Joint Authorities for Rulemaking on Unmanned Systems

JARUS guidelines on SORA

Annex A

Guidelines on collecting and presenting system and operation information for a specific UAS operation

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Abstract

This document recommends ways on collecting and presenting system and operation information for a specific UAS operation. Guidance is being provided on how to document a risk assessment based on SORA, how the operation can be described and visualised and on how to structure an operations manual.

Keywords

SORA, SAIL, Specific, Risk, Operational Manual, Compliance Matrix, Flight Area

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0.1	22.04.2016	Version for JARUS Internal Consultation	First edition
0.2	25.08.2016	Version for JARUS External Consultation	All
1.0	26.06.2017	Version for Public Release	All
2.0	22.01.2018	Version for JARUS External Consultation	All Addition of documentation templates for SORA risk assessment.
2.5	13.05.2024	Version for Public Release	Reduction of guidance on writing operational manual. Separation of risk assessment templates to support the newly introduced two phase approach to SORA. Addition of examples on how to describe a flight area.

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As multiple WG-SRM members have assumed new responsibilities and changed affiliations over the years of document development, all contributors are listed with their affiliation at the time of their last contribution.

CONTENTS

Introduction

The aim of this annex is to provide guidance to operators for collecting and presenting evidence and data. This will assist applicants with compiling a complete application to obtain operational authorization for unmanned aircraft operations in the 'specific' category.

This document does not replace civil regulations but provides recommendations and guidance as to how civil Unmanned Aircraft Systems (UAS) operators can comply with those regulations, using the Specific Operations Risk Assessment (SORA) process. Wherever possible the guidance has been harmonised with any relevant emerging international UAS regulatory developments.

This document is composed of five chapters.

A.1: Key Principles for completing the application documents in the 'specific' Category

This chapter explains the different documents and how to use them to present an application.

A.2: SORA Risk Assessment writing template

This chapter is intended to support the applicant with compiling all the information necessary to perform a risk assessment.

A.3: Operations Manual Structure

This chapter provides an operations manual structure for applicants to follow in order to present their operations manual in an appropriate manner.

A.4: Compliance Matrix

This chapter provides a template for applicants on how to present the reference between the SORA driven requirements and the operations manual.

A.5: How to present a flight area

This chapter contains guidance to applicants on how to create and include a flight area into the operations manual.

A.1 Key Principles for completing the application documents

How does an application generally work?

The operations manual document can serve as the basis for an Operational Authorisation in the 'specific' Category. When the competent authority authorises a specific operation, it will usually do that, by accepting and approving an operations manual.

General workflow

Before starting to collect information and describing procedures, the applicant should outline a preliminary operational concept (Refer to SORA Main Body). This preliminary operational concept ensures that the applicant can effectively explore all available options, and select the most suitable approach for their specific needs.

Key considerations for this initial plan include:

- The intended flight location(s).
- The maximum operational flight altitude and speed.
- The flight mode: either Visual Line of Sight (VLOS), Extended Visual Line Of Sight (EVLOS) or Beyond Visual Line of Sight (BVLOS).
- The type of UAS to be used.
- Environmental limitations (time of day, weather).

In the next step, the applicant assesses the risk for the intended operation and develops a high level view of the SORA requirements. For this, they should use the template provided in section A.2 and follow each step of the SORA process.

It is considered best practice for applicants to engage with the competent authority before moving to the data collection and procedure description (phase 2, see figure 1).

In this dialogue, the applicant shares their preliminary operational information and initial risk assessment (phase 1, see figure 1).

The competent authority and the applicant evaluate the alignment of the risk assessment with the operational information and check the correct application of the SORA steps.

The competent authority may provide feedback to applicants on their expectations on how to achieve an operational authorisation considering the resulting Specific Assurance Integrity Level (SAIL).

Once the risk assessment has been validated and the applicant has secured confirmation from the competent authority, the next step involves identifying the specific requirements that arise from this risk assessment. Following this identification, the applicant must then collect the relevant evidence and information, as well as describe the procedures that will be implemented. The applicant must ensure that all integrity and corresponding assurance requirements are met. These can be found in the SORA Annexes B - E. It is recommended to utilize the operations manual structure from Chapter A.3 for this purpose.

The applicant should use the template provided in Chapter A.4 (Comprehensive Safety Portfolio), once all procedures are described and the evidence collected. This is done by providing the corresponding reference to the integrity and/or assurance evidence for each requirement. This document serves as a check list for the applicant to review prior to submission of an application. The competent authority may use this document as a reference to assist in the review process.

The competent authority reviews the application in accordance with the provisions arising from the risk assessment and the respective SAIL. In this process, the implementation of all technical and operational requirements are checked based on the descriptions in the operations manual, or other associated documents as required. The competent authority has the option to request revisions of documents or to ask for additional supporting documentation.

For the applicant to address the additional demands effectively, the competent authority may also provide guidance on how the applicant can proceed to close any outstanding issues.

Figure 1 below graphically depicts the process described above and thus serves as an additional illustration of the general workflow.

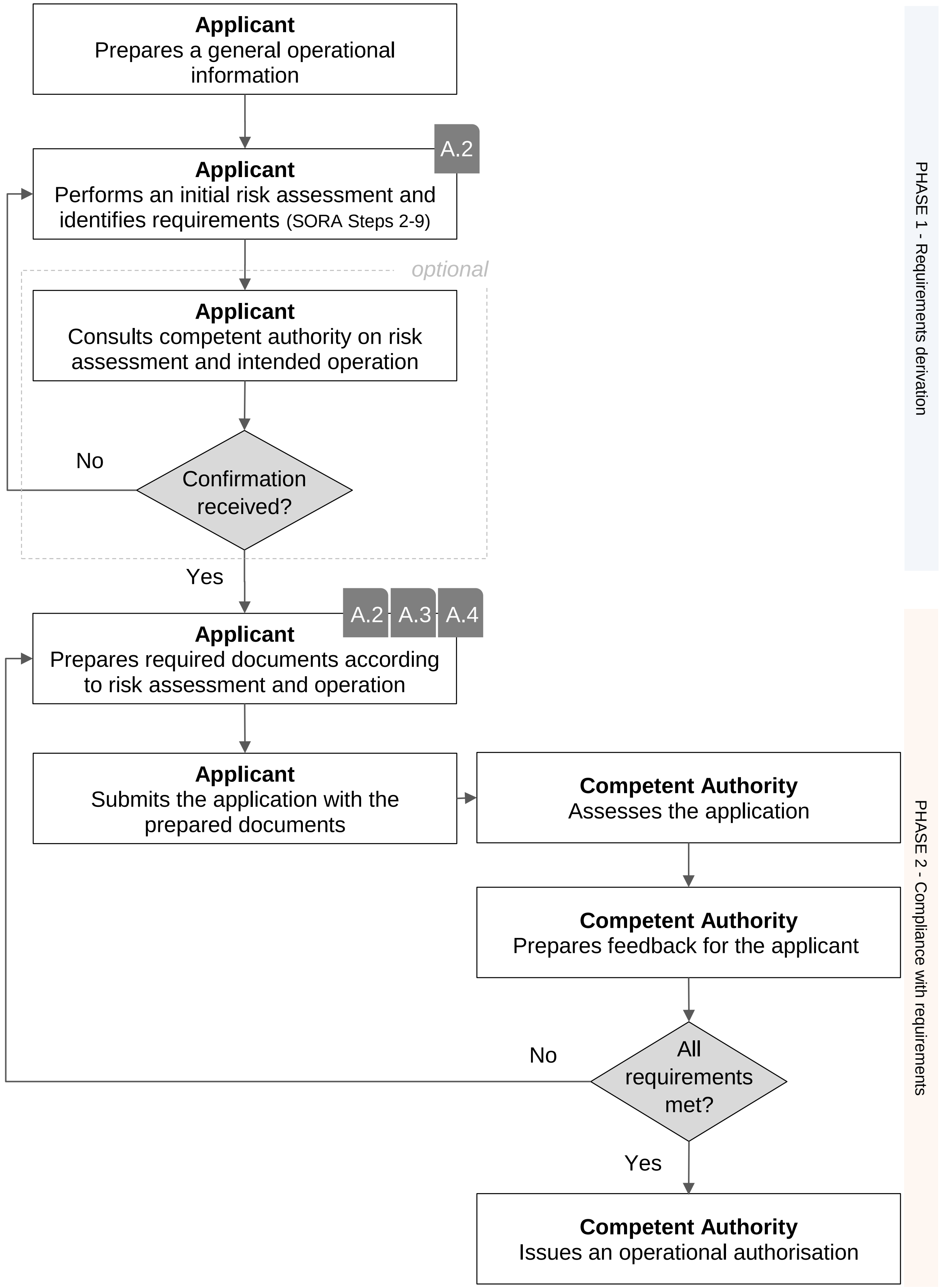

Figure 1: general workflow for the application process

Recommended level of detail and use of supporting documents and references

The operations manual and associated operations manual annexes should enable the applicant to describe to the competent authority the intended operation(s) to a level of detail that effectively enables:

- the identification of the Ground Risk Class (GRC), Air Risk Class (ARC), associated mitigations, and SAIL determination.
- compliance with the required Operational Safety Objectives (OSOs), mitigations and containment. The provisions can be assessed and verified with the information contained or referenced by it.

The applicant should only put information into the operations manual that is recommended above. Supporting documents as evidence for the points above can usually be kept internal to the operator's organisation and may not need to be submitted to the competent authority. The competent authority may request further documents, if considered necessary for the given operation.

Document setup for additional flight areas, UAS or operations

When an operator seeks to expand their approved operations manual(s) to include a new flight area, UAS, or operation, the primary question is whether the underlying risk assessment covers these additions. If it does, the new information can be incorporated into existing parts (See chapter A.3 - part A to T) of the operations manual. Otherwise, it is considered best practice to establish new parts for this information.

When dealing with complex operational structures it's recommended to align the manual's structure with the competent authority to ensure it meets both national and industry standards.

Operation-specific details should typically be organized into separate parts for clarity during approval and ease of use. Conversely, general or related information can be consolidated into a shared segment. An example would be adding an additional UAS with the same characteristic dimensions, but a different set of procedures. This could be added to the existing part B, for illustration purposes see Figure 2.

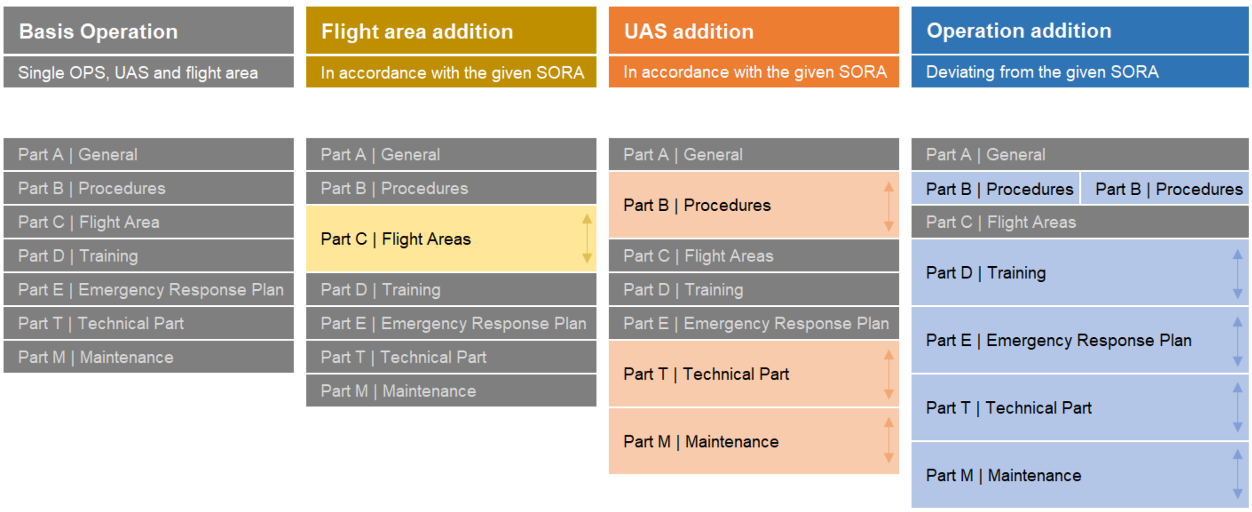

Figure 2 Common scenarios and how they may impact the operations manual

A.2 SORA risk assessment template

How to use this chapter?

This chapter serves as a guide to assist applicants in compiling all the necessary information for conducting a risk assessment. By providing this questionnaire-style template for documenting the risk assessment, applicants are encouraged to focus on the essential information required and to avoid unnecessary lengthy explanations about their operational procedures.

The remarks section is optional and designed for applicants to provide additional information when needed, helping to prevent misunderstandings. At this stage, no evidence is required, as the requirements are determined by the risk analysis process.

Once this document (A.2) is completed, both the applicant and the competent authority will have all the necessary information to complete phase 1 assessment (for reference see figure 1).

In situations involving the use of multiple UAs or flight locations with varying ground or air risk classes, it is advisable to consult with the competent authority. This practice helps ensure alignment with expectations and adherence to national standards. In certain cases, it might be possible to include multiple flight areas or UAs into one form.

Evidence should not be included in A.2. Instead, it should be incorporated into the operations manual (OM) A.3 and referenced in the Comprehensive Safety Portfolio (A.4.).

Specific Operational Risk Assessment overview for UAS operations

0.	**Data of the UAS and operation**	
0.1	**UAS operator identification**	
0.2	**Manufacturer or type certificate holder**	
0.3	**Model name**	
0.4	**Type of UAS configuration**	☐Conventional airplane ☐Helicopter ☐Multirotor ☐Hybrid/VTOL ☐Lighter than air ☐Other, please specify:
0.5	**Is the UAS tethered during the operation?**	☐Yes ☐No
0.6	**Maximum characteristic dimension**	m
0.7	**Maximum take-off mass (MTOM)** (indicated by the operator equal to or less than the manufacturer's specification)	kg
0.8	**Maximum operational speed**	m/s
0.9	**Type of propulsion system**	☐Electric ☐Combustion ☐Hybrid, specify type: ____________ ☐Other, please specify: ____________
0.10	**Number of type certificate or design verification report** (if available)	
0.11	**Certificate of airworthiness** (if available)	
0.12	**Number of noise certificate** (if available)	
0.13	**Transport of dangerous goods**	☐Yes ☐No
0.14	**Type of operation**	☐Visual line of sight (VLOS) ☐Extended visual line of sight (EVLOS) ☐Beyond visual line of sight (BVLOS)
0.15	**Does the remote pilot control more than one UA simultaneously?**	☐Yes ☐No

1. Specific Operations Risk Assessment		
Step #1 Operations manual		
#1.1	**Description of proposed operation including the locations**	• If location-specific: Please provide the geo-coordinates for each operational volume (flight geography and contingency volume), the ground risk buffer and the air risk buffer (if available) as a separate file using either .txt; .kmz or .kml. Give reference to the file: ____ • If location-independent: Please provide a reference to the documented process for the determination of volumes and buffers and the assessment of the local conditions and their compliance limitations. Give reference to the file: ____ *Please provide a list with the information if there are multiple locations.*
Short description of proposed operation: *e.g., transport, inspection, filming, testing, etc...*		
#1.2	**Dimensions of the operational volume and the adjacent volume** (Rounded up to first decimal place)	Height of the flight geography H_{FGmax} _________ m Height of the contingency volume H_{CVmax} _________ m Width of the contingency volume S_{CVmax} _________ m Width of the ground risk buffer S_{GRBmax} _________ m Height of the adjacent volume H_{AV} _________ m Width of the adjacent volume S_{AV} _________ m *Please provide a list with this information if there are multiple locations.*
Step #2 UAS intrinsic ground risk class		
#2.1	**Type of operational areas on the ground** (including flight geography, contingency volume and ground risk buffer)	☐ Controlled ground area ☐< 5 People/km^2 (remote) ☐< 50 People/km^2 (lightly populated) ☐< 500 People/km^2 (sparsely populated) ☐< 5000 People/km^2 (suburban/low density metropolitan) ☐< 50.000 People/km^2 (high density metropolitan) ☐> 50.000 People/km^2 (assemblies of people)
#2.2	**Specify the intrinsic ground risk class**	
Remarks/Reasoning for Step #2 (optional)		

