Joint Authorities for Rulemaking on Unmanned Systems

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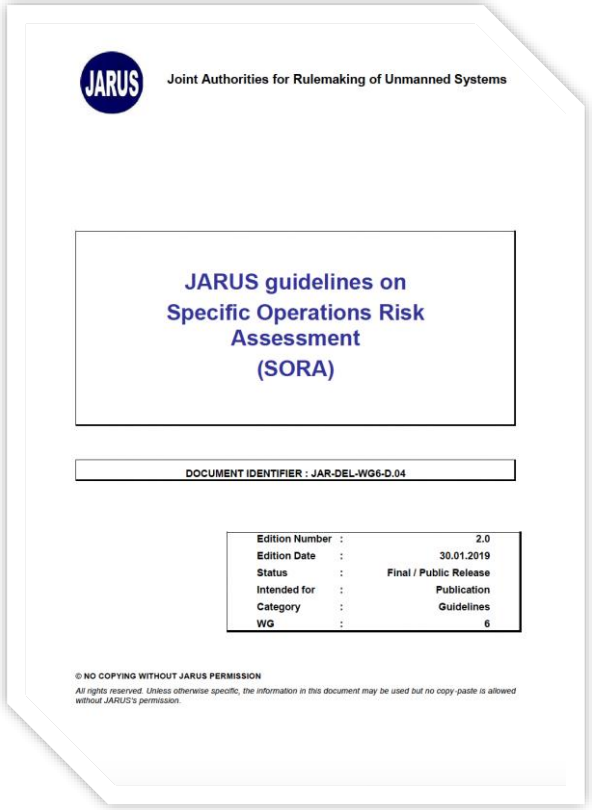
Joint Authorities for Rulemaking of Unmanned Systems

JARUS guidelines on
Specific Operations Risk Assessment
(SORA)

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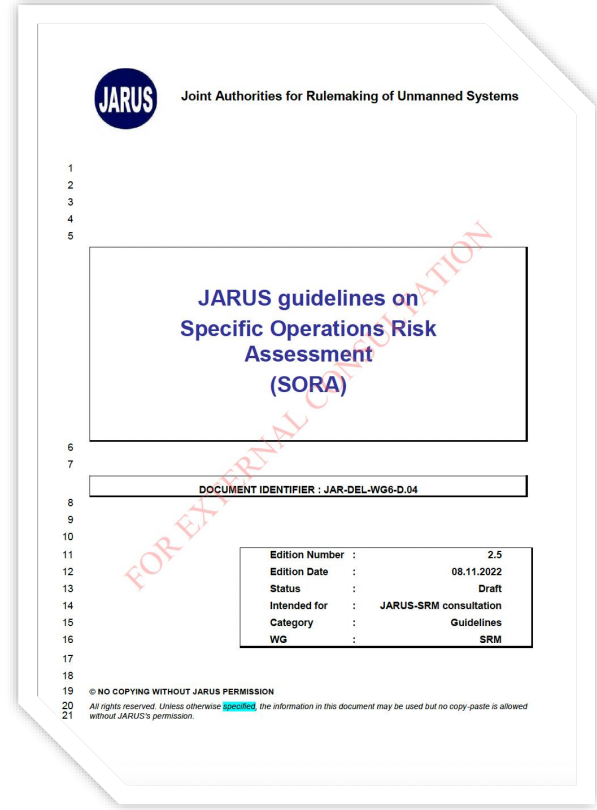
SORA v2.0 to v2.5

Summary of changes for external consultation


Joint Authorities for Rulemaking of Unmanned Systems

JARUS guidelines on
Specific Operations Risk Assessment
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DOCUMENT IDENTIFIER : JAR-DEL-WG6-D.04

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The package v2.0

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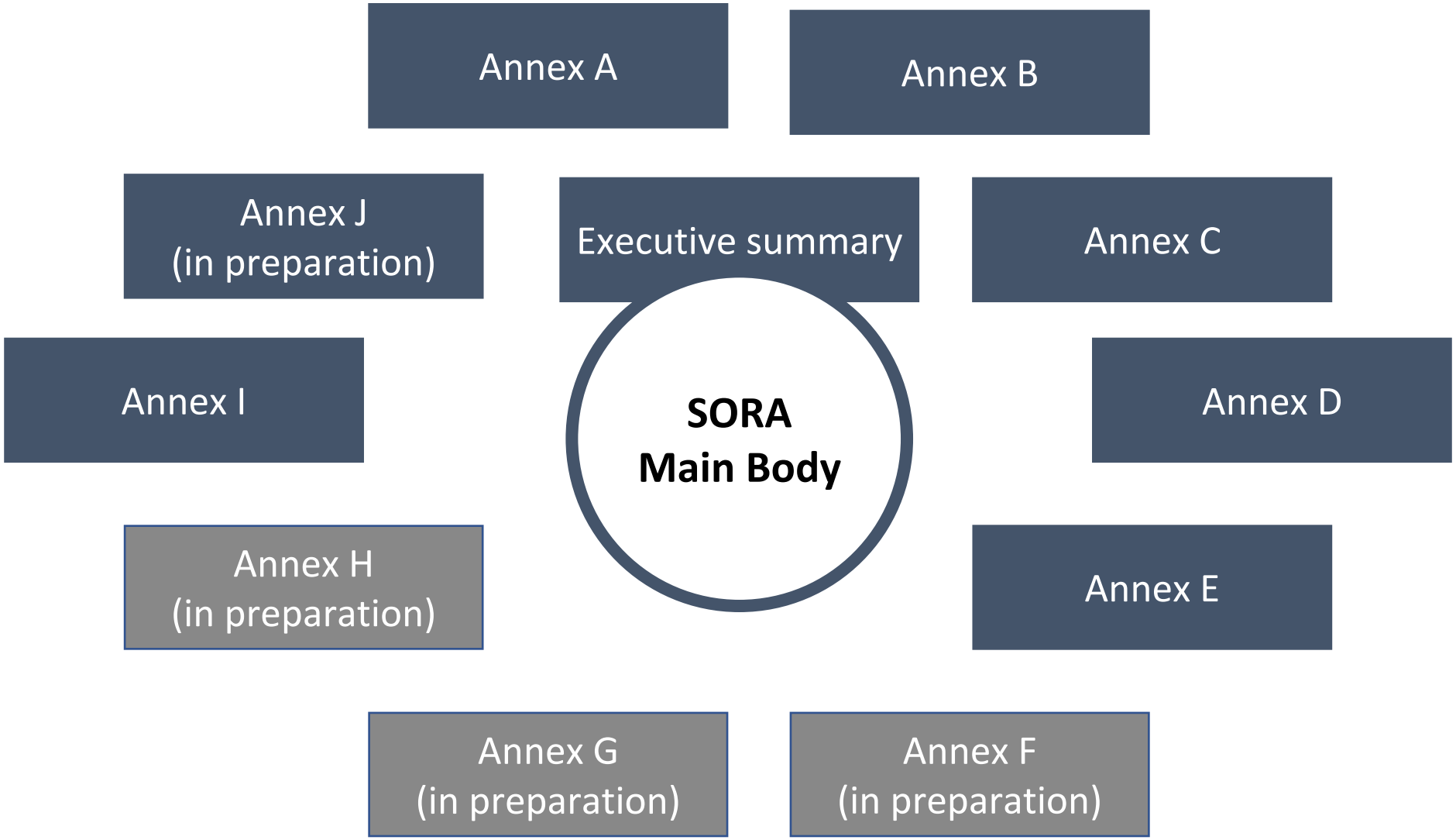

The package v2.5

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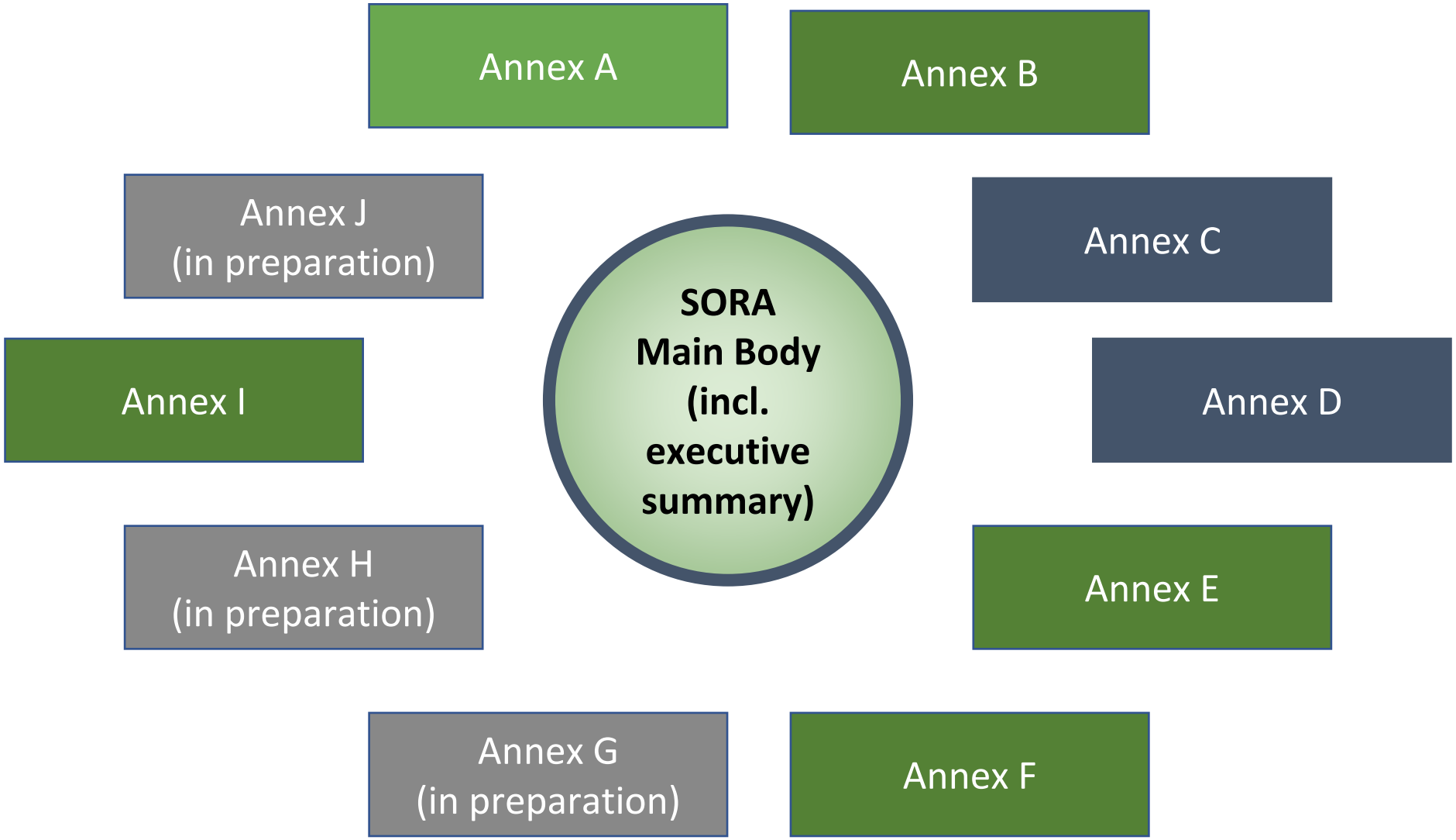

