity**		
		Low	**Medium**	**High**
OSO #03 UAS maintained by a competent and/or proven entity (e.g. industry standards)	Criteria	(a) The UAS maintenance instructions are defined, and, when applicable, cover the UAS designer's instructions and requirements. (b) The maintenance staff is competent and has received an authorisation to carry out UAS maintenance. (c) The maintenance staff use the UAS maintenance instructions while performing maintenance.	Same as low. In addition: (a) Scheduled maintenance of each UAS is organised and in accordance with a maintenance programme. (b) Upon completion, the maintenance log system is used to record all the maintenance conducted on the UAS, including releases. A maintenance release can only be accomplished by a staff member who has received a maintenance release authorisation for that particular UAS model/family.	Same as medium. In addition, the maintenance staff work in accordance with a maintenance procedure manual that provides information and procedures relevant to the maintenance facility, records, maintenance instructions, release, tools, material, components, defect deferral, etc.
	Comments	*N/A*	*N/A*	*N/A*

TECHNICAL ISSUE WITH THE UAS		Level of assurance		
		Low	**Medium**	**High**
OSO #03 UAS maintained by a competent and/or proven entity (e.g. industry standards)	Criterion #1 (Procedure)	(a) The maintenance instructions are documented. (b) The maintenance conducted on the UAS is recorded in a maintenance log system[1/2]. (c) A list of the maintenance staff authorised to carry out maintenance is established and kept up to date.	Same as low. In addition: (a) The maintenance programme is developed in accordance with standards considered adequate by the competent authority of the MS and/or in accordance with a means of compliance acceptable to that authority. In addition, if the UAS has a DVR or a (R)TC, the maintenance programme includes the scheduled maintenance requirements developed as part of the design. (b) A list of the maintenance staff with maintenance release authorisation is established and kept up to date.	Same as medium. In addition, the maintenance programme and the maintenance procedures manual are validated by the competent authority of the MS or by an entity that is designated by the competent authority.
	Comments	*[1] The objective is to record all the maintenance performed on the aircraft, and why it is performed (rectification of defects or malfunctions, modifications, scheduled maintenance, etc.).* *[2] The maintenance log may be requested for inspection/audit by the approving authority or an authorised representative.*	*N/A*	*N/A*
	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.	Same as low. In addition: (a) The initial training syllabus and training standard, including theoretical/practical elements, duration, etc., is defined and is commensurate with the authorisation held by the maintenance staff. (b) For staff that hold a maintenance release authorisation, the initial training is specific to that particular UAS model/family. (c) All maintenance staff have undergone initial training.	Same as medium. In addition: (a) A programme for the recurrent training of staff holding a maintenance release authorisation is established; and (b) This programme is validated by the competent authority of the MS or by an entity that is designated by the competent authority.
	Comments	*N/A*	*N/A*	*N/A*

OSO #04 — UAS developed to authority recognised design standards

TECHNICAL ISSUE WITH THE UAS		**Level of integrity**		
		Low	**Medium**	**High**
OSO #04 UAS developed to authority recognised design standards	Criteria	The UAS is designed to standards considered adequate by the competent authority and/or in accordance with a means of compliance acceptable to that authority. The standards and/or the means of compliance should be applicable to a low level of integrity and the intended operation.	The UAS is designed to standards considered adequate by the competent authority and/or in accordance with a means of compliance acceptable to that authority. The standards and/or the means of compliance should be applicable to a medium level of integrity and the intended operation.	The UAS is designed to standards considered adequate by the competent authority and/or in accordance with a means of compliance acceptable to that authority. The standards and/or the means of compliance should be applicable to a high level of integrity and the intended operation.
	Comments	*In case of experimental flights that investigate new technical solutions, the competent authority may accept that recognised standards are not met.*		

TECHNICAL ISSUE WITH THE UAS		**Level of assurance**		
		Low	**Medium**	**High**
OSO #04 UAS developed to authority recognised design standards	Criteria	The competent authority should request the applicant to use a UAS for which EASA has verified the claimed integrity through a DVR.	The competent authority should request the applicant to use a UAS for which EASA has issued a type certificate or restricted type certificate in accordance with Annex I (Part 21) to Regulation (EU) No 748/2012	The competent authority should request the applicant to use a UAS for which EASA has issued a type certificate or restricted type certificate in accordance with Annex I (Part 21) to Regulation (EU) No 748/2012
	Comments	*N/A*	*N/A*	*N/A*

OSO #05 — UAS is designed considering system safety and reliability

This OSO complements:

(a) the safety requirements for containment defined in the main body; and

(b) OSO #10 and OSO #12, which only address the risk of a fatality while operating over populated areas or assemblies of people.