Step #3 Final ground risk class determination		
#3.1	**Specify the applied ground risk mitigations** (if applicable)	**M1** (A) strategic mitigation - sheltering Specify the level of robustness: ☐None ☐Low
		M1 (B) strategic mitigation – operational restrictions Specify the level of robustness: ☐None ☐Medium ☒High
		M1 (C) tactical mitigation – ground observation Specify the level of robustness: ☐None ☐Low
		M2 Effects on UA impact dynamics are reduced Specify the level of robustness: ☐None ☐Medium ☐High
#3.2	**Specify the final ground risk class**	
Remarks/Reasoning for Step #3 (optional)		

Step #4 Initial air risk class			
#4.1	**Classification of the airspace where the operation is intended to be conducted** (multiple answers possible)	☐A ☐B ☐C ☐D ☐E ☐F ☐G	
		☐Restricted area (ED-R) ☐Danger area (ED-D)	
		☐TMZ ☐RMZ ☐ATZ	
#4.2	**Specify the initial air risk class and the reasoning for choosing it**	**Operational volume**	**Adjacent airspace**
		☐ARC-a ☐ARC-b ☐ARC-c ☐ARC-d	☐ARC-a ☐ARC-b ☐ARC-c ☐ARC-d
Remarks/Reasoning for Step #4 (optional)			

Step #5 Strategic air risk mitigations and final air risk class		
#5.1	**Specify, if strategic mitigations of the air risk class were applied**	☐Yes ☐No
#5.2	**Residual air risk class** (after strategic mitigation)	☐ARC-a ☐ARC-b ☐ARC-c ☐ARC-d
Remarks/Reasoning for Step #5 (optional)		

Step #6 TMPR and robustness level			
#6 Tactical mitigations performance Requirements	☐VLOS ☐BVLOS ☐No requirement (ARC-a) ☐Low (ARC-b) ☐Medium (ARC-c) ☐High (ARC-d)		
Remarks/Reasoning for Step #6 (optional)			
Step #7 SAIL determination			
#7 Specific Assurance and Integrity Level	☐SAIL I ☐SAIL II ☐SAIL III ☐SAIL IV ☐SAIL V ☐SAIL VI		
Step #8 Determination of containment requirements			
#8 Containment	☐Low	☐Medium	☐High
Remarks/Reasoning for Step #8 (optional)			
Step #9 Identification of operational safety objectives (OSOs)			
#9 Operational safety objectives	As per identified SAIL from Step #7		
Confirmation			
Place, date	**Name and signature**		

A.3 Operations Manual Structure

How to use this chapter?

The intention of this operations manual structure is to provide a standardised framework for documenting essential information related to a specific operation. This serves only as an example structure for applicants to create a comprehensive document that outlines the procedures and relevant details necessary for the safe and efficient execution of an operation.

The structure divides the operations manual into logical subject parts, that offer a structure on where to include specific topics crucial for creating a standardised manual for safe UAS operation.

While the structure is not inherently mandatory, the topics it contains should be incorporated into the operations manual as needed for the specific operation(s) to provide the relevant information and evidence required for safe UAS operation. It is advisable to adhere to the provided structure, as it aligns with the expectations and practices of most authorities.

In general, any information that does not have direct operational relevance to the operator or staff should be placed in the relevant Annex to ensure the document remains concise and reader-friendly.

The key intentions and purposes of this structure include:

1. **Standardisation:** It ensures that all critical aspects of the operation are documented consistently, following industry standards, regulations, and best practices.
2. **Compliance:** It helps operators meet regulatory requirements by specifying the information and procedures needed to obtain necessary approvals and certifications.
3. **Clarity:** It provides a clear and organized structure for conveying operational procedures, safety protocols, and other essential information, reducing the risk of misunderstandings and errors.
4. **Safety:** It emphasizes safety measures, emergency procedures, and risk mitigation strategies to enhance overall safety during the operation.
5. **Efficiency:** It streamlines the process of creating an operations manual by providing predefined sections and guidelines, saving time and effort for applicants.
6. **Consistency:** It ensures that all UAS operators involved in the same type of operation follow the same documented procedures, promoting uniformity and reducing the potential for confusion.
7. **Reference:** It serves as a valuable reference document for UAS operators, remote crew members, authorities, and other stakeholders involved in or overseeing the operation.
8. **Documentation:** It aids in the systematic recording of operational details, making it easier to track changes, updates, and compliance with evolving regulations.

Recommended structure for the operations manual

Cover Page

Document Control

Other applicable documents

Purpose and scope of this document

List of Contents

List of Abbreviations

1 General Part (Part A)

1.1 Opening Statement

1.2 Security and Privacy Statement

1.3 Environmental Statement

1.4 The Operating Organization

1.4.1 Structure / Organisation Chart

1.4.2 Duties and Responsibilities of the personal

1.5 Change Management

1.6 Retention Periods

1.7 Document Control

1.8 Requirements and Qualifications for Personnel

1.8.1 Pilot / Ground Station:

1.8.2 Maintenance Personnel

1.8.3 Ground Staff

1.8.4 Training, Examination and Supervision Personnel

1.9 Crew Member is “fit for the operation”

1.9.1 Preventive Health Care

1.9.2 Duty Hours and Rest Periods

2 Procedures (Part B)

2.1 Multi-crew Coordination

2.2 Flight Planning

2.2.1 Use of Up-to-date Materials

2.2.2 Geographical Zones

2.3 External Services and Systems

2.3.1 Services

2.3.2 Systems

2.4 Procedures for Obtaining and Evaluating Weather Conditions

2.5 Procedures for Responding to Unexpected Adverse Weather Conditions

2.6 Procedures for TMPR (Tactical Mitigation Performance Requirement)

2.7 Occurrence Reporting

6 Technical Part of UAS (Part T)

6.1 UAS 1 [Model/Type]

6.1.1 Description

6.1.2 Image / Graphic

6.1.3 C3 Link

6.1.4 Parachute (M2)

6.1.5 TMPR

6.1.6 Containment

6.1.7 Human-Machine Interface - HMI

6.1.8 Payload

6.2 UAS 2 [Model/Type]

6.2.1 Description

6.2.2 Image / Graphic

6.2.3 C3 Link

6.2.4 Parachute (M2)

6.2.5 TMPR

6.2.6 Containment

6.2.7 Human-Machine Interface – HMI

6.2.8 Payload

6.2.9 Automatic Protection of the Flight Envelope

6.2.10 Designed and Qualified for Adverse Environmental Conditions

7 Maintenance (Part M)

7.1 General

7.2 Software Updates

7.3 Maintenance UAS 1 [Model/Typ]

7.4 Maintenance UAS 2 [Model/Typ]

8 Annex

8.1 Evidence

8.1.1 Organisational

8.1.1.1 Organisational Operating Certificate

8.1.1.2 Maintenance Program / Organisation Certificate

8.1.2 Operational

8.1.2.1 Operational Agreements (e.g. with ATC)

8.1.2.2 M1

8.1.2.3 Flight Tests

8.1.2.4 Performance of External Services and Systems

8.1.3 Technical

8.1.3.1 Design (DVR, TC)

8.1.3.2 M2

8.1.3.3 Manufacturer Competence

8.2 Printed Forms

8.2.1 List of Maintenance Personnel

8.2.2 List of Personal authorised to conduct Pre-flight and Post-flight Inspections

8.2.3 List of the Training / Experience Level of Personnel

8.2.4 List of authorised Pilots

8.2.5 List of Training on the Emergency Response Plan (ERP)

8.2.6 Operator Flight Logbook

8.2.7 Technical Logbook

8.3 Check Lists

8.3.1 ERP Template

8.3.2 Pre-flight Inspection - Check List

8.3.3 Post-flight Inspection - Check List

8.4 Manuals

8.4.1 Maintenance manual for UAS 1

Reference table for requirements

The following table offers a comprehensive overview of the suitable locations within the operations manual where the requirements specified in the SORA Annexes can be sensibly incorporated.