Document: Main Body

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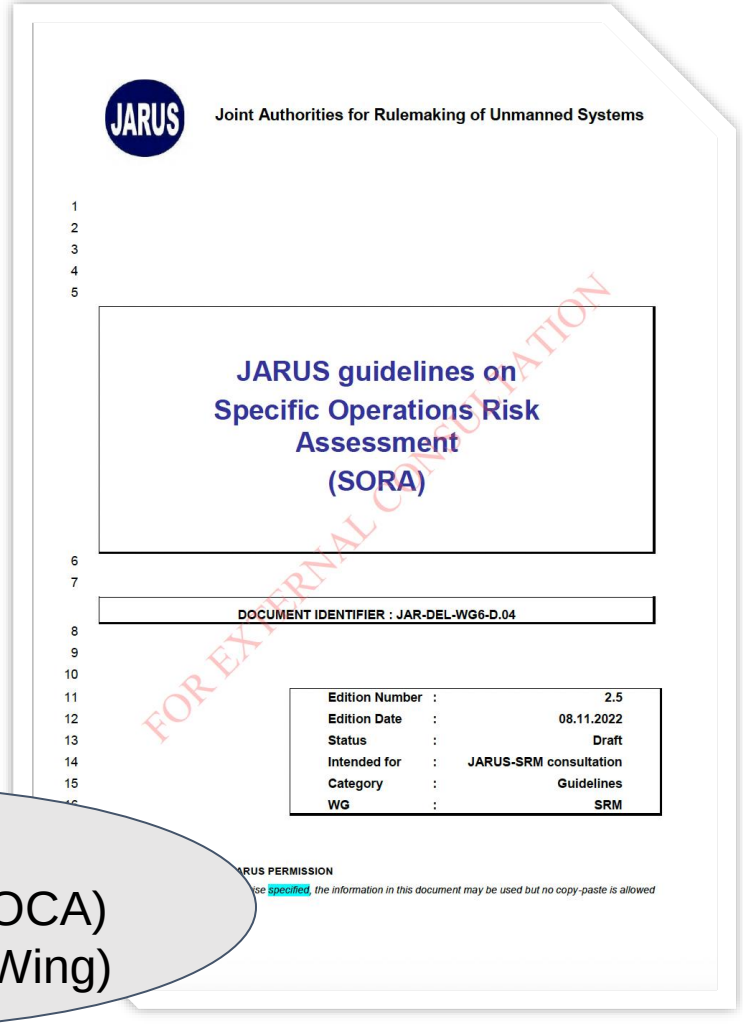

Joint Authorities for Rulemaking of Unmanned Systems

JARUS guidelines on
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Co-Leads:
Andreea Perca (FOCA)
Anthony Naninni (Wing)

Document: Main Body
Content change: Executive summary

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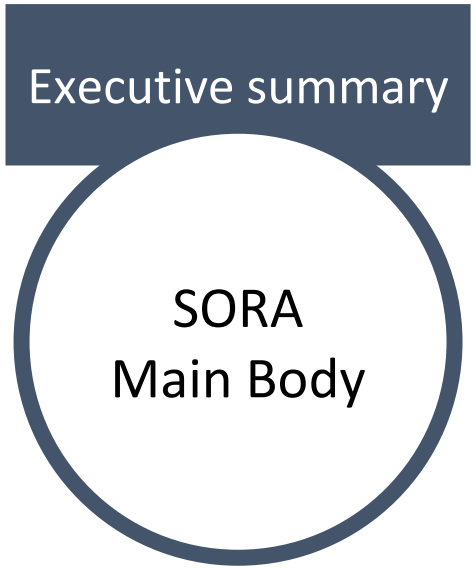
v2.0



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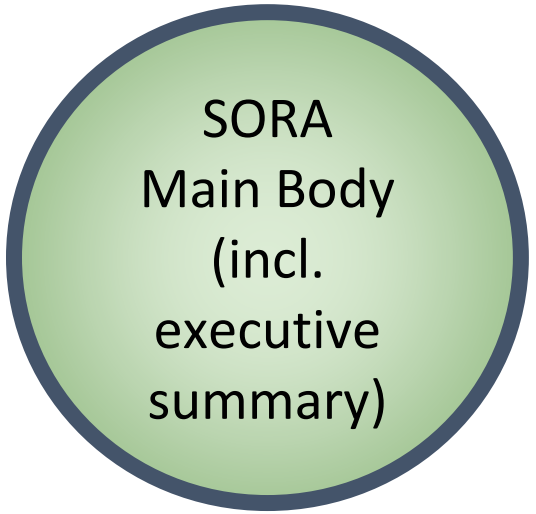

Content:

- Explanation of the SORA approach
- Target Level of Safety
- SORA Steps

Document: Main Body
Content change: Applicability

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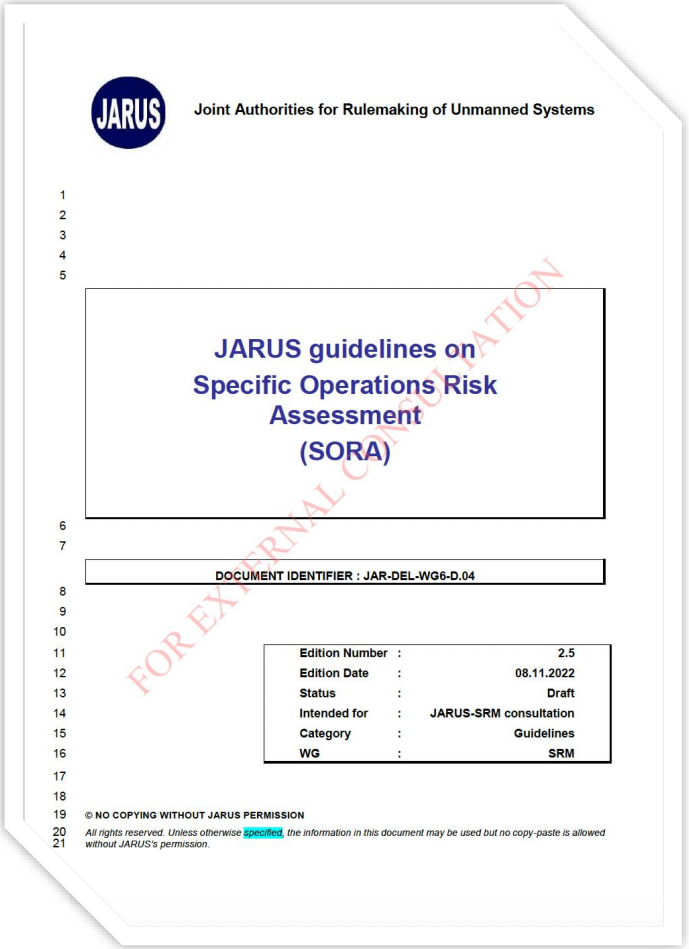
v2.5

Reference to Annex E sub-Annex on cybersecurity:

Where cyber security threats apply and may have an impact on safety, a sub-Annex to Annex E provides guidelines to ensure that reasonable and proportionate cyber safety considerations are applied.

Reference to Annex H not yet included, pending external consultation.



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Document: Main Body
Content change: Semantic model