TECHNICAL ISSUE WITH THE UAS		Level of integrity		
		Low	Medium	High
OSO #05 UAS is designed considering system safety and reliability	Criteria	The equipment, systems, and installations are designed to minimise hazards[1] in the event of a probable[2] malfunction or failure of the UAS.	Same as low. In addition, the strategy for detection, alerting and management of any malfunction, failure or combination thereof, which would lead to a hazard, is available.	Same as medium. In addition: (a) Major failure conditions are not more frequent than remote[3]; (b) Hazardous failure conditions are not more frequent than extremely remote[3]; (c) Catastrophic failure conditions are not more frequent than extremely improbable[3]; and (d) SW and AEH whose development error(s) may cause or contribute to hazardous or catastrophic failure conditions are developed to an industry standard or a methodology considered adequate by EASA and/or in accordance with means of compliance acceptable to EASA[4].
	Comments	*[1] For the purpose of this assessment, the term 'hazard' should be interpreted as a failure condition that relates to major, hazardous, or catastrophic consequences.* *[2] For the purpose of this assessment, the term 'probable' should be interpreted in a qualitative way as 'anticipated to occur one or more times during the entire system/operational life of a UAS'.*	*N/A*	*[3] Safety objectives may be derived from JARUS AMC RPAS.1309 Issue 2 Table 3 depending on the kinetic energy assessment made in accordance with Section 6 of EASA policy E.Y013-01.* *[4] Development assurance levels (DALs) for SW/AEH may be derived from JARUS AMC RPAS.1309 Issue 2 Table 3 depending on the kinetic energy assessment made in accordance with Section 6 of EASA policy E.Y013-01.*

TECHNICAL ISSUE WITH THE UAS		Level of assurance		
		Low	Medium	High
OSO #05 UAS is designed considering system safety and reliability	Criteria	A functional hazard assessment[1] and a design and installation appraisal that show that hazards are minimised, are available.	Same as low. In addition: (a) Safety analyses are conducted in line with standards considered adequate by the competent authority and/or in accordance with a means of compliance acceptable to that authority. (b) A strategy for the detection of single failures of concern includes pre-flight checks.	The competent authority should request the applicant to use a UAS for which EASA has issued a type certificate or restricted type certificate in accordance with Annex I (Part

TECHNICAL ISSUE WITH THE UAS		Level of assurance		
		Low	**Medium**	**High**
			The competent authority should request the applicant to use a UAS for which EASA has validated the claimed integrity through a DVR.	21) to Regulation (EU) No 748/2012.
	Comments	*[1] The severity of failure conditions (no safety effect, minor, major, hazardous and catastrophic) should be determined according to the definitions provided in JARUS AMC RPAS.1309 Issue 2.*	*N/A*	*N/A*

OSO #06 — C3 link characteristics (e.g. performance, spectrum use) are appropriate for the operation

(a) For the purpose of the SORA and this specific OSO, the term 'C3 link' encompasses:

(1) the C2 link; and

(2) any communication link required for the safety of the flight.

(b) To correctly assess the integrity of this OSO, the applicant should identify the following:

(1) The performance requirements for the C3 links necessary for the intended operation.

(2) All the C3 links, together with their actual performance and RF spectrum usage.

Note: The specification of the performance and RF spectrum for a C2 Link is typically documented by the UAS designer in the UAS manual.

Note: The main parameters associated with the performance of a C2 link (RLP) and the performance parameters for other communication links (e.g. RCP for communication with ATC) include, but are not limited to, the following:

(i) the transaction expiration time;

(ii) the availability;

(iii) the continuity; and

(iv) the integrity.

Refer to the ICAO references for definitions.

(3) The RF spectrum usage requirements for the intended operation (including the need for authorisation if required).

Note: Usually, countries publish the allocation of RF spectrum bands applicable in their territories. This allocation stems mostly from the International Communication Union (ITU) Radio Regulations. However, the applicant should check the local requirements and request authorisation when needed since there may be national differences and specific allocations (e.g. national sub-divisions of ITU allocations). Some aeronautical bands (e.g. AM(R)S, AMS(R)S 5030-5091MHz) were allocated for potential use in UAS operations under the ICAO scope for UAS operations classified as cat. C ('certified'), but their use may be authorised for operations under the 'specific' category. It is expected that the use of other licensed bands (e.g. those allocated to mobile networks) may also be authorised under the 'specific' category. Some un-licensed bands (e.g. industrial, scientific and medical (ISM) or short-range devices (SRDs)) may also be acceptable under the 'specific' category; for instance, for operations with lower integrity requirements.

(4) Environmental conditions that might affect the performance of C3 links.

TECHNICAL ISSUE WITH THE UAS		**Level of integrity**		
		Low	**Medium**	**High**
OSO #06 C3 link characteristics (e.g. performance, spectrum use) are appropriate for the operation	Criteria	(a) The applicant determines that the performance, RF spectrum usage[1] and environmental conditions for C3 links are adequate to safely conduct the intended operation. (b) The remote pilot has the means to continuously monitor the C3 performance and ensures that the performance continues to meet the operational requirements[2].	Same as low[3].	Same as low. In addition, the use of licensed[4] frequency bands for C2 Links is required.
	Comments	*[1] For a low level of integrity, unlicensed frequency bands might be acceptable under certain conditions, e.g.:* *(a) 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* *(b) the use of mechanisms to protect against interference (e.g. FHSS, frequency de-confliction by procedure).*	*[3] Depending on the operation, the use of licensed frequency bands might be necessary. In some cases, the use of non-aeronautical bands (e.g. licensed bands for cellular network) may be acceptable.*	*[4] This ensures a minimum level of performance and is not limited to aeronautical licensed frequency bands (e.g. licensed bands for cellular network). Nevertheless, some operations may require the use of bands allocated to the aeronautical mobile service for the use of C2 Link (e.g. 5030 – 5091 MHz).* *In any case, the use of licensed frequency bands needs authorisation.*