OSOs ↓	Integrity (I) / Assurance (A)	Criterion	OM
OSO #01	I	-	A D
	A	-	Annex 8.1.1.1
OSO #02	I	-	T
	A	-	Annex 8.1.3.3
OSO #03	I	-	M 7.1 Annex 8.1.1.2
	A	#1	A 1.7 Annex 8.1.1.2
		#2	A 1.6 A 1.7 Annex 8.1.1.2
OSO #04	I	-	T
	A	-	Annex 8.1.3.1
OSO #05	I	-	T
	A	-	Annex 8.1.3.1
OSO #06	I	-	T 6.1.3
	A	-	Annex 8.1.3.1
OSO #07	I	-	B 2.8.1 D Annex 8.2.6
	A	#1	A 1.7
		#2	A 1.7
OSO #08	I	#1	B D Annex 8.3
		#2	B D
		#3	E
	A	-	B D Annex 8.1.2.3 E Annex 8.3.1
OSO #09	I	-	A 1.7
	A	-	D
OSO #13	I	-	B 2.3

	A	-	B2.3 Annex 8.1.2.4
OSO #16	I	#1	B 2.1
		#2	D
	A	#1	B 2.1 Annex 8.1.2.3
		#2	D
		#3	Annex 8.1.2.4
OSO #17	I	-	A 1.9
	A	-	A 1.9
OSO #18	I	-	T
	A	-	Annex 8.1.3.1
OSO #19	I	-	B 2.8
	A	-	Annex 8.1.3.1
OSO #20	I	-	T 6.1.7
	A	-	Annex 8.1.3.1
OSO #23	I	-	B 2.4 C 3.1.1 D
	A	-	C 3.1 B 2.4 Annex 8.1.2.3 D
OSO #24	I	-	T
	A	-	Annex 8.1.3.1
M1	I	-	C 3.2.3.2
	A	-	Annex 8.1.2.2
M2	I	-	T
	A	-	Annex 8.1.3.2
ARC Mitigation	I	-	C 3.2.3.3
	A	-	Annex 8.1.2.1
TMPR	I	-	B 2.8.3.4 B 2.8.3.5 T 6.1.5
	A	-	Annex 8.1.3.1
Containment	I	-	T 6.1.6
	A	-	Annex 8.1.3.1
Payload	I	-	T 6.1.8
	A	-	Annex 8.1.3.1

A.4 Compliance Matrix

How to use this chapter?

This chapter provides a template for applicants on how to present the reference between the SORA driven requirements and the operations manual from A.3 to the competent authority.

For all requirements that must be fulfilled to conduct a safe UAS operation the applicant should put the specific reference in to the table where it can be found.

This is not a list of declarations or evidence - but the reference where it can be found.

Example:

Requirement	Level of robustness	Reference to documentation
OSO #08	☒ Low ☐ Medium ☐ High	Document name: *MyOperationsManual.pdf* Chapter or Page number: *Chapter B, page 42 – 47* *Chapter Annex, page 815*

(The level of robustness is in this case is SAIL dependant and should be checked accordingly (e.g. low for SAIL II)

Compliance Matrix		
Requirement	**Level of robustness**	**Reference to documentation**

Ground risk mitigations		
M1 (A) Strategic mitigations **- Sheltering**	☐ None ☐ Low	Document name: ________________________________ Chapter or Page number: ________________________________
M1 (B) Strategic mitigations **- Operational restrictions**	☐ None ☐ Medium ☐ High	Document name: ________________________________ Chapter or Page number: ________________________________
M1 (C) Tactical mitigations **- Ground observation**	☐ None ☐ Low	Document name: ________________________________ Chapter or Page number: ________________________________
M2 – Effects of UA impact dynamics are reduced	☐ None ☐ Medium ☐ High	Document name: ________________________________ Chapter or Page number: ________________________________

Strategic air risk mitigations		
Air risk class mitigation	☐ ARC-d (AEC 1 or 2) → ARC-c ☐ ARC-d (AEC 1 or 2) → ARC-b ☐ ARC-d (AEC 3) → ARC-c ☐ ARC-d (AEC 3) → ARC-b ☐ ARC-c (AEC 4) → ARC-b ☐ ARC-c (AEC 5) → ARC-b ☐ ARC-c (AEC 6,7,8) → ARC-b ☐ ARC-c (AEC 9) → ARC-b	Document name: ________________________________ Chapter or Page number: ________________________________

Tactical mitigations performance requirements		
TMPR level	☐ VLOS (deconfliction scheme) ☐ BVLOS ☐ No requirement (ARC-a) ☐ Low requirement (ARC-b) ☐ Medium requirement (ARC-c) ☐ High requirement (ARC-d)	Document name: ________________________________ Chapter or Page number: ________________________________
TMPR function	Detect	Document name: ________________________________ Chapter or Page number: ________________________________
	Decide	Document name: ________________________________ Chapter or Page number: ________________________________
	Command	Document name: ________________________________ Chapter or Page number: ________________________________
	Execute	Document name: ________________________________ Chapter or Page number: ________________________________
	Feedback loop	Document name: ________________________________ Chapter or Page number: ________________________________
TMPR robustness	TMPR integrity and assurance objectives	Document name: ________________________________ Chapter or Page number: ________________________________

Containment requirements		
Containment	☐ Low ☐ Medium ☐ High	Document name: ___________________________________ Chapter or Page number: ___________________________________

Operational Safety Objectives		
OSO #01 **Ensure that the UAS operator is competent and/or proven**	☐ NR ☐ Low ☐ Medium ☐ High	Document name: ___________________________________ Chapter or Page number: ___________________________________
OSO #02 **UAS manufactured by competent and/or proven entity**	☐ NR ☐ Low ☐ Medium ☐ High	Document name: ___________________________________ Chapter or Page number: ___________________________________:
OSO #03 **UAS maintained by competent and/or proven entity**	☐ Low ☐ Medium ☐ High	Document name: ___________________________________ Chapter or Page number: ___________________________________
OSO #04 **UAS components essential to safe operations are designed to an Airworthiness Design Standard (ADS)**	☐ NR ☐ Low ☐ Medium ☐ High	Document name: ___________________________________ Chapter or Page number: ___________________________________:
OSO #05 **UAS is designed considering system safety and reliability**	☐ NR ☐ Low ☐ Medium ☐ High	Document name: ___________________________________ Chapter or Page number: ___________________________________:
OSO #06 **C3 link characteristics (e.g. performance spectrum use) are appropriate for the operation**	☐ NR ☐ Low ☐ Medium ☐ High	Document name: ___________________________________ Chapter or Page number: ___________________________________:
OSO #07 **Conformity check of the UAS configuration**	☐ Low ☐ Medium ☐ High	Document name: ___________________________________ Chapter or Page number:

		________________________________
OSO #08 **Operational procedures are defined, validated and adhered to**	☐ Low ☐ Medium ☐ High	Document name: ________________________________ Chapter or Page number: ________________________________
OSO #09 **Remote crew trained and current**	☐ Low ☐ Medium ☐ High	Document name: ________________________________ Chapter or Page number: ________________________________
OSO #13 **External services supporting UAS operations are adequate for the operation**	☐ Low ☐ Medium ☐ High	Document name: ________________________________ Chapter or Page number: ________________________________
OSO #16 **Multi-crew coordination**	☐ Low ☐ Medium ☐ High	Document name: ________________________________ Chapter or Page number: ________________________________
OSO #17 **Remote crew is fit to operate**	☐ Low ☐ Medium ☐ High	Document name: ________________________________ Chapter or Page number: ________________________________
OSO #18 **Automatic protection of the flight envelope from human errors**	☐ NR ☐ Low ☐ Medium ☐ High	Document name: ________________________________ Chapter or Page number: ________________________________
OSO #19 **Safe recovery from human error**	☐ NR ☐ Low ☐ Medium ☐ High	Document name: ________________________________ Chapter or Page number: ________________________________
OSO #20 **A human factors evaluation has been performed and the human machine interface (HMI) found appropriate for the mission**	☐ NR ☐ Low ☐ Medium ☐ High	Document name: ________________________________ Chapter or Page number: ________________________________

OSO #23 **Environmental conditions for safe operations are defined, measurable and adhered to**	☐ Low ☐ Medium ☐ High	Document name: ________________________________ Chapter or Page number: ________________________________
OSO #24 **UAS is designed and qualified for adverse environmental conditions**	☐ NR ☐ Medium ☐ High	Document name: ________________________________ Chapter or Page number: ________________________________

Confirmation	
Have all safety requirements been described and met?	☐Yes ☐No
Place, date	**Name and signature**

A.5 How to document and present a flight area

How to use this chapter?