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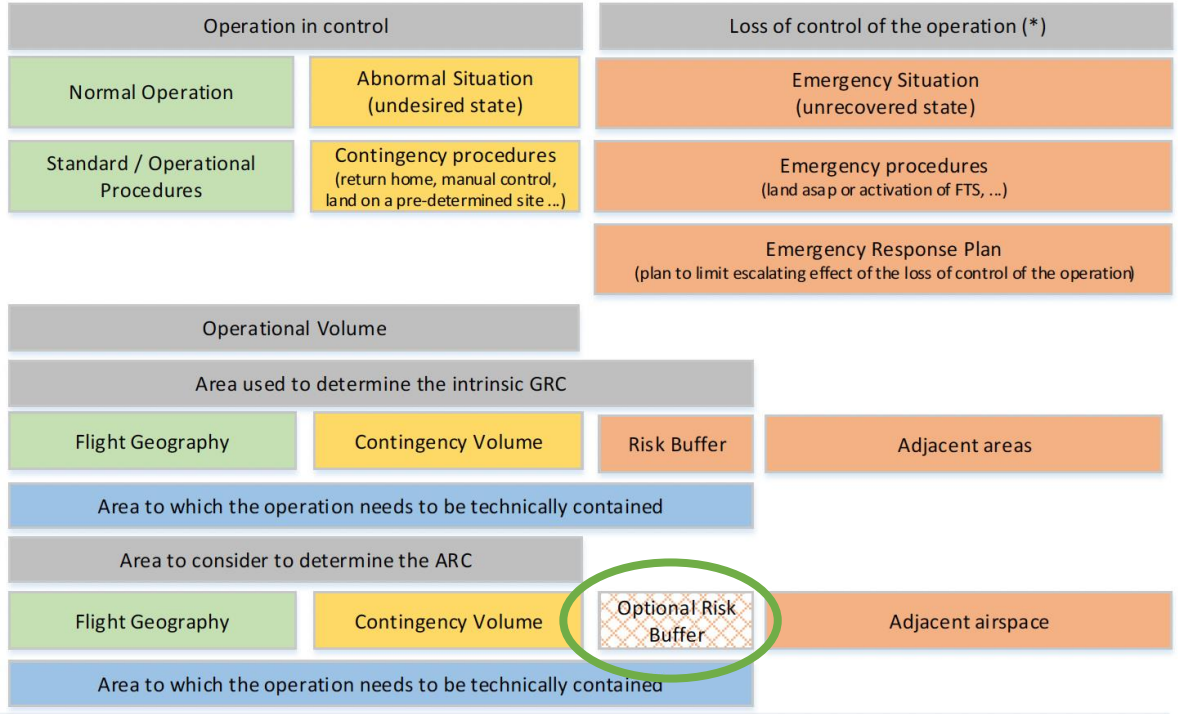
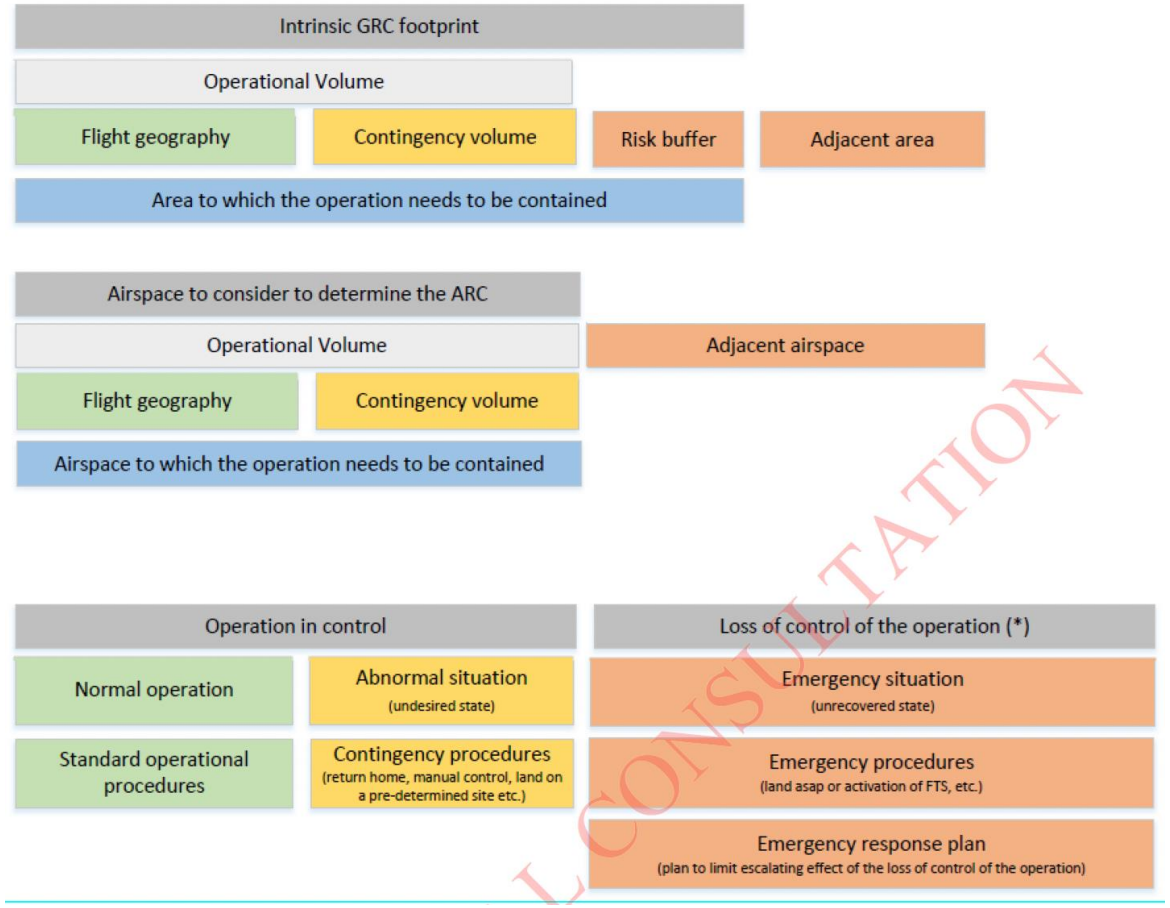


v2.5



CONSULTATION

Document: Main Body
Content change: Semantic model

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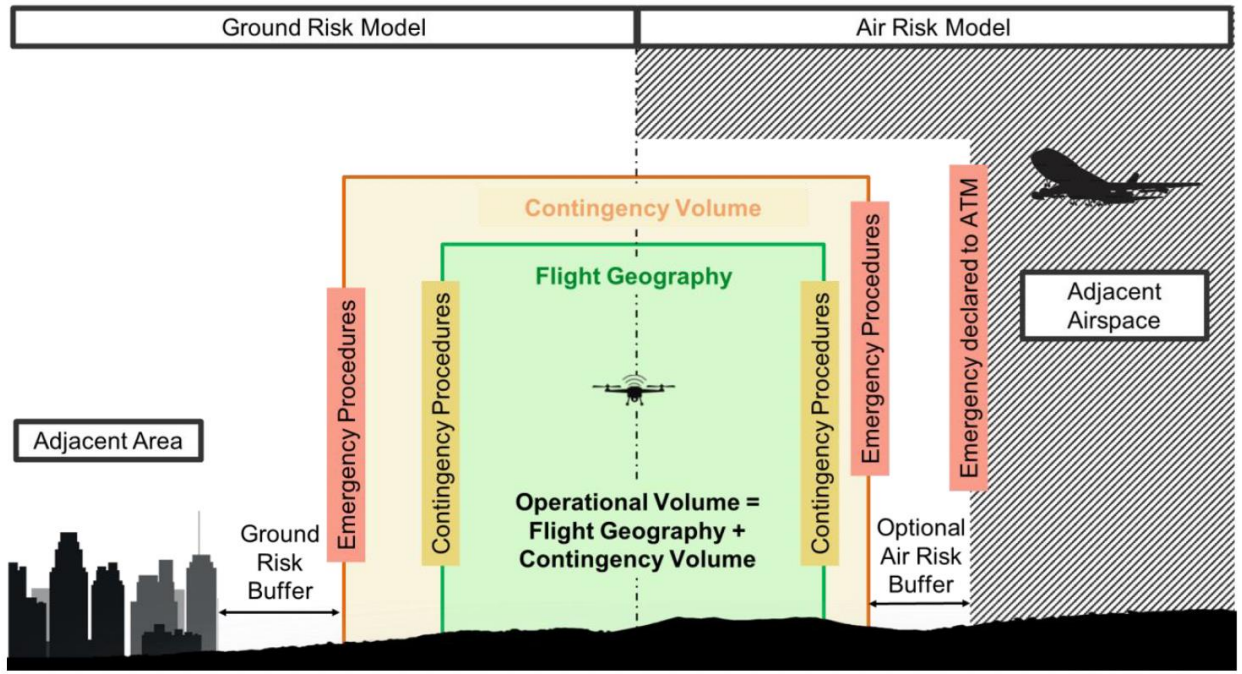
v2.0



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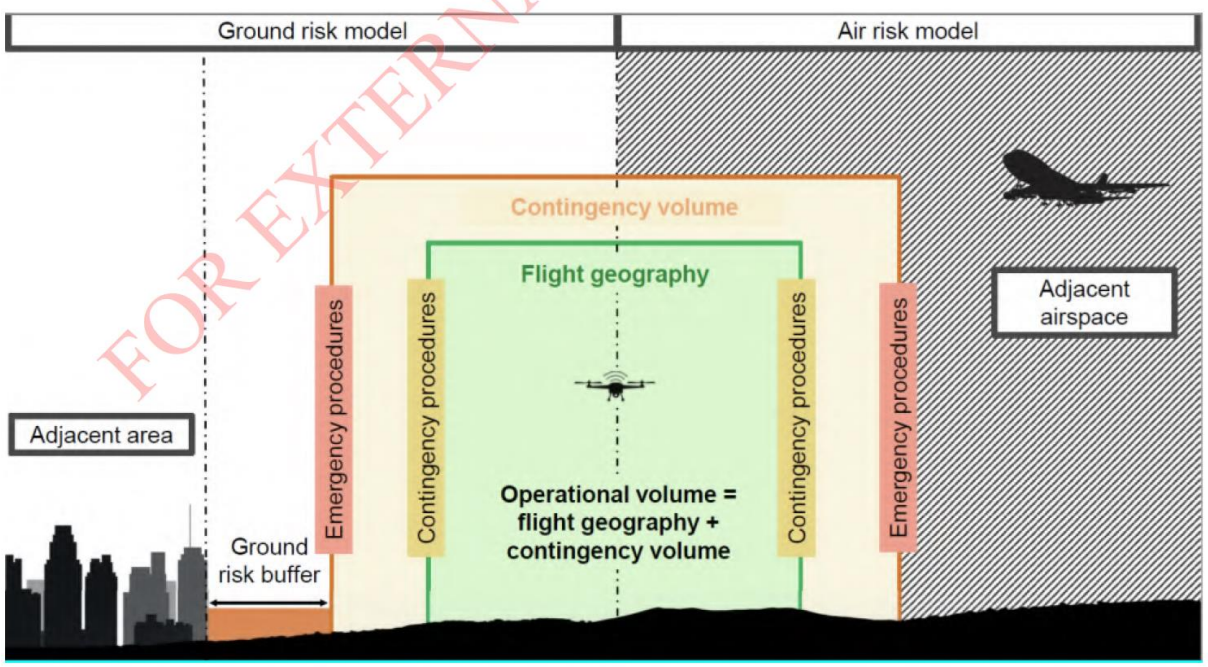