TECHNICAL ISSUE WITH THE UAS		Level of integrity		
		Low	Medium	High
		[2] *The remote pilot has continual and timely access to the relevant C3 information that could affect the safety of flight. For operations requesting only 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 strength becomes too low.*		

TECHNICAL ISSUE WITH THE UAS		Level of assurance		
		Low	Medium	High
OSO #06 C3 link characteristics (e.g. performance, spectrum use) are appropriate for the operation	Criteria	The applicant declares that the required level of integrity has been achieved.	The competent authority should request the applicant to use a UAS for which EASA has verified the claimed integrity through a DVR.	The competent authority should request the applicant to use a UAS for which EASA has issued a type certificate or restricted type certificate in accordance with Annex I (Part 21) to Regulation (EU) No 748/2012.
	Comments	*N/A*	*N/A*	*N/A*

OSO #07 — Inspection of the UAS (product inspection) to ensure consistency with the ConOps

The intent of this OSO is to ensure that the UAS used for the operation conforms to the UAS data used to support the approval/authorisation of the operation.

TECHNICAL ISSUE WITH THE UAS		Level of integrity		
		Low	Medium	High
OSO #07 Inspection of the UAS (product inspection) to ensure consistency with the ConOps	Criteria	The remote crew ensures that the UAS is in a condition for safe operation and conforms to the approved ConOps.[1]		
	Comments	[1] *The distinction between a low, a medium and a high level of robustness for this criterion is achieved through the level of assurance (see the table below).*		

TECHNICAL ISSUE WITH THE UAS		Level of assurance		
		Low	**Medium**	**High**
OSO #07 Inspection of the UAS (product inspection) to ensure consistency with the ConOps	Criterion #1 (Procedures)	Product inspection is documented and accounts for the manufacturer's recommendations, if available.	Same as low. In addition, the product inspection is documented using checklists.	Same as medium. In addition, the product inspection procedures are validated by the competent authority of the MS or by an entity that is designated by the competent authority.
	Comments	*N/A*	*N/A*	*N/A*
	Criterion #2 (Training)	The remote crew is trained to perform the product inspection, and that training is self-declared (with evidence available).	(a) A training syllabus including a product inspection procedure is available. (b) The UAS operator provides competency-based, theoretical and practical training.	The competent authority of the MS or an entity that is designated by the competent authority: (a) validates the training syllabus; and (b) verifies the remote crew competencies.
	Comments	*N/A*	*N/A*	*N/A*

E.3 OSOs related to operational procedures

OPERATIONAL PROCEDURES		Level of integrity		
		Low	**Medium**	**High**
OSO #08, OSO #11, OSO #14 and OSO #21	Criterion #1 (Procedure definition)	(a) Operational procedures[1] appropriate for the proposed operation are defined and, as a minimum, cover the following elements: (1) Flight planning; (2) Pre- and post-flight inspections; (3) Procedures to evaluate the environmental conditions before and during the mission (i.e. real-time evaluation); (4) Procedures to cope with unexpected adverse operating conditions (e.g. when ice is encountered during an operation not approved for icing conditions); (5) Normal procedures; (6) Contingency procedures (to cope with abnormal situations); (7) Emergency procedures (to cope with emergency situations); (8) Occurrence-reporting procedures; and (b) The limitations of the external systems supporting the UAS operation[2] are defined in an OM.		
	Comments	*[1] Operational procedures cover the deterioration of the UAS itself and any external system supporting the UAS operation.* *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, GDOP/PDOP, 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 ; and* *(d) describe the procedure(s) used when deterioration is detected (e.g. activation of the emergency recovery capability, switch to manual control, etc.).* *[2] In the scope of this assessment, external systems supporting the UAS operation are defined as systems that are not already part of the UAS but are used to:* *(a) launch/take off the UA;* *(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.*		
	Criterion #2 (Procedure complexity)	Operational procedures are complex and may potentially jeopardise the crew's ability to respond by increasing the remote crew's workload and/or their interaction with other entities (e.g. ATM, etc.).	Contingency/emergency procedures require manual control by the remote pilot[2] when the UAS is usually automatically controlled.	Operational procedures are simple.

OPERATIONAL PROCEDURES		Level of integrity		
		Low	**Medium**	**High**
	Comments	*N/A*	*[2] It should be considered that not all UAS have a mode where the pilot could directly control the surfaces; moreover, it may require significant skill not to make things worse.*	*N/A*
	Criterion #3 (Consideration of Potential Human Error)	At a minimum, operational procedures provide: (a) a clear distribution and assignment of tasks, and (b) an internal checklist to ensure staff are adequately performing their assigned tasks.	Operational procedures take human error into consideration.	Same as medium. In addition, the remote crew[3] receives crew resource management (CRM)[4] training.
	Comments	*N/A*	*N/A*	*[3] In the context of SORA, the term 'remote crew' refers to any person involved in the mission.* *[4] CRM training focuses on the effective use of all the remote crew to ensure safe and efficient operation, reducing error, avoiding stress and increasing efficiency.*