This chapter provides guidelines on how to prepare and present a flight area, typically located under Part C of the operations manual. The goal is to present the proposed flight area in a way that is both straightforward and easy to understand. This is crucial not just for the competent authority reviewing this section, but especially for all individuals participating in the flight operation who consult the operations manual.

It is worth noting that this section is also relevant for operators who have the privilege to analyse, approve and document flight areas independently, such as those under a generic operational authorisation.

For better usability, section A.5 is divided into two main subsections:

A.5.1 provides a comprehensive guide on creating a KML file, which is a file format for displaying information in a geographic context. It also specifies the basic necessities for the illustration and delves into the methods of depicting the flight area, as well as explaining the underlying reasons for these representations in the operations manual.

A.5.2 provides a sample computation for determining the minimum dimensions of the contingency volume and the ground risk buffer. These examples are intended solely as illustrative calculations. For a more in-depth analysis, one can also employ sophisticated flight mechanics-based computations. These calculations can be incorporated into the operations manual annex.

While adhering to these guidelines, it is important to cite the source of the calculations used. If the applicant chooses to use alternative calculations, it is important to provide clear explanation and supporting documentation that outlines the methodology and its safety assurances.

A.5.1 Presentation

The provided graphical representation of the flight area should contain as a minimum:

- An area: Flight Geography in transparent green colour
- An area: Contingency Volume in transparent yellow colour
- An area: Ground Risk Buffer in transparent red colour
- A position: Pilots Position (for VLOS operation)
- A position: Take Off / Landing Position (optional)

The applicant should provide the flight area to the competent authority when required. This should be in the format of a *.kml file or a similar format suitable for visualisation, accompanied by the operations manual or a referenced document that includes all pertinent flight area details. There are two methods for delineating the flight area: "inside out" or "reverse". The choice between them largely depends on the constraining factor. For many applications, the "inside out" method will provide the desired areas based on the specific flight geography.

However, there may be situations where it's preferable to utilise the maximum available ground risk buffer (e.g., controlled ground) and then determine the maximum possible flight geography from that. This is called “reverse”.

inside out: reverse:

Figure 3 inside out vs reverse computation of the flight area

Areas within the flight geography that need to be excluded for any reason (e.g. higher ground risk) should be addressed in the same way as to surround them with a contingency volume and a ground risk buffer.

A screenshot of the flight area, accompanied by a concise description, all input values, and the calculations for contingency volume (CV) and ground risk buffer (GRB) should be documented. For instance, in Part C of the operations manual according to A.3.

The content should be presented in a manner that is easily comprehensible to all parties involved in the operation, enabling swift access to all pertinent data during routine operations. It is also crucial for the competent authority to understand the calculation process. If the derivation of the calculation or the overall rationale is unusually extensive, it is advisable to relocate the sections not directly pertinent to daily operations, to the OM's annex.

Example:

Detailed information for each flight area is typically located under Part C, following the recommended format outlined in A.3. In a structured chapter layout, this might appear as:

3 Part C – Flight Areas

3.2 Flight area [project name]

Description

The flight area, along with its precise coordinates, is delineated in the accompanying KML file "[project name.kml]".

Figure 4 Graphical representation of the flight area

The centre of the figure is located at **[N53.1234567 E11.1234567]**.

The pilot's position is located at **[N53.1434567 E11.1434567]**.

General comment: [The flight area is an area used for agricultural purposes, …]

Special procedures/mitigations: [CTR Clearance for airport XY is required, as per OM 2.2]

Calculation of CV / GRB

The contingency volume and the ground risk buffer were determined using Annex A, Chapter 5

UA characteristics:

- Type: **[rotary wing without parachute]**
- Altitude measurement: **[barometric]**
- Maximum speed in operation V_0: **[10,0 m/s]**
- Maximum permissible wind speed V_{Wind}: **[3,0 m/s]**
- Characteristic dimension **CD**: **[1,50 m]**
- Maximum pitch angle Θ_{max}: **[45°]**

The following parameters were used:

- Hight of the Flight Geography H_{FG}: **[100,0 m]**
- Calculation method: **[from inside]**
- Manoeuvre on entering into the contingency volume (horizontal): **[stopping]**
- Manoeuvre on entering the contingency volume (vertical): **[kinetic into potential]**
- Manoeuvre on entering the Ground Risk Buffer: **[power off]**

Assumptions:

- GNSS accuracy S_{GNSS}: **[0,5 m]**
- Position holding error S_{Pos}: **[3,0 m]**
- Map error S_K: **[1,0 m]**
- Reaction time t_R: **[1,0 s]**
- Altitude measurement error H_{AM}: **[H_{Baro} = 1,0 m]**
- Additional distance (horizontal) S_{Add}: **[0,0 m]**
- Additional distance (vertical) H_{Add}: **[0,0 m]**

Reasons for deviations from the standard values:

- S_{GPS} (**[0,5 m]** instead of **[3,0 m]**): **[The UA is equipped with …]**
- …
- H_{CM} (**[3,0 m]** instead of **[5,1 m]**): **[The assumption based on …]**

Results

Flight altitude

- Altitude of the flight geography $\boldsymbol{H_{FG}}$: **[100,0 m]**

Contingency Volume:

- Horizontal $\boldsymbol{S_{CV}}$: **[34,5 m]**
- Vertical $\boldsymbol{H_{CV}}$**:** **[113,1 m]**

Ground Risk Buffer:

- Horizontal $\boldsymbol{S_{GRB}}$: **[113,8 m]**

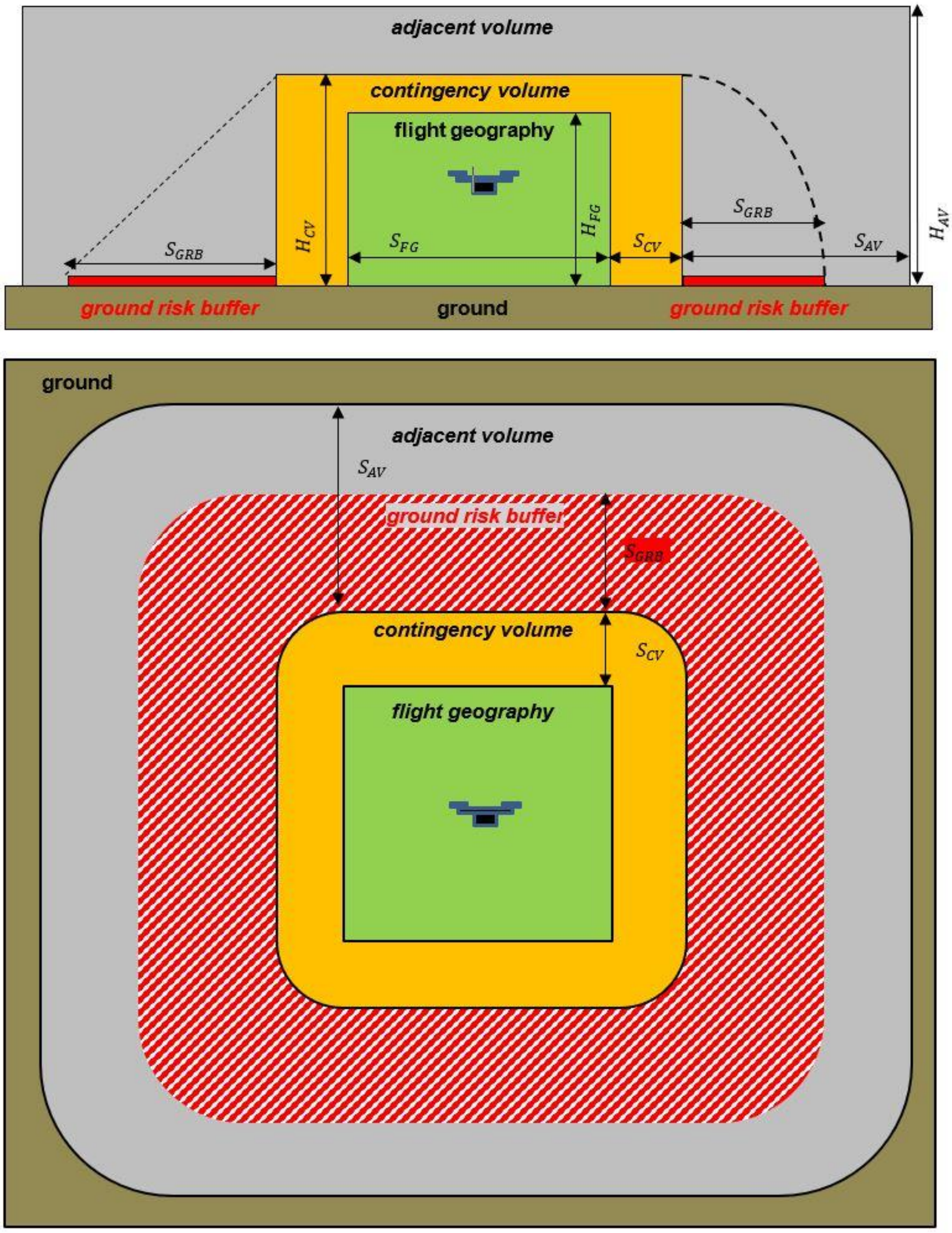

Figure 5 Schematic representation of Flight Geography, Contingency Volume and Ground Risk Buffer

A.5.2 Calculations used in the example case above.

A.5.2.1 Information Required for Calculations

V_0, m/s	Maximum operational speed that is flown. This corresponds to the information in field 0.8 in the A.2 form. *Note: A speed below 3 m/s for multirotor and 1.25 ⋅ $V_{\text{Stall,clean}}$ for fixed-wing aircraft is not considered realistic.*
CD, m	The "Maximum UA characteristic dimension" or "CD" is the maximum possible length of a straight line that can be spanned from one point on the UA geometry to another point. Propellers and rotors are part of the geometry, whereby their most unfavourable position is considered. This corresponds to the information in field 0.6 of the A.2 form. *Note: Commonly used values for:* *Fixed-wing aircraft* • *Wing-span or* • *Fuselage length* *Multirotor* • *Diagonal distance from rotor tip to rotor tip, rotors in unfavourable position*
V_{Wind}, m/s	Maximum wind speed specified in the operations manual up to which the UA may be operated.
FG	Flight Geography
CV	Contingency Volume
GRB	Ground Risk Buffer

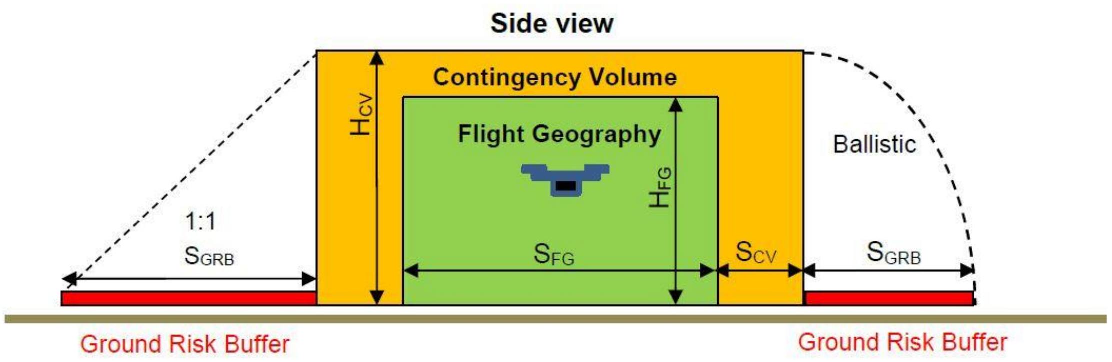

Figure 6 Schematic representation of Flight Geography, Contingency Volume and Ground Risk Buffer

A.5.2.2 Computation Flight Geography

Variant 1 (inside out):

The size of the flight geography usually results from the operator's desired flight geography. The contingency volume and the ground risk buffer just add up to this area.

Variant 2 (reverse):

Determination of the maximum flight geography available, e.g. when operating over a controlled ground area.

In this example (controlled ground), the ground projection of flight geography, contingency volume and the ground risk buffer must be completely contained in the controlled ground area. A calculation in reverse is recommended:

The outer limit of the ground risk buffer corresponds to the topology of the controlled ground area.

In the first step, the horizontal extent (width) of the ground risk buffer is subtracted from the topology of the controlled ground area. This gives the boundary between the contingency volume and the ground risk buffer.

In the second step, the horizontal extent (width) of the contingency volume is then subtracted from this limit. This results in the maximum possible expansion of the flight geography as the remaining area.

Notes on the realistic definition of particularly small flight geographies:

FG horizontal	
Width flight geography: S_{FG}	$S_{\mathrm{FG}} \geq 3\ \mathrm{CD}$
FG vertical	
Height flight geography: H_{FG}	$H_{\mathrm{FG}} \geq 3\ \mathrm{CD}$
Note: Smaller values than $H_{\mathrm{FG}} = 3\ \mathrm{CD}$ and $S_{\mathrm{FG}} = 3\ \mathrm{CD}$ are considered unrealistic, also for automated waypoint flights.	

A.5.2.3 Computation Contingency Volume

Notes on the realistic dimensioning of the contingency volume. Assumptions can be substituted with real values if evidence is available:

CV horizontal	
GNSS accuracy: S_{GNSS}	$S_{\mathrm{GNSS}} = 3\ \mathrm{m}$
Position holding error: S_{Pos}	$S_{\mathrm{Pos}} = 3\ \mathrm{m}$
Map error: S_{K}	$S_{\mathrm{K}} = 1\ \mathrm{m}$
Reaction distance: S_{R}	<u>Manual initiation of measures</u> Reaction time: $t_{\mathrm{R}} = 1\ \mathrm{s}$, with V_0 results in $S_{\mathrm{R}} = V_0\ t_R$ *Note: t_{R} can also be smaller in fully automatic systems (e.g. geofence).*
Contingency manoeuvres: S_{CM}	<u>Multirotor - stopping</u> Based on $S_{\mathrm{CM}} = \frac{1}{2}\ a\ {t_{\mathrm{R}}}^2 + V_0\ t_{\mathrm{R}}$ follows for a thrust to weight ratio of at least 2 $\mathrm{thrust} \geq 2\ m\ g$ and a maximum pitch angle of less than 45 degrees $\Theta_{\max} \leq 45^{\circ}$ The minimum distance for stopping to hovering mode is: $S_{\mathrm{CM}} = \frac{1}{2} \frac{{V_0}^2}{g\ \tan(\Theta)}$ <u>Fixed-wing aircraft -180° turn:</u> Assumption: roll angle $\Phi_{\max} \leq 30^{\circ}$ The radius for the turn is: $S_{\mathrm{CM}} = \frac{{V_0}^2}{g\ \tan(\Phi)}$
Alternative contingency manoeuvre parachute: S_{CM}	Flight terminated with parachute triggered when leaving the FG t_{P} =Time to open the parachute $S_{\mathrm{CM}} = V_0\ t_{\mathrm{P}}$
Horizontal extension of the contingency volume: S_{CV}	$S_{\mathrm{CV}} = S_{\mathrm{GPS}} + S_{\mathrm{Pos}} + S_{\mathrm{K}} + S_{\mathrm{R}} + S_{\mathrm{CM}}$