FOR EXTERN

Document: Main Body
Content change: Process outline

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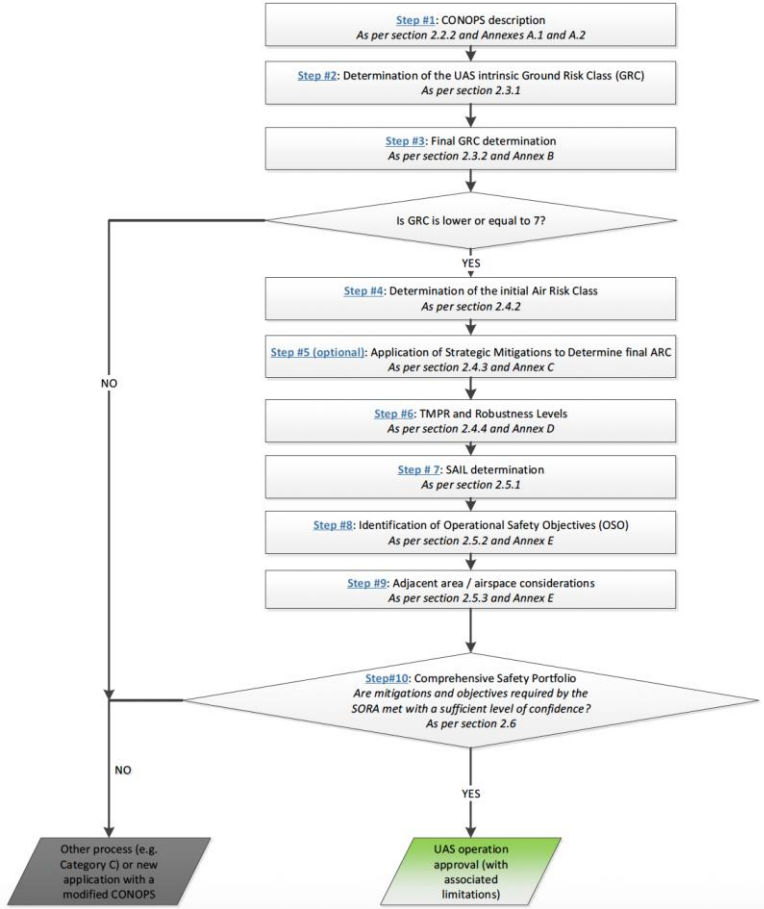

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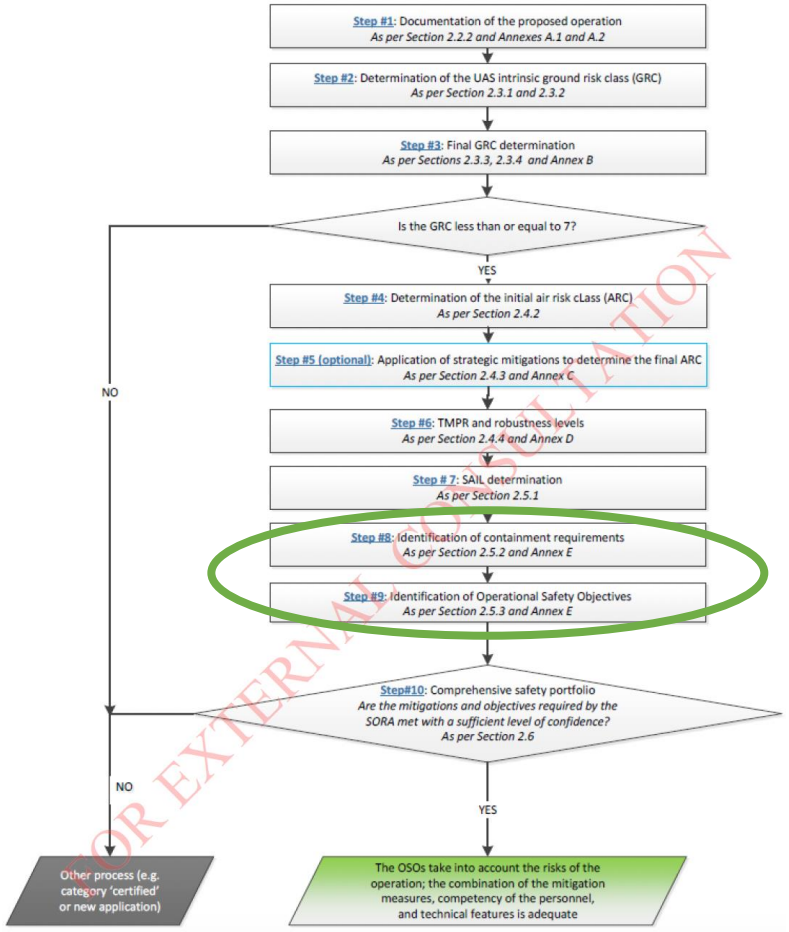

Document: Main Body
Content change: SORA Phases (new)

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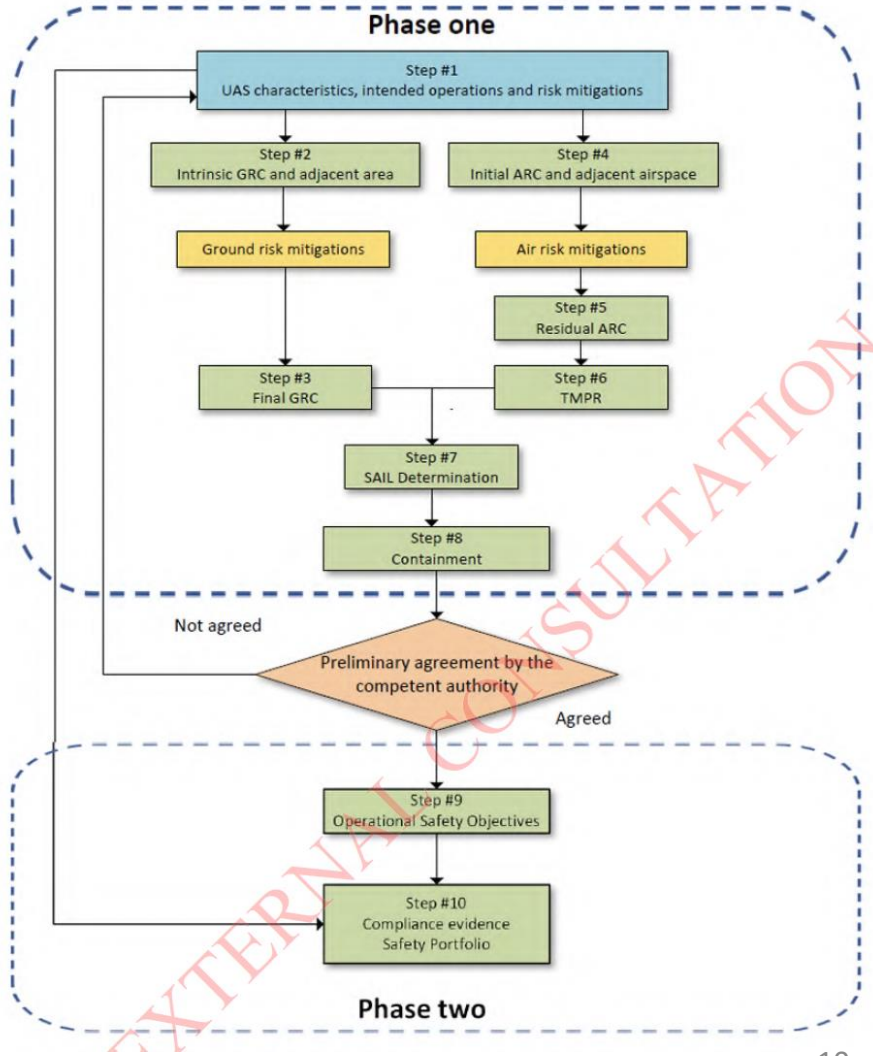
v2.5

This iterative process may be split into two phases, as described. This approach should minimise the risk of further iterations in the UAS design, in the envisaged operations and the envisaged risk mitigations.



EXTERNAL CONSULTATION

Document: Main Body / Annex A
Content change: Step #1

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v2.0

Step#1 – ConOps Description

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.

v2.5

Step#1 – Documentation of the proposed operation(s)

The purpose of this step is to describe the documentation set that should be compiled and presented to the competent authority for assessment after Step #10 completion. This usually consists of the:

i. Operator manual,
ii. Compliance evidence,
iii. SORA safety case

Document: Main Body / Annex F
Content change: Step #2 - The ground risk process

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v2.0

Intrinsic UAS Ground Risk Class				
Max UAS characteristics dimension	1 m / approx. 3ft	3 m / approx. 10ft	8 m / approx. 25ft	>8 m / approx. 25ft
Typical kinetic energy expected	*< 700 J (approx. 529 Ft Lb)*	*< 34 KJ (approx. 25000 Ft Lb)*	*< 1084 KJ (approx. 800000 Ft Lb)*	*> 1084 KJ (approx. 800000 Ft Lb)*
Operational scenarios				
VLOS/BVLOS over controlled ground area	1	2	3	4
VLOS in sparsely populated environment	2	3	4	5
BVLOS in sparsely populated environment	3	4	5	6
VLOS in populated environment	4	5	6	8
BVLOS in populated environment	5	6	8	10
VLOS over gathering of people	7			
BVLOS over gathering of people	8			

Table 2 – Intrinsic Ground Risk Classes (GRC) Determination

v2.5

Intrinsic UAS Ground Risk Class						
Max UA characteristics dimension		1 m	3 m	8 m	20 m	40 m
Max cruise speed		*25 m/s*	*35 m/s*	*75 m/s*	*150 m/s*	*200 m/s*
Maximum iGRC population density (ppl/km²)	**Controlled ground area**	1	2	3	4	5
	< 25	3	4	5	6	7
	< 250	4	5	6	7	8
	< 2,500	5	6	7	8	9
	< 25,000	6	7	8	9	10
	< 250,000	7	8	9	10	11
	> 250,000	7	9	Category C Operations (Not part of SORA)		

Table 2 – Intrinsic Ground Risk Class (GRC) Determination

Document: Main Body / Annex F
Content change: Step #2 - The ground risk process

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v2.0

Intrinsic UAS Ground Risk Class				
Max UAS characteristics dimension	1 m / approx. 3ft	3 m / approx. 10ft	8 m / approx. 25ft	>8 m / approx. 25ft
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BVLOS in populated environment	5	6	8	10
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BVLOS over gathering of people	8			

Table 2 – Intrinsic Ground Risk Classes (GRC) Determination

v2.5

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Max UA characteristics dimension		1 m	3 m	8 m	20 m	40 m
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Maximum iGRC population density (ppl/km²)	**Controlled ground area**	1	2	3	4	5
	< 25	3	4	5	6	7
	< 250	4	5	6	7	8
	< 2,500	5	6	7	8	9
	< 25,000	6	7	8	9	10
				9	10	11
Category C Operations (Not part of SORA)						

(GRC) Determination

Quantitative Population Value (ppl/km2)	< 25	< 250	< 2,500	< 25,000	< 250,000	> 250,000
Qualitative Description	Rural	Sparsely Populated	Suburban	Urban	Dense Urban	Assembly of people 10,000 is the minimum number of people to qualify for assembly of people