OPERATIONAL PROCEDURES		Level of assurance		
		Low	**Medium**	**High**
OSO #08, OSO #11, OSO #14 and OSO #21	Criteria	(a) Operational procedures do not require validation against either a standard or a means of compliance that is considered adequate by the competent authority of the MS. (b) The adequacy of the operational procedures is declared, except for emergency procedures, which are tested.	(a) Normal, contingency, and emergency procedures are documented and part of the operations manual (OM). (b) Operational procedures are validated against standards considered adequate by the competent authority of the MS and/or in accordance with the means of compliance acceptable to that authority[1]. (c) The adequacy of the contingency and emergency procedures is proven through: (1) dedicated flight tests; or	Same as medium. In addition: (a) Flight tests performed to validate the procedures and checklists cover the complete flight envelope or are proven to be conservative. (b) The procedures, checklists, flight tests and simulations are validated by the competent authority of the MS or by an entity that is

			(2) simulation, provided that the representativeness of the simulation means is proven valid for the intended purpose with positive results; or (3) any ot+her means acceptable to the competent authority.	designated by the competent authority.
	Comments	*N/A*	*[1] AMC2 UAS.SPEC.030(3)(e) (Operational procedures for medium and high levels of robustness) is considered an acceptable means of compliance.*	

E.4 OSOs related to remote crew training

(a) The applicant needs to propose competency-based, theoretical and practical training that:

(1) is appropriate for the operation to be approved; and

(2) includes proficiency requirements and recurrent training.

(b) The entire remote crew (i.e. any person involved in the operation) should undergo competency-based, theoretical and practical training specific to their duties (e.g. pre-flight inspection, ground equipment handling, evaluation of the meteorological conditions, etc.).

REMOTE CREW COMPETENCIES		**Level of integrity**		
		Low	**Medium**	**High**
OSO #09, OSO #15 and OSO #22	Criteria	The competency-based, theoretical and practical training is adequate for the operation[1] and ensures knowledge of: (a) the UAS Regulation; (b) airspace operating principles; (c) airmanship and aviation safety; (d) human performance limitations; (e) meteorology; (f) navigation/charts; (g) the UAS; and (h) operating procedures.		
	Comments	*[1] The distinction between a low, a medium and a high level of robustness for this criterion is achieved through the level of assurance (see table below).*		

REMOTE CREW COMPETENCIES		Level of assurance		
		Low	**Medium**	**High**
OSO #09, OSO #15 and OSO #22	Criteria	Training is self-declared (with evidence available).	(a) Training syllabus is available and kept up to date. (b) The UAS operator provides competency-based, theoretical and practical training.	The competent authority of the MS or an entity that is designated by the competent authority: (a) validates the training syllabus; and (b) verifies the remote crew competencies.
	Comments	*N/A*	*N/A*	*N/A*

E.5 OSOs related to safe design

(a) The objectives of OSO#10 and OSO#12 are to complement the technical containment safety requirements by addressing the risk of a fatality while operating over populated areas or assemblies of people.

(b) In the scope of this assessment, external systems supporting UAS operations are defined as systems that are not already part of the UAS but are used to:

(1) launch/take off the UA;

(2) make pre-flight checks; or

(3) 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.

		LEVEL of INTEGRITY		
		Low	**Medium**	**High**
OSO #10 & OSO #12	Criteria	When operating over populated areas or assemblies 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.	When operating over populated areas or assemblies of people, it can be reasonably expected that a fatality will not occur from any single failure[3] of the UAS or any external system supporting the operation. SW and AEH whose development error(s) could directly lead to a failure affecting the operation in such a way that it can be reasonably expected that a fatality will occur, are developed to a standard considered adequate by the competent authority and/or in accordance with means of compliance acceptable to that authority.	Same as medium

	Comments	*[1] For the purpose of this assessment, the term 'probable' should be interpreted in a qualitative way as, 'anticipated to occur one or more times during the entire system/operational life of a UAS'.* *[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.*	*[3] Some structural or mechanical failures may be excluded from the no-single failure criterion if it can be shown that these mechanical parts were designed to a standard considered adequate by the competent authority and/or in accordance with a means of compliance acceptable to that authority*	

		LEVEL of ASSURANCE		
		Low	**Medium**	**High**
OSO #10 & OSO #12	Criteria	A design and installation appraisal is available. In particular, this appraisal shows that: (a) the design and installation features (independence, separation and redundancy) satisfy the low integrity criterion; and (b) particular risks relevant to the ConOps (e.g. hail, ice, snow, electromagnetic interference, etc.) do not violate the independence claims, if any.	Same as low. In addition, the level of integrity claimed is substantiated by analysis and/or test data with supporting evidence. If the operation is classified as SAIL IV, the competent authority should request the applicant to use a UAS for which EASA has verified the claimed integrity through a DVR.	The competent authority should request the applicant to use a UAS for which EASA has issued a type certificate or restricted type certificate in accordance with Annex I (Part 21) to Regulation (EU) No 748/2012.
	Comments	*N/A*	*N/A*	*N/A*

E.6 OSOs related to the deterioration of external systems supporting UAS operations

For the purpose of SORA and this specific OSO, the term 'external services supporting UAS operations' encompasses any service providers necessary for the safety of the flight, such as communication service providers (CSPs) and U-space service providers[1].