Examples	
Example multirotors: $V_0 = 10\ \frac{\mathrm{m}}{\mathrm{s}}, \Theta = 45^{\circ}, [\tan(45°) = 1]$	$$S_{\mathrm{CV}} = 3\ \mathrm{m} + 3\ \mathrm{m} + 1\ \mathrm{m} + 10\ \mathrm{m} + \frac{1}{2} \cdot \frac{\left(10\ \frac{\mathrm{m}}{\mathrm{s}}\right)^2}{9{,}81\ \frac{\mathrm{m}}{\mathrm{s}^2} \cdot 1} = 22{,}1\ \mathrm{m}$$
Example fixed-wing aircraft: $V_0 = 30\ \frac{\mathrm{m}}{\mathrm{s}}, \Phi = 30^{\circ}$	$$S_{\mathrm{CV}} = 3\ \mathrm{m} + 3\ \mathrm{m} + 1\ \mathrm{m} + 30\ \mathrm{m} + \frac{\left(30\ \frac{\mathrm{m}}{\mathrm{s}}\right)^2}{9{,}81\ \frac{\mathrm{m}}{\mathrm{s}^2} \cdot \tan(30°)} = 195{,}9\ \mathrm{m}$$
CV vertical	
Altitude measurement error: H_{AM}	$H_{\mathrm{AM}} = H_{\mathrm{Baro}} = 1\ \mathrm{m}$ for barometric altitude measurement, or $H_{\mathrm{AM}} = H_{\mathrm{GNSS}} = 4\ \mathrm{m}$ for GNSS-based altitude measurement
Reaction distance: H_{R}	<u>Manual initiation of measures</u> Reaction time: $t_{\mathrm{R}} = 1$ s, with 45° pitch angle results $$H_{\mathrm{R}} = V_0 \cdot 0{,}7 \cdot t_{\mathrm{R}}$$ *Note: t_{R} can also be smaller in fully automatic systems (e.g. geofence).*
Contingency manoeuvres: H_{CM}	<u>For multirotor</u> The forward kinetic energy is completely converted into potential energy. This results in $$H_{\mathrm{CM}} = \frac{1}{2} \frac{{V_0}^2}{g}$$ <u>For fixed-wing aircraft</u> Exit the FG upwards with a 45° pitch angle, then fly on a constant circular path with V_0 and radius *r* until level flight is achieved. With $$r = \frac{{V_0}^2}{g}$$ results in the contingency manoeuvre height being approximately $$H_{\mathrm{CM}} = \frac{{V_0}^2}{g} \cdot 0{,}3$$
Alternate contingency manoeuvre parachute: H_{CM}	Flight terminated with parachute triggered when leaving the FG Exit FG with 45° pitch angle t_{P} = Time to open the parachute $$H_{\mathrm{CM}} = V_0 \cdot t_{\mathrm{P}} \cdot 0{,}7$$

Contingency volume: H_{CV}	$H_{\mathrm{CV}} = H_{\mathrm{FG}} + H_{\mathrm{AM}} + H_{\mathrm{R}} + H_{\mathrm{CM}}$
Examples	
Height of flight geography	$H_{\mathrm{FG}} = 100\ \mathrm{m}$
Example multirotor: $V_0 = 10\ \frac{\mathrm{m}}{\mathrm{s}}$	$H_{\mathrm{CV}} = 100\ \mathrm{m} + 1\ \mathrm{m} + 7\ \mathrm{m} + \frac{1}{2} \cdot \frac{\left(10\ \frac{\mathrm{m}}{\mathrm{s}}\right)^2}{9{,}81\ \frac{\mathrm{m}}{\mathrm{s}^2}} = 113{,}1\ \mathrm{m}$
Example fixed-wing a/c: $V_0 = 30\ \frac{\mathrm{m}}{\mathrm{s}}$	$H_{\mathrm{CV}} = 100\ \mathrm{m} + 1\ \mathrm{m} + 21\ \mathrm{m} + \frac{\left(30\ \frac{\mathrm{m}}{\mathrm{s}}\right)^2}{9{,}81\ \frac{\mathrm{m}}{\mathrm{s}^2}} \cdot 0{,}3 = 149{,}52\ \mathrm{m}$

A.5.2.4 Computation Ground Risk Buffer

GRB horizontal	
Simplified approach: 1:1 rule: S_{GRB}	$S_{\mathrm{GRB}} = H_{\mathrm{CV}} + \frac{1}{2}\ \mathrm{CD}$
Ballistic approach: S_{GRB} ***Note: Only permitted for rotorcraft and multirotors!***	$S_{\mathrm{GRB}} = V_0 \sqrt{\frac{2\ H_{\mathrm{CV}}}{g}} + \frac{1}{2}\mathrm{CD}$
Termination with parachute: S_{GRB} *Note: Values below $V_{\mathrm{Wind}} = 3\ \frac{\mathrm{m}}{\mathrm{s}}$ are not considered realistic for this computation.*	t_{P} = Time to open the parachute From the rate of descent with the parachute open (V_{z}) and the maximum permissible wind speed for operation (V_{Wind}) results $S_{\mathrm{GRB}} = V_0\ t_{\mathrm{P}} + V_{\mathrm{Wind}}\ \frac{H_{\mathrm{CV}}}{V_{\mathrm{z}}}$
Termination with fixed-wing aircraft: S_{GRB}	• <u>Power is switched off:</u> A glide ratio of $E = \frac{1}{\varepsilon} = \frac{C_{\mathrm{L}}}{C_{\mathrm{D}}}$ results in $S_{\mathrm{GRB}} = E\ H_{\mathrm{CV}}$ • <u>Power is switched off and the flight control surfaces are permanently set in a way that no gliding is possible:</u> The simplified approach can be chosen (1:1 rule).
Examples	
Simplified approach: Multirotor: $V_0 = 10\ \frac{\mathrm{m}}{\mathrm{s}}$, $\mathrm{CD} = 1{,}5\ \mathrm{m}$, $H_{\mathrm{CV}} = 113{,}1\ \mathrm{m}$	$S_{\mathrm{GRB}} = 113{,}1\ \mathrm{m} + \frac{1}{2} \cdot 1{,}5\ \mathrm{m} = 113{,}85\ \mathrm{m}$
Ballistic Approach: Multirotor: $V_0 = 10\ \frac{\mathrm{m}}{\mathrm{s}}$, $\mathrm{CD} = 1{,}5\ \mathrm{m}$, $H_{\mathrm{CV}} = 113{,}1\ \mathrm{m}$	$S_{\mathrm{GRB}} = 10\ \frac{\mathrm{m}}{\mathrm{s}} \sqrt{\frac{2 \cdot 113{,}1\ \mathrm{m}}{9{,}81\ \frac{\mathrm{m}}{\mathrm{s}^2}}} + \frac{1}{2} \cdot 1{,}5\ \mathrm{m} = 48{,}77\ \mathrm{m}$
Fixed-wing aircraft only power is switched off: $V_0 = 30\ \frac{\mathrm{m}}{\mathrm{s}}$, $\mathrm{CD} = 3\ \mathrm{m}$, $H_{\mathrm{CV}} = 149{,}52\ \mathrm{m}$	$E = 20$ $S_{\mathrm{GRB}} = 149{,}52\ \mathrm{m} \cdot 20\ = 2990{,}4\ \mathrm{m}$
Fixed-wing aircraft power is switched off and flight control surfaces set so that no gliding is possible: $V_0 = 30\ \frac{\mathrm{m}}{\mathrm{s}}$, $\mathrm{CD} = 3\ \mathrm{m}$, $H_{\mathrm{CV}} = 149{,}52\ \mathrm{m}$	$S_{\mathrm{GRB}} = 149{,}52\ \mathrm{m} + \frac{1}{2} \cdot 3\ \mathrm{m} = 151{,}02\ \mathrm{m}$
GRB vertical	- not applicable -

A.5.2.5 Examples of Computation for VLOS/BVLOS Maximum Distance(s)

When determining the operating range for visual line of sight (VLOS) operations, care must be taken to ensure that the remote pilot can actually operate the UAS within visual range.