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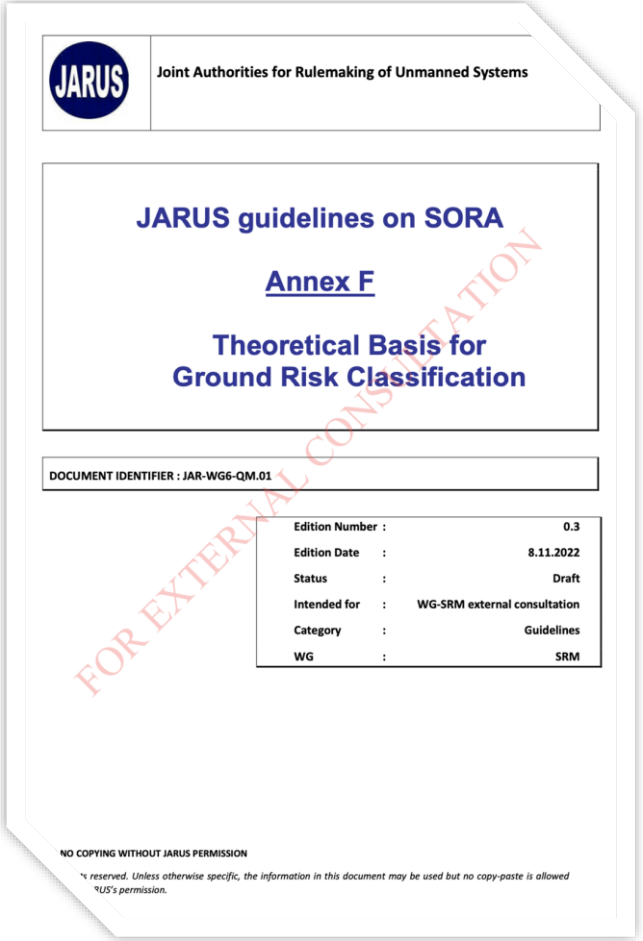
Document: Annex F
Content: Theoretical Basis for Ground Risk Classification

v2.5

Annex F provides all details and justification for the GRC.

Normally, applicants are not required to consult Annex F, unless they would like to propose to the NAA some more sophisticated solutions tailoring the model to their operation.



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Annex F

Theoretical Basis for Ground Risk Classification

FOR EXTERNAL CONSULTATION

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Document: Main Body
Content: Step #2 - Determination of the adjacent area size and adjacent area intrinsic GRC

v2.5

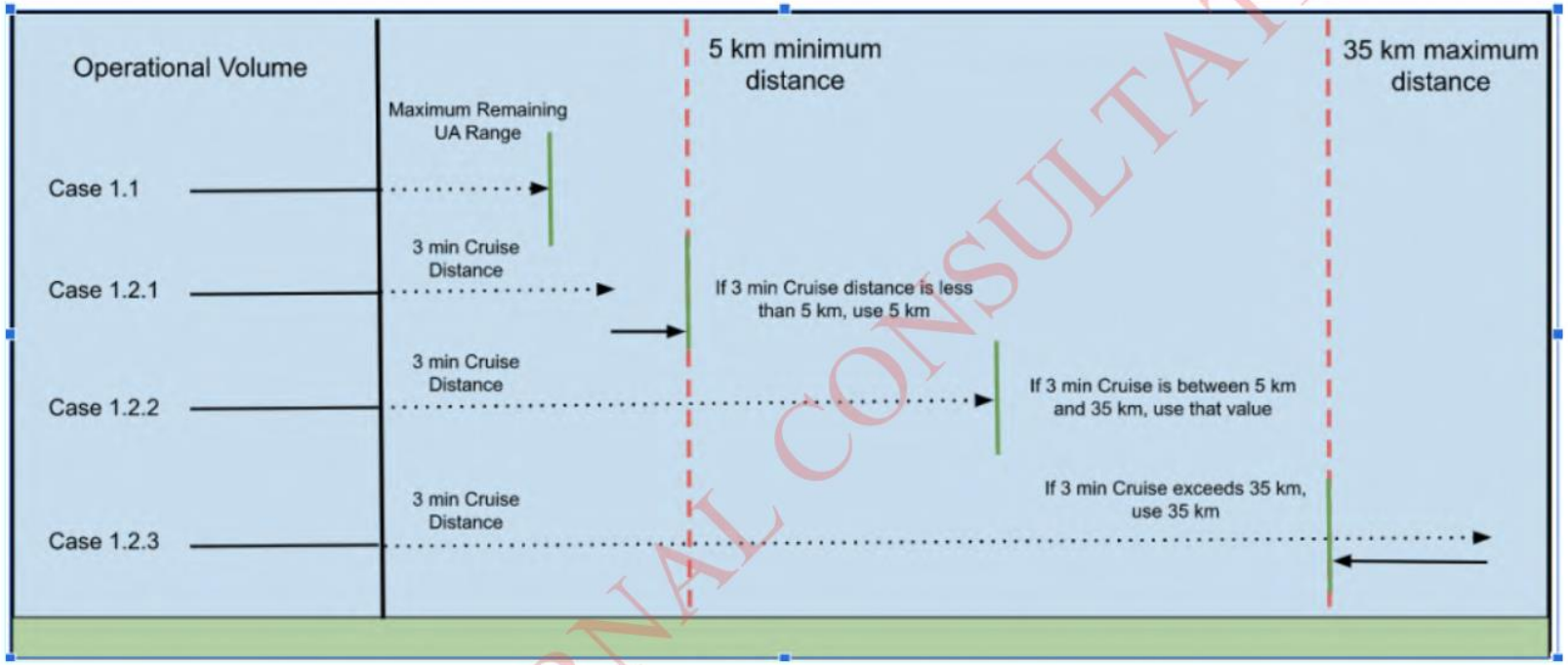

Figure 6 – Adjacent Area Lateral Distance Calculation

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Document: Main Body / Annex B / Annex E
Content change: Step #3 - Final GRC Determination

v2.0

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

Table 3 – Mitigations for Final GRC determination

v2.5

	Level of Robustness		
Mitigations for ground risk	**Low**	**Medium**	**High**
M1(A) - Strategic mitigations for ground risk	**-1**	**-2**	**-3**
M1(B) - Visual Line of Sight (VLOS) - avoid flying over people	**-1**	**N/A**	**N/A**
M2 - Effects of UA impact dynamics are reduced	**0**	**-1**	**-2 / -3**

Table 4 – Mitigations for Final GRC Determination

Document: Main Body
Content: Step #3 - Determination of final adjacent area GRC

v2.5

Mitigations might be applied to reduce the GRC of the adjacent area.

i. M1 for using the assumption of sheltering;
ii. M2 mitigations based on passive designs or inherent UA characteristics, like frangibility.

Applicants may provide justification to the competent authority for additional mitigations as long as they are still applicable in a fly away scenario.

	Level of Robustness		
Mitigations for ground risk	**Low**	**Medium**	**High**
M1(A) - Strategic mitigations for ground risk	**-1**	**-2**	**-3**
M1(B) - Visual Line of Sight (VLOS) - avoid flying over people	**-1**	**N/A**	**N/A**
M2 - Effects of UA impact dynamics are reduced	**0**	**-1**	**-2 / -3**

Table 4 – Mitigations for Final GRC Determination

Document: Main Body
Content: Step #4 – The Air Risk Process

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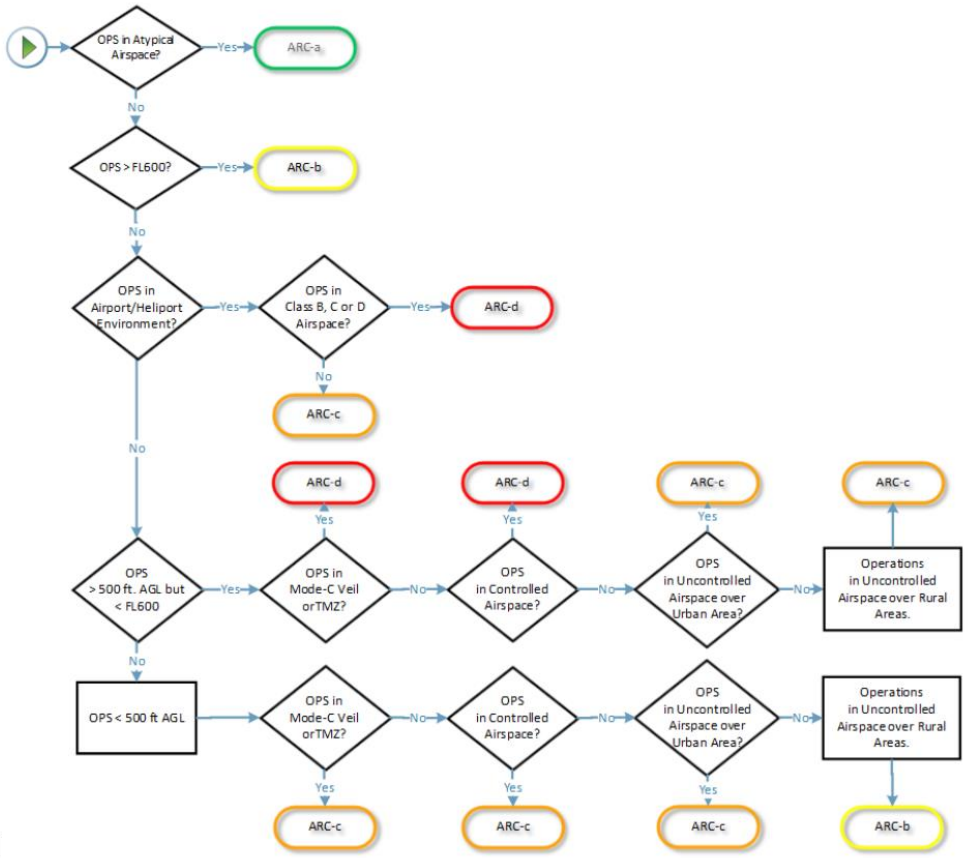

Figure 4 – ARC assignment process

v2.5

Only minimal changes for text clarity.