DETERIORATION OF EXTERNAL SYSTEMS SUPPORTING UAS OPERATIONS BEYOND THE CONTROL OF THE UAS		**Level of integrity**		
		Low	**Medium**	**High**
OSO #13 External services supporting UAS operations are adequate for the operation	Criteria	The applicant ensures that the level of performance for 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. Roles and responsibilities between the applicant and the external service provider are defined.		
	Comments	*N/A*	*N/A*	*Requirements for contracting services with the service provider may be derived from ICAO Standards and Recommended Practices (SARPs) that are currently under development.*

[1] External service should be understood as any service that is provided to the UAS operator, which is necessary to ensure the safety of a UAS operation and is provided by a service provider other than the UAS operator. Examples of external services are:

- provision of geographical zones data and geographical limitations (including orography);
- collection and transfer of occurrence data;
- training and assessment of remote pilots;
- communication services that support the C2 link and any other safety-related communication;
- services that support navigation, e.g. GNSS services (compliance with requirement UAS.STS-01.030(6) could be ensured by referring to the conditions of use of such services in the corresponding Service Definition Document (SDD) or an equivalent one if available.);
- provision of services related to flight planning and management, including related safety assessments; and
- U-space services, which are defined in the corresponding regulation(s) and may include one or more of the above-mentioned services.

DETERIORATION OF EXTERNAL SYSTEMS SUPPORTING UAS OPERATIONS BEYOND THE CONTROL OF THE UAS		Level of assurance		
		Low	**Medium**	**High**
OSO #13 External services supporting UAS operations are adequate for the operation	Criteria	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 being necessarily available).	The applicant has supporting evidence that the required level of performance for any externally provided service required for the safety of the flight can be achieved for the full duration of the mission. This may take the form of a service-level agreement (SLA) or any official commitment that prevails between a service provider and the applicant on the relevant aspects of the service (including quality, availability, and responsibilities). The applicant has a means to monitor externally provided services which affect flight-critical systems and take appropriate actions if real-time performance could lead to the loss of control of the operation.	Same as medium. In addition: (a) the evidence of the performance of an externally provided service is achieved through demonstrations; and (b) the competent authority of the MS or an entity that is designated by the competent authority validates the claimed level of integrity.
	Comments	*N/A*	*N/A*	*N/A*

E.7 OSOs related to human error

OSO #16 — Multi-crew coordination

This OSO applies only to those personnel directly involved in the flight operation.

HUMAN ERROR		Level of integrity		
		Low	**Medium**	**High**
OSO #16 Multi crew coordination	Criterion #1 (Procedures)	Procedure(s) to ensure coordination between the crew members and robust and effective communication channels is (are) available and at a minimum cover: (a) assignment of tasks to the crew, and (b) establishment of step-by-step communications.[1]		
	Comments	*[1] The distinction between a low, a medium and a high level of robustness for this criterion is achieved through the level of assurance (see the table below).*		

	Criterion #2 (Training)	Remote crew training covers multi-crew coordination	Same as low. In addition, the remote crew[2] receives CRM[3] training.	Same as medium.
	Comments	*N/A*	*[2] In the context of the SORA, the term 'remote crew' refers to any person involved in the mission.* *[3] CRM training focuses on the effective use of all the remote crew to assure a safe and efficient operation, reducing error, avoiding stress and increasing efficiency.*	*N/A*
	Criterion #3 (Communication devices)	N/A	Communication devices comply with standards considered adequate by the competent authority and/or in accordance with a means of compliance acceptable to that authority.	Communication devices are redundant[4] and comply with standards considered adequate by the competent authority and/or in accordance with a means of compliance acceptable to that authority.
	Comments	*N/A*	*N/A*	*[4] This implies the provision of an extra device to cope with the failure of the first device.*

HUMAN ERROR		**LEVEL of ASSURANCE**		
		Low	**Medium**	**High**
OSO #16 Multi crew coordination	Criterion #1 (Procedures)	(a) Procedures are not validated against either a standard or a means of compliance considered adequate by the competent authority of the MS. (b) The adequacy of the procedures and checklists is declared.	(a) Procedures are validated against standards considered adequate by the competent authority of the MS and/or in accordance with the means of compliance acceptable to that authority[1]. (b) The adequacy of the procedures is proven through: (1) dedicated flight tests; or (2) simulation, provided that the representativeness of the simulation means is proven valid for the intended purpose with positive results; or (3) any other means acceptable to the competent authority.	Same as medium. In addition: (a) flight tests performed to validate the procedures cover the complete flight envelope or are proven to be conservative; and (b) the procedures, flight tests and simulations are validated by the competent authority of the MS or an entity designated by the competent authority.
	Comments	*N/A*	*[1] AMC2 UAS.SPEC.030(3)(e) (Operational procedures for medium and high levels of robustness) is considered an acceptable means of compliance.*	*N/A*

HUMAN ERROR		LEVEL of ASSURANCE		
		Low	**Medium**	**High**
	Criterion #2 (Training)	Training is self-declared (with evidence available).	(a) Training syllabus is available. (b) The UAS operator provides competency-based, theoretical and practical training.	The competent authority of the MS or an entity that is designated by the competent authority: (a) validates the training syllabus; and (b) verifies the remote crew competencies.
	Comments	*N/A*	*N/A*	*N/A*
	Criterion #3 (Communication devices)	*N/A*	The applicant has supporting evidence that the required level of integrity is achieved. This is typically done by testing, analysis, simulation1, inspection, design review or through operational experience.	The competent authority should request the applicant to operate a UAS designed by an organisation approved by EASA according to Subpart J of Annex I (Part 21) to Regulation (EU) No 748/2012.
	Comments	*N/A*	*[1] When simulation is performed, the validity of the targeted environment that is used in the simulation needs to be justified.*	*N/A*

OSO #17 — Remote crew is fit to operate

(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 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) handover/takeover procedures.