To check whether the described UAS operation is in VLOS or beyond visual line of sight (BVLOS), the following calculations may be used.

VLOS / EVLOS limit	The maximum possible VLOS distance between remote pilot or observer and UA results from the **<u>smaller</u> value of ALOS and DLOS**. Anything beyond that is considered **BVLOS**.
ALOS	Attitude Line of Sight The attitude line of sight defines the maximum distance up to which a remote pilot can detect the position and orientation of the UA. Up to this limit, the remote pilot is able to control the flight path of the UA and is able to determine the attitude and position of the UA. This distance was determined in practical tests.
DLOS	Detection Line of Sight The detection line of sight defines the distance up to which other aircraft can be visually detected, and sufficient time is available for an avoidance manoeuvre. The ground visibility is crucial for this.
GV	Ground Visibility The ground visibility depends on the operational area and the meteorological conditions, and must be determined at the respective time of operation. The procedure for precisely determining ground visibility should be described in the operations manual. The use of landmarks or the use of a transmissometer are possible. The maximum ground visibility to be assumed is **5 km**, analogue to the visibility according to the VFR rules in airspace G.

ALOS limit	<u>For rotorcraft and multirotors</u> $\mathrm{ALOS_{max}} = 327 \cdot \mathrm{CD} + 20\ \mathrm{m}$ <u>For fixed-wing aircraft:</u> $\mathrm{ALOS_{max}} = 490 \cdot \mathrm{CD} + 30\ \mathrm{m}$
DLOS limit	$\mathrm{DLOS_{max}} = 0{,}3 \cdot \mathrm{GV}$ GV depends on the actual ground visibility at site and time of operation. However, it always applies: $\mathrm{GV_{max}} = 5\ \mathrm{km}$

If the largest possible distance between the pilot's location and the outer side of the contingency volume (boundary between contingency volume and ground risk buffer) is greater than the VLOS boundary, no VLOS operation can take place. Operations must then take place in BVLOS.

A.5.2.6 Examples for maximum VLOS distances

The following table is valid for a ground visibility of 5 km or more.

Characteristic dimension (CD)	Maximum VLOS distance	
	Rotary Wing	Fixed Wing
1 m	347 m	520 m
2 m	674 m	1010 m
3 m	1000 m	1500 m
3,5 m	1164,5 m	1500 m
4 m	1328 m	1500 m
4,53 m	1500 m	1500 m
> 4,53 m	1500 m	1500 m

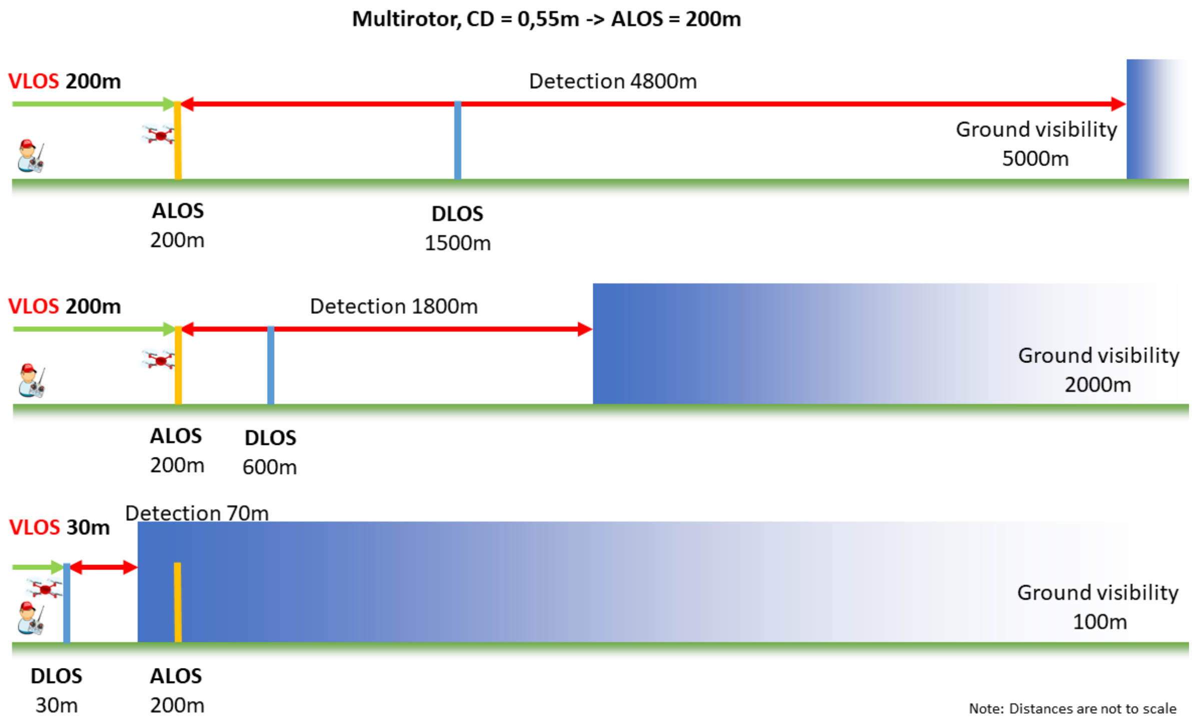

Figure 7: Multirotor VLOS Range

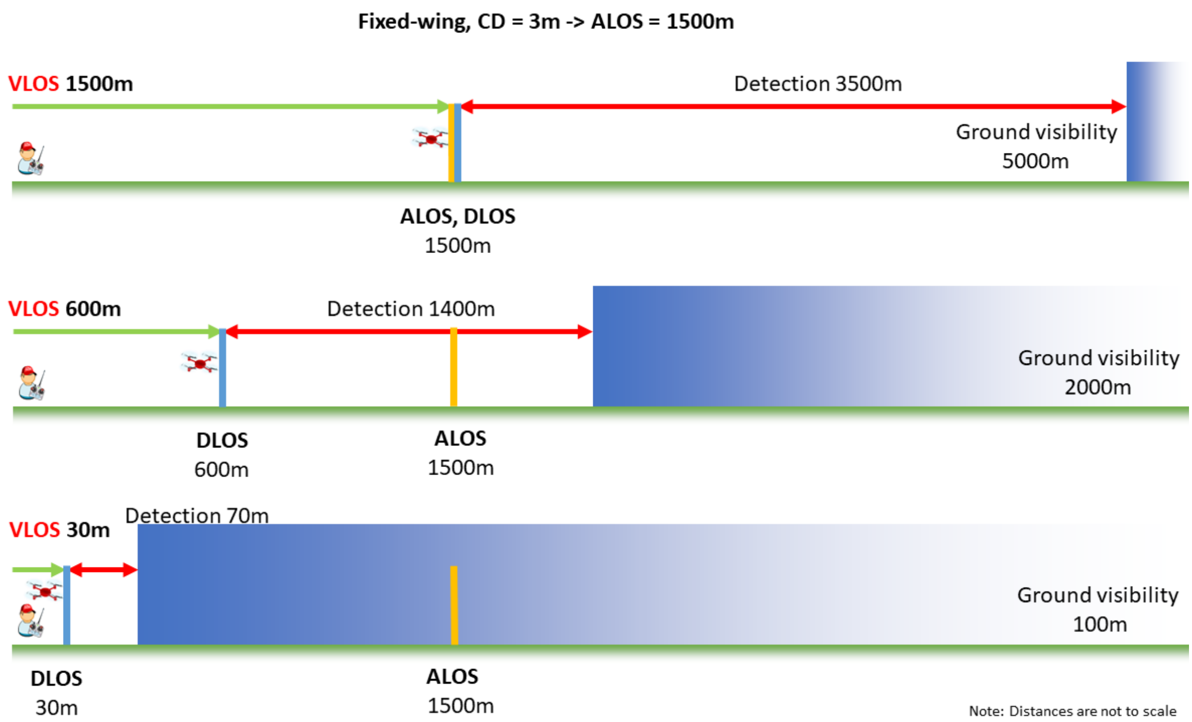

Figure 8: Fixed-wing VLOS Range