Document: Main Body
Content: Step #4 – Determination of adjacent airspace size

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v2.5

The vertical limits of the Adjacent Airspace are calculated as:

1. Maximum Altitude:
    1.1. Calculate the altitude gained in 3 minutes using the maximum climb rate of the UA and add it to the maximum altitude of the operational volume;
    1.2. If the above value is less than 500m above the maximum altitude of the operational volume, use 500m above the maximum altitude.

2. Minimum Altitude: if the operational volume does not reach the ground, any airspace below the operational volume is considered adjacent airspace

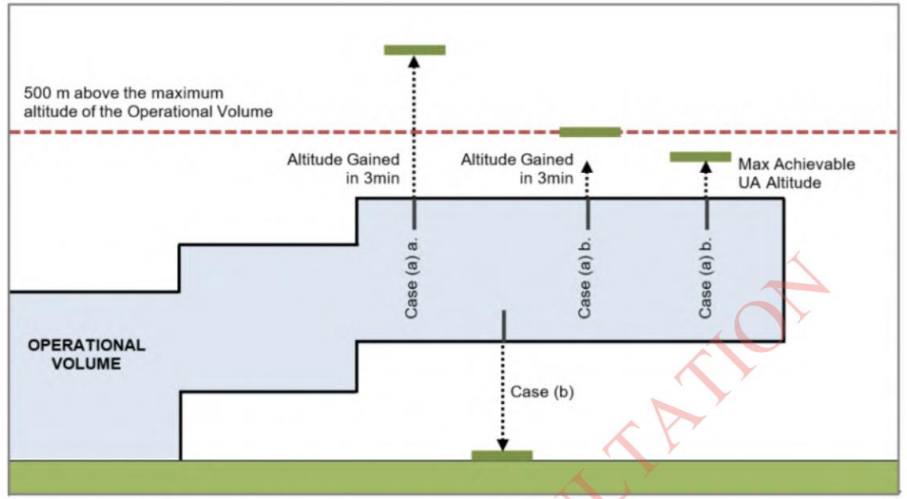

Figure 8 – Determination of the vertical outer limits of the adjacent airspace

Document: Main Body
Content update: Step #5 – Application of Strategic Mitigations to determine Residual ARC

v2.5

Point (d) below added:

(d) The strategic mitigation by operational limitation (restriction by boundary and chronology) may be used to reduce the air risk by one class in the case of VLOS operations with a considerably low time of exposure.

Note: This information will be reflected in a later version of Annex C.

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Document: Main Body
Content update: First containment, then OSOs

v2.0

Step#8 – Identification of Operational Safety Objectives (OSO)

v2.5

Step#8 – Identification of containment requirements

Document: Main Body / Annex E
Content: Step #8 – Identification of containment requirements

v2.5

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Adjacent area final GRC	SAIL					
	I	II	III	IV	V	VI
≤3	N					
4	L	N				
5	L[16]	L	N			
6	M	M	L	N		
7	H	H	M	L	N	
8	C	C	C	M	L	N
9				C	M	L
10					C	M

Table 7 – Adjacent Area Containment Requirements

Highest Adjacent Airspace	SAIL I, II, III, IV	SAIL V, VI
ARC-a or ARC-b	None	None
ARC-c or ARC-d	Low	None

Table 8 – Adjacent Airspace Containment Requirements

Adjacent Airspace Containment Requirements		Adjacent Area Containment Requirements			
		None	Low	Medium	High
	None	None	Low	Medium	High
	Low	Low	Low	Medium	High

Table 9 – Final Containment Requirements

Document: Main Body
Content update: Step#9 – Identification of Operational Safety Objectives (OSO)

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v2.0

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

v2.5

New OSO	Old OSO		SAIL						Operator	Training org.	Manufacturer
			I	II	III	IV	V	VI			
# I	#01	Ensure the operator is competent and/or proven	NR	L	M	H	H	H	x		
# II	#02	UAS manufactured by competent and/or proven entity	NR	NR	L	M	H	H			x
# III	#17	Remote crew is fit to operate	L	L	M	M	H	H	x	x	

FOR

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Document: Main Body
Content update: Step#10 – Identification of Operational Safety Objectives (OSO)

v2.5

Link to Step #1 added:

(a) As mentioned in Step #1, the Comprehensive Safety Portfolio may consist of:

i. The operator manual,
ii. Compliance evidence(s), and
iii. Documentation of the SORA process.

Link to external services added:

(c) In the case the operator uses external service(s), reference(s) to Service Level Agreement(s) (SLA) providing a delineation of responsibilities between the Service Provider(s) and the operator. (…)

Document: Main Body
Content change: Restructuring

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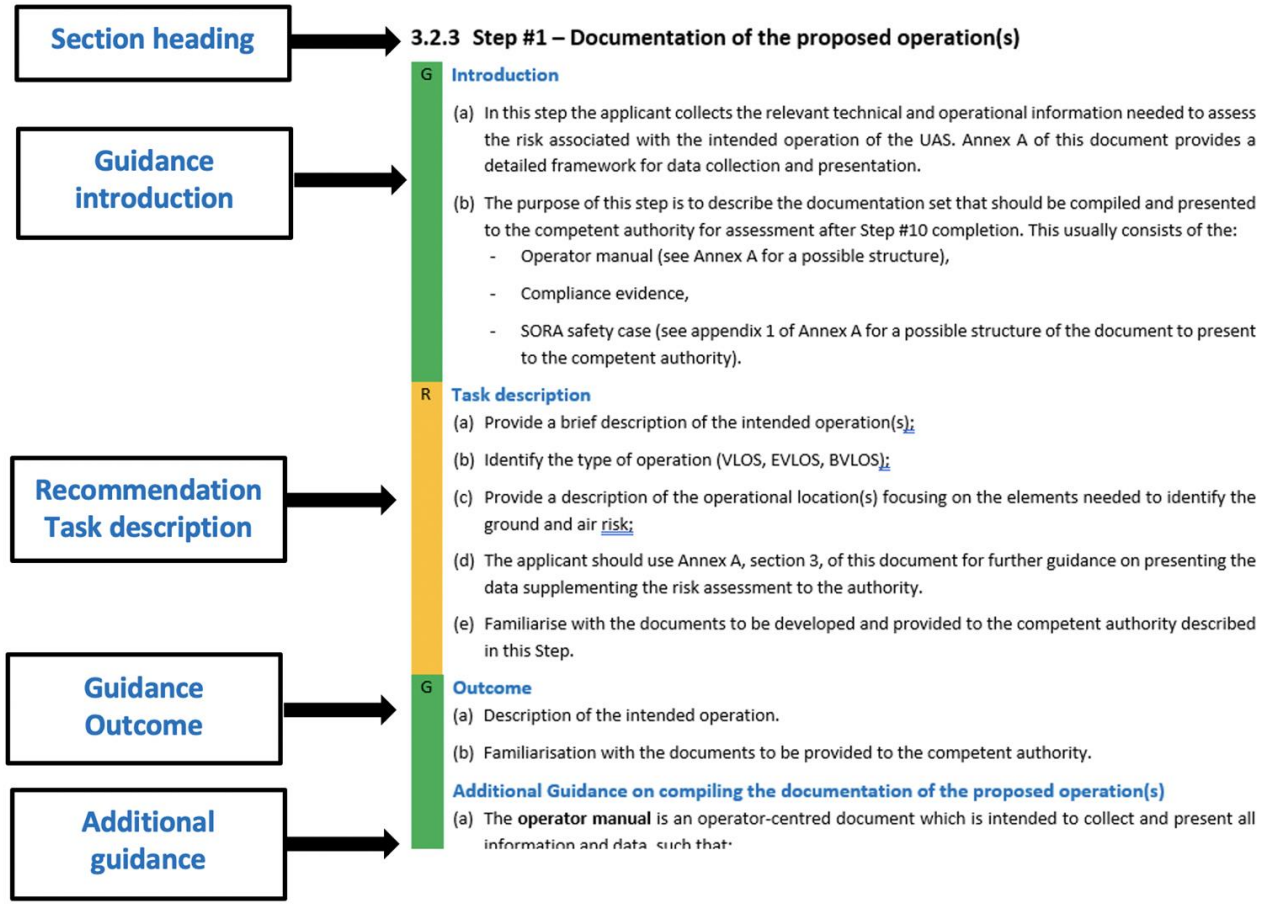
v2.5

A proposal example for restructuration of SORA Main Body has been provided in Appendix B of explanatory note.

Provided that positive feedback is received, the group intends to publish the Main Body in this updated form.

Content feedback is not expected for this part.



Document: Annex B

Joint Authorities for Rulemaking on Unmanned Systems

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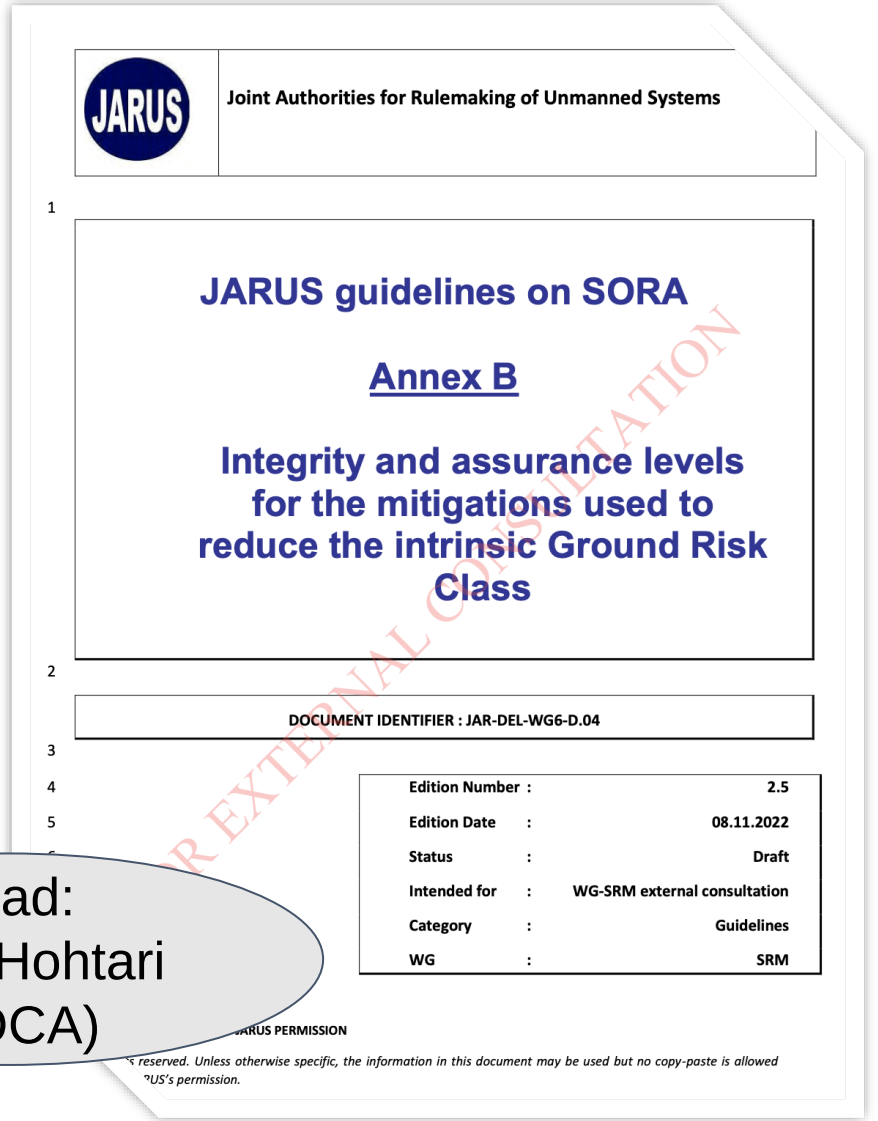