HUMAN ERROR		**Level of integrity**		
		Low	**Medium**	**High**
OSO #17 Remote crew is fit to operate	Criteria	The applicant has a policy defining how the remote crew can declare themselves fit to operate before conducting any operation.	Same as low. In addition: — Duty, flight duty and resting times for the remote crew are defined by the applicant and adequate for the operation. — The UAS operator defines requirements appropriate for the remote crew to operate the UAS.	Same as Medium. In addition: — The remote crew is medically fit, — A fatigue risk management system (FRMS) is in place to manage any escalation in duty/flight duty times.
	Comments	*N/A*	*N/A*	*N/A*

HUMAN ERROR		**LEVEL of ASSURANCE**		
		Low	**Medium**	**High**
OSO #17 Remote crew is fit to operate	Criteria	The policy to define how the remote crew declares themselves fit to operate (before an operation) is documented. The remote crew fit-to-operate declaration (before an operation) is based on a policy defined by the applicant.	Same as low. In addition: — Remote crew duty, flight duty and the resting time policy are documented. — Remote crew duty cycles are logged and cover at a minimum: — when the remote crew member's duty day commences, — when the remote crew members are free from duties, and — resting times within the duty cycle. — There is evidence that the remote crew is fit to operate the UAS.	Same as medium. In addition: — Medical standards considered adequate by the competent authority and/or the means of compliance acceptable to that authority are established and the competent authority of the MS or an entity that is designated by the competent authority verifies that the remote crew is medically fit. — The competent authority of the MS or an entity that is designated by the competent authority validates the duty/flight duty times. — If an FRMS is used, it is validated and monitored by the competent authority of the MS or an entity that is designated by the competent authority.
	Comments	*N/A*	*N/A*	*N/A*

OSO #18 — Automatic protection of the flight envelope from human errors

(a) Each UA is designed with a flight envelope that describes its safe performance limits with regard to minimum and maximum operating speeds, and its operating structural strength.

(b) Automatic protection of the flight envelope is intended to prevent the remote pilot from operating the UA outside its flight envelope. If the applicant demonstrates that the remote-pilot is not in the loop, this OSO is not applicable.

(c) A UAS implementing such an automatic protection function will ensure that the UA is operated within an acceptable flight envelope margin even in the case of incorrect remote-pilot control inputs (human errors).

(d) UAS without automatic protection functions are susceptible to incorrect remote-pilot control inputs (human errors), which can result in the loss of the UA if the designed performance limits of the aircraft are exceeded.

(e) Failures or development errors of the flight envelope protection are addressed in OSOs #5, #10 and #12.

HUMAN ERROR		**LEVEL of INTEGRITY**		
		Low	**Medium**	**High**
OSO #18 Automatic protection of the flight envelope from human errors	Criteria	The UAS flight control system incorporates automatic protection of the flight envelope to prevent the remote pilot from making any single input under normal operating conditions that would cause the UA to exceed its flight envelope or prevent it from recovering in a timely fashion.	The UAS flight control system incorporates automatic protection of the flight envelope to ensure the UA remains within the flight envelope or ensures a timely recovery to the designed operational flight envelope following remote pilot error(s).[1]	
	Comments	*N/A*	*[1] The distinction between a medium and a high level of robustness for this criterion is achieved through the level of assurance (see table below).*	

HUMAN ERROR		LEVEL of ASSURANCE		
		Low	**Medium**	**High**
OSO #18 Automatic protection of the flight envelope from human errors	Criteria	The automatic protection of the flight envelope has been developed in-house or out of the box (e.g. using commercial off-the-shelf elements), without following specific standards.	The competent authority should request the applicant to use a UAS for which EASA has verified the claimed integrity through a DVR.	The competent authority should request the applicant to use a UAS for which EASA has issued a type certificate or restricted type certificate in accordance with Annex I (Part 21) to Regulation (EU) No 748/2012.
	Comments	*N/A*	*N/A*	*N/A*

OSO #19 — Safe recovery from human errors

(a) This OSO addresses the risk of human errors which may affect the safety of the operation if not prevented or detected and recovered in a timely fashion.

i) Errors can be made by anyone involved in the operation.

ii) An example could be a human error leading to the incorrect loading of the payload, with the risk of it falling off the UA during the operation.

iii) Another example could be a human error not to extend the antenna mast, thus reducing the C2 link coverage.

Note: the flight envelope protection is excluded from this OSO since it is specifically covered by OSO #18.