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Annex B

Integrity and assurance levels for the mitigations used to reduce the intrinsic Ground Risk Class

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Lead:
Henri Hohtari
(FOCA)

Document: Annex B
Content update: Restructure of mitigations

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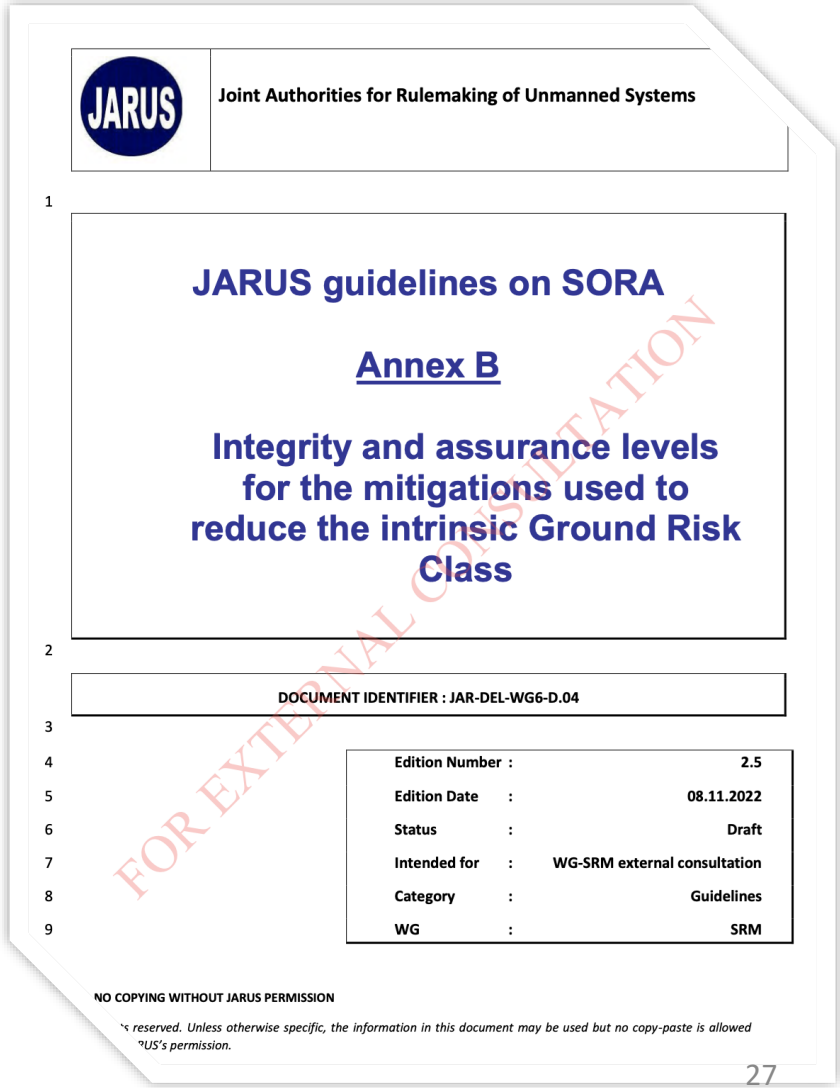
v2.5

- M1 integrity criteria have been merged in one single column - 1 point of credit reduction requires demonstration of 1 order of magnitude reduction in the population at risk.

- A new M1b has been introduced for VLOS operations, while VLOS/BVLOS criteria have been removed from Step #2.



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Annex B

Integrity and assurance levels for the mitigations used to reduce the intrinsic Ground Risk Class

FOR EXTERNAL CONSULTATION

DOCUMENT IDENTIFIER : JAR-DEL-WG6-D.04

Edition Number	:	2.5
Edition Date	:	08.11.2022
Status	:	Draft
Intended for	:	WG-SRM external consultation
Category	:	Guidelines
WG	:	SRM

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Document: Annex B
Content update: Restructure of mitigations

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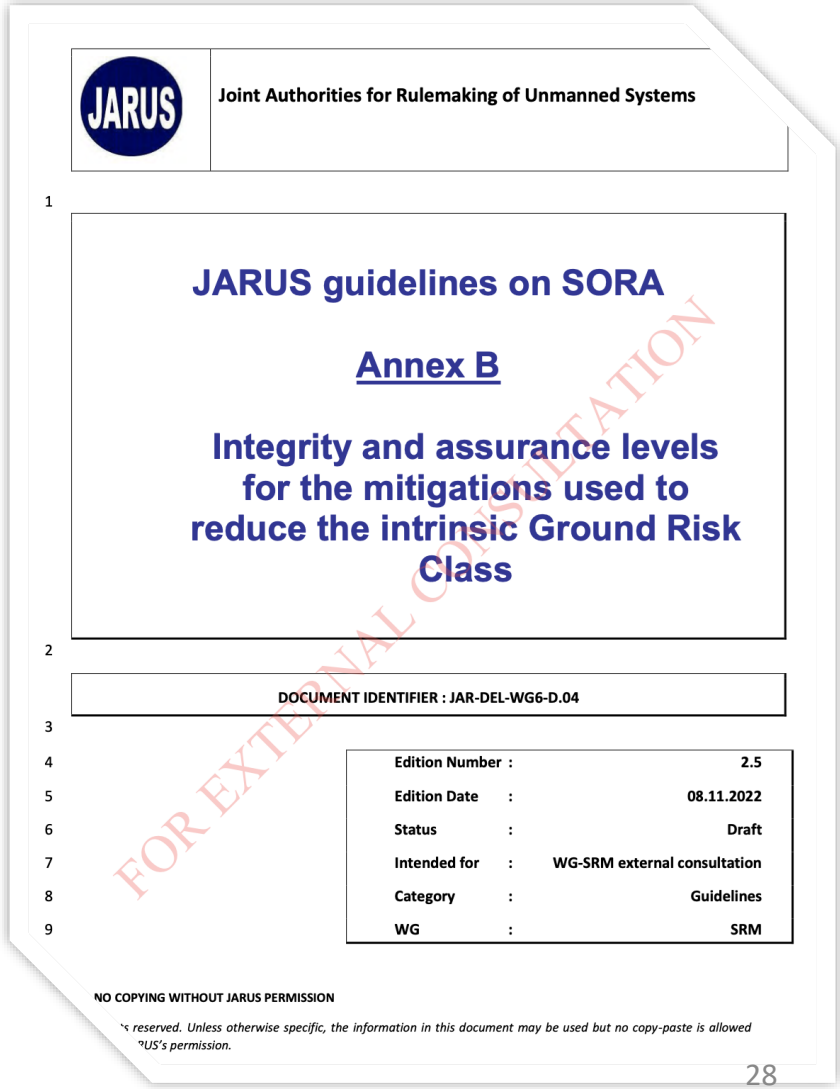
v2.5

- For M2 the table with the critical areas used in the ground risk model detailed in Annex F is included, in addition to the percentage reductions of lethality of the impact.

- M3 ERP mitigation was removed due to it causing confusion. It has been moved to Annex E.



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Annex B

Integrity and assurance levels for the mitigations used to reduce the intrinsic Ground Risk Class

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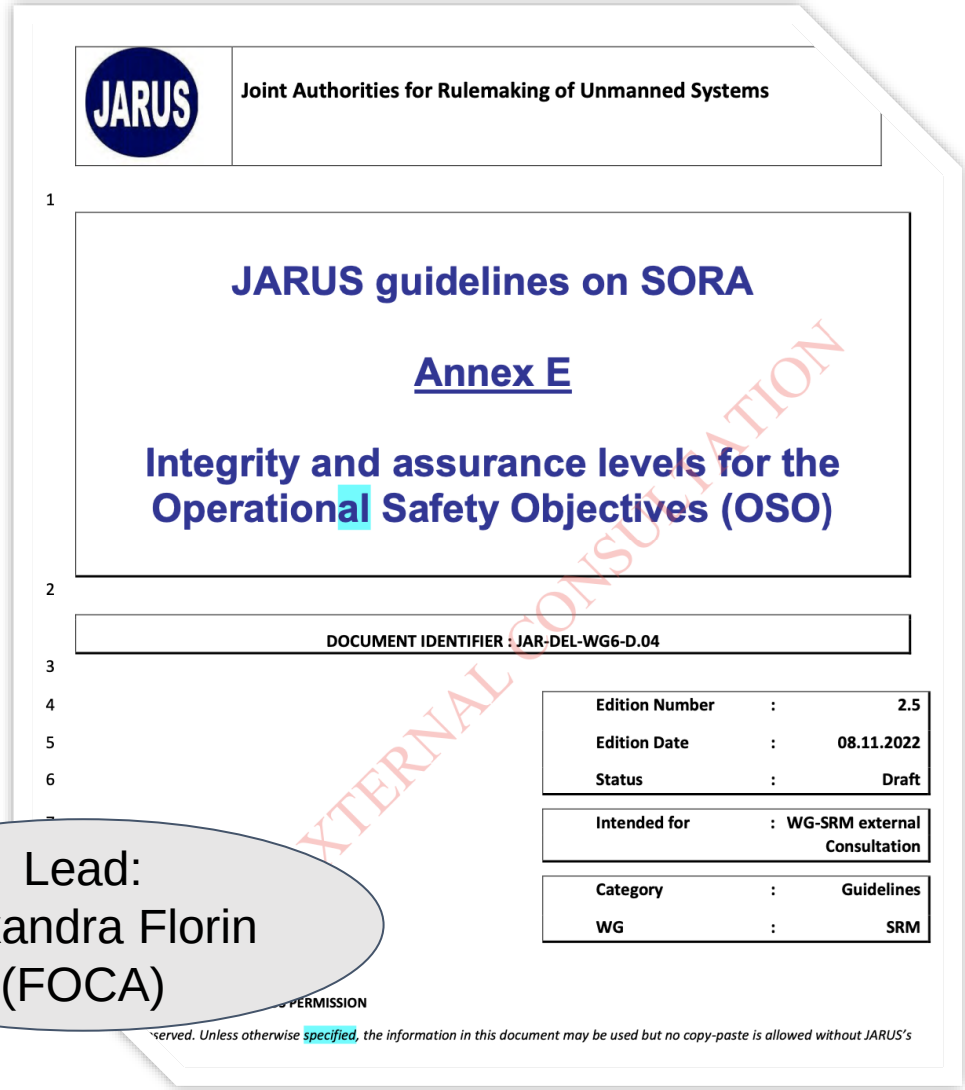