(b) This OSO covers:

i) procedures and lists,

ii) training, and

iii) UAS design, i.e. systems detecting and/or recovering from human errors (e.g. safety pins, use of acknowledgment features, fuel or energy consumption monitoring functions …)

HUMAN ERROR		LEVEL of INTEGRITY		
		Low	**Medium**	**High**
OSO #19 Safe recovery from Human Error	Criterion #1 (Procedures and checklists)	Procedures and checklists that mitigate the risk of potential human errors from any person involved with the mission are defined and used. Procedures provide at a minimum: — a clear distribution and assignment of tasks, and — an internal checklist to ensure staff are adequately performing their assigned tasks.		
	Comments	*N/A*	*N/A*	*N/A*
	Criterion #2 (Training)	— The remote crew[1] is trained to use procedures and checklists. — The remote crew[1] receives CRM[2] training.[3]		
	Comments	*[1] In the context of SORA, the term 'remote crew' refers to any person involved in the mission.* *[2] CRM training focuses on the effective use of all the remote crew to ensure a safe and efficient operation, reducing error, avoiding stress and increasing efficiency.* *[3] The distinction between a low, a medium and a high level of robustness for this criterion is achieved through the level of assurance (see table below).*		
	Criterion #3 (UAS design)	Systems detecting and/or recovering from human errors are developed according to industry best practices.	Systems detecting and/or recovering from human errors are developed to standards considered adequate by the competent authority and/or in accordance with a means of compliance acceptable to that authority.	Same as medium.
	Comments	*N/A*	*N/A*	*N/A*

HUMAN ERROR		LEVEL of ASSURANCE		
		Low	**Medium**	**High**
OSO #19 Safe recovery from human error	Criterion #1 (Procedures and checklists)	(a) Procedures and checklists are not validated against either a standard or a means of compliance considered adequate by the competent authority of the MS. (b) The adequacy of the procedures and checklists is declared.	(a) Procedures and checklists are validated against standards considered adequate by the competent authority of the MS and/or in accordance with the means of compliance acceptable to that authority[1]. (b) The adequacy of the procedures and checklists is proven through: (1) dedicated flight tests, or (2) simulation, provided that the representativeness of the simulation means is	Same as medium. In addition: (a) Flight tests performed to validate the procedures and checklists cover the complete flight envelope or are proven to be conservative. (b) The procedures, checklists, flight tests and simulations are validated by the competent authority of the MS or an entity that is

HUMAN ERROR		LEVEL of ASSURANCE		
		Low	**Medium**	**High**
			proven valid for the intended purpose with positive results; or (3) any other means acceptable to the competent authority of the MS.	designated by the competent authority.
	Comments	*N/A*	*[1] AMC2 UAS.SPEC.030(3)(e) (Operational procedures for medium and high levels of robustness) is considered an acceptable means of compliance.*	*N/A*
	Criterion #2 (Training)	Consider the criteria defined for the level of assurance of the generic remote crew training OSO (i.e. OSO #09, OSO #15 and OSO #22) corresponding to the SAIL of the operation.		
	Comments	*N/A*	*N/A*	*N/A*
	Criterion #3 (UAS design)	The applicant declares that the required level of integrity has been achieved[1].	The applicant has supporting evidence that the required level of integrity is achieved. That evidence is provided through testing, analysis, simulation[2], inspection, design review or operational experience. If the operation is classified as SAIL IV, the competent authority should request the applicant to use a UAS for which EASA has verified the claimed integrity through a DVR. If the operation is classified as SAIL V the competent authority should request the applicant to use a UAS for which EASA has issued a type certificate or restricted type certificate in accordance with Annex I (Part 21) to Regulation (EU) No 748/2012.	The competent authority should request the applicant to use a UAS for which EASA has issued a type certificate or restricted type certificate in accordance with Annex I (Part 21) to Regulation (EU) No 748/2012.
	Comments	*[1] Supporting evidence may or may not be available.*	*[2] When simulation is performed, the validity of the targeted environment that is used in the simulation needs to be justified.*	*N/A*

OSO #20 — A human factors evaluation has been performed and the HMI has been found appropriate for the mission

HUMAN ERROR		LEVEL of INTEGRITY		
		Low	**Medium**	**High**
OSO #20 A Human Factors evaluation has been performed and the HMI found appropriate for the mission	Criteria	The UAS information and control interfaces are clearly and 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	*If an electronic means is used to support potential VOs in their role to maintain awareness of the position of the unmanned aircraft, its HMI:* — *is sufficient to allow the VOs to determine the position of the UA during operation; and* — *does not degrade the VO's ability to:* — *scan the airspace visually where the unmanned aircraft is operating for any potential collision hazard; and* — *maintain effective communication with the remote pilot at all times.*		

HUMAN ERROR		LEVEL of ASSURANCE		
		Low	**Medium**	**High**
OSO #20 A Human Factors evaluation has been performed and the HMI has been found appropriate for the mission	Criteria	The applicant conducts a human factors evaluation of the UAS to determine whether the HMI is appropriate for the mission. The HMI evaluation is based on inspection or analyses.	Same as Low but the HMI evaluation is based on demonstrations or simulations.[1] The competent authority should request EASA to witness the HMI evaluation of the UAS.	Same as Medium. In addition, EASA witnesses the HMI evaluation of the UAS and the competent authority of the MS or an entity that is designated by the competent authority witnesses the HMI evaluation of the possible electronic means used by the AO.
	Comments	*N/A*	*[1] When simulation is performed, the validity of the targeted environment that is used in the simulation needs to be justified.*	*N/A*

E.8 OSOs related to adverse operating conditions

OSO #23 — Environmental conditions for safe operations are defined, measurable and adhered to

ADVERSE OPERATING CONDITIONS		LEVEL of INTEGRITY		
		Low	**Medium**	**High**
OSO #23 Environmental conditions for safe operations are defined, measurable and adhered to	Criterion #1 (Definition)	The environmental conditions for safe operations are defined and reflected in the flight manual or equivalent document.[1]		
	Comments	*[1] The distinction between a low, a medium and a high level of robustness for this criterion is achieved through the level of assurance (see table below).*		
	Criterion #2 (Procedures)	Procedures to evaluate environmental conditions before and during the mission (i.e. real-time evaluation) are available and include assessment of meteorological conditions (METAR, TAFOR, etc.) with a simple recording system.[2]		
	Comments	*[2] The distinction between a low, a medium and a high level of robustness for this criterion is achieved through the level of assurance (see table below).*		
	Criterion #3 (Training)	Training covers assessment of meteorological conditions.[3]		
	Comments	*[3] The distinction between a low, a medium and a high level of robustness for this criterion is achieved through the level of assurance (see table below).*		

ADVERSE OPERATING CONDITIONS		LEVEL of ASSURANCE		
		Low	**Medium**	**High**
OSO #23 Environmental conditions for safe operations defined, measurable and adhered to	Criterion #1 (Definition)	The applicant declares that the required level of integrity has been achieved.	The applicant has supporting evidence that the required level of integrity is achieved. This is typically done by testing, analysis, simulation, inspection, design review or through operational experience. If the operation is classified as SAIL IV, the competent authority should request the applicant to use a UAS for which EASA has issued a DVR.	The competent authority should request the applicant to use a UAS for which EASA has issued a type certificate or restricted type certificate in accordance with Annex I (Part 21) to Regulation (EU) No 748/2012
	Comments	*N/A*		
	Criterion #2 (Procedures)	(a) Procedures do not require validation against either a standard or a means of compliance considered adequate	(a) Procedures are validated against standards considered adequate by the competent authority of the MS and/or in accordance with the means of compliance acceptable to that authority[1].	Same as medium. In addition: (a) Flight tests performed to validate the procedures cover the complete flight envelope or are proven to be conservative.

		by the competent authority of the MS. (b) The adequacy of the procedures and checklists is declared.	(b) The adequacy of the procedures is proven through: (1) dedicated flight tests, or (2) simulation, provided that the representativeness of the simulation means is proven valid for the intended purpose with positive results; or (3) any other means acceptable to the competent authority of the MS.	(b) The procedures, flight tests and simulations are validated by the competent authority of the MS or an entity that is designated by the competent authority.
	Comments	*N/A*	*[1] AMC2 UAS.SPEC.030(3)(e) (Operational procedures for medium and high levels of robustness) is considered an acceptable means of compliance.*	*N/A*
	Criterion #3 (Training)	Training is self-declared (with evidence available).	— Training syllabus is available. — The UAS operator provides competency-based, theoretical and practical training.	The competent authority of the MS or an entity that is designated by the competent authority: — validates the training syllabus; and — verifies the remote crew competencies.
	Comments	*N/A*	*N/A*	*N/A*

OSO #24 — UAS is designed and qualified for adverse environmental conditions (e.g. adequate sensors, DO-160 qualification)

(a) To assess the integrity of this OSO, the applicant determines:

(1) whether credit can be taken for the equipment environmental qualification tests / declarations, e.g. by answering the following questions:

(i) Is there a Declaration of Design and Performance (DDP) available to the applicant stating the environmental qualification levels to which the equipment was tested?

(ii) Did the environmental qualification tests follow a standard considered adequate by the competent authority (e.g. DO-160)?

(iii) Are the environmental qualification tests appropriate and sufficient to cover all the environmental conditions related to the ConOps?

(iv) If the tests were not performed following a recognised standard, were the tests performed by an organisation/entity that is qualified or that has experience in performing DO-160 like tests?

(2) Can the suitability of the equipment for the intended/expected UAS environmental conditions be determined from either in-service experience or relevant test results?

(3) Any limitations which would affect the suitability of the equipment for the intended/expected UAS environmental conditions.

(b) The lowest integrity level should be considered for those cases where a UAS equipment has only a partial environmental qualification and/or a partial demonstration by similarity and/or parts with no qualification at all.

ADVERSE OPERATING CONDITIONS		**LEVEL of INTEGRITY**		
		N/A	**Medium**	**High**
OSO #24 UAS is designed and qualified for adverse environmental conditions	Criteria	N/A	The UAS is designed to limit the effect of environmental conditions.	The UAS is designed using environmental standards considered adequate by the competent authority and/or in accordance with a means of compliance acceptable to that authority.
	Comments	*N/A*	*N/A*	*N/A*

ADVERSE OPERATING CONDITIONS		**LEVEL of ASSURANCE**		
		N/A	**Medium**	**High**
OSO #24 UAS is designed and qualified for adverse environmental conditions	Criteria	N/A	The applicant has supporting evidence that the required level of integrity has been achieved. This is typically done by testing, analysis, simulation[2], inspection, design review or through operational experience.	If the operation is classified as SAIL IV, the competent authority should request the applicant to use a UAS for which EASA has issued a DVR. If the operation is classified SAIL V or VI, the competent authority should request the applicant to use a UAS for which EASA has issued a type certificate or restricted type certificate in accordance with Annex I (Part 21) to Regulation (EU) No 748/2012.
	Comments	*N/A*	*[2] When simulation is performed, the validity of the targeted environment that is used in the simulation needs to be justified*	*N/A*