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Annex E

Integrity and assurance levels for the Operational Safety Objectives (OSO)

DOCUMENT IDENTIFIER : JAR-DEL-WG6-D.04

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Lead:
Alexandra Florin
(FOCA)

Document: Annex E
Content update: Restructure, inclusion of FTB, ERP inclusion

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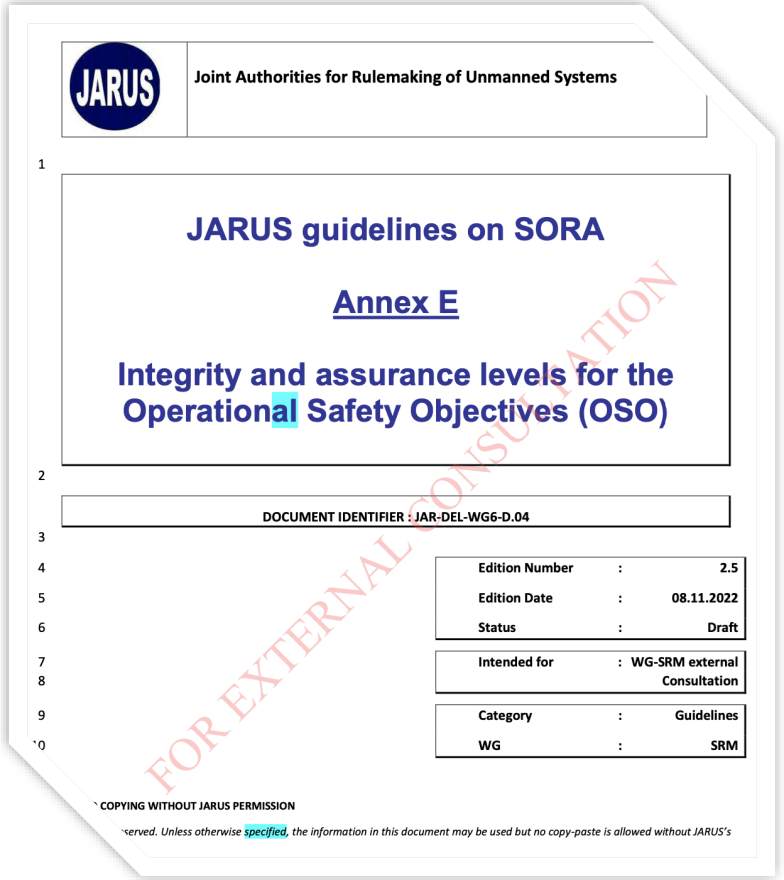
v2.5

- The order in which the OSOs appear has been modified as described in Step 9 of the main body and they were renumbered using roman numbers.

- The possibility to use a functional test based method to qualify the UA or procedures was added in the relevant OSOs.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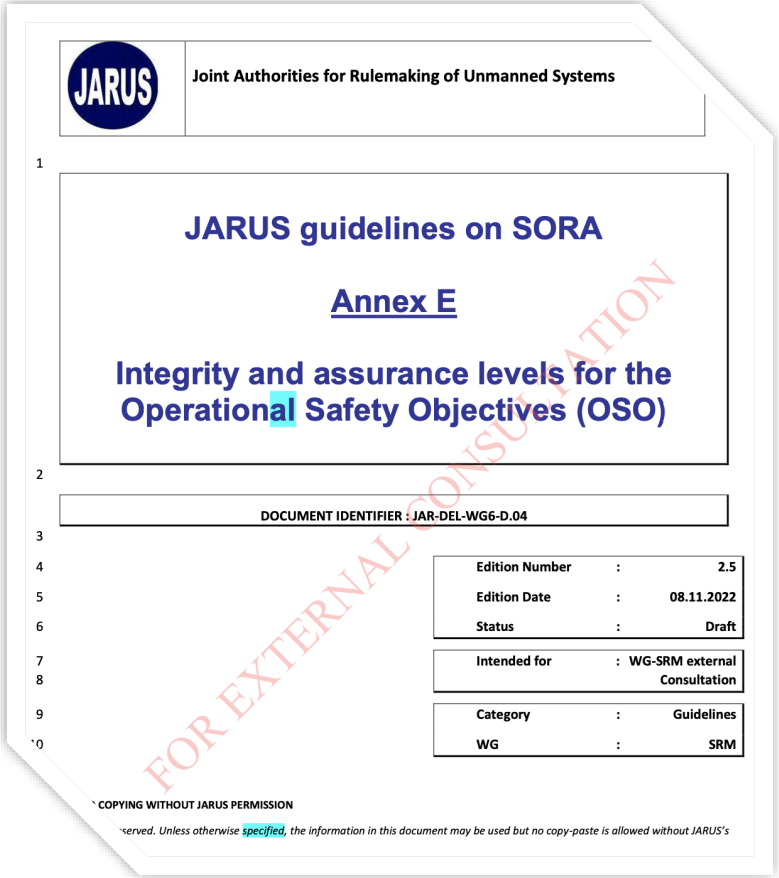
Document: Annex E
Content update: Restructure, inclusion of FTB, ERP inclusion

v2.5

- In the new OSO #IV (corresponding to OSO #8 in SORA 2.0) a new criteria related to the ERP has been added and it has been clarified that the operator should develop procedures to protect involved persons.

- Chapter dedicated to containment requirements included.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Document: Annex I

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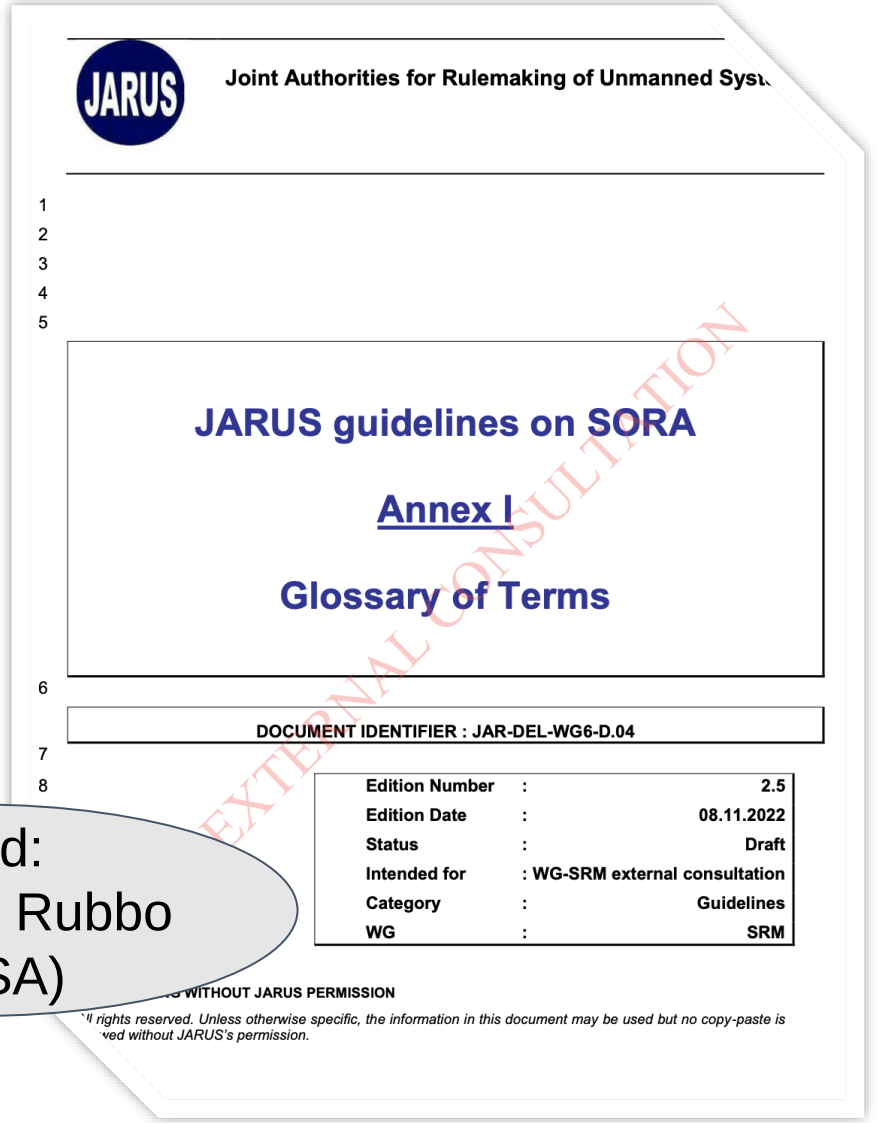

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JARUS guidelines on SORA

Annex I

Glossary of Terms

6

DOCUMENT IDENTIFIER : JAR-DEL-WG6-D.04

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Lead:
Natale Di Rubbo
(EASA)

Document: Annex I
Content update: Update of terms and abbreviations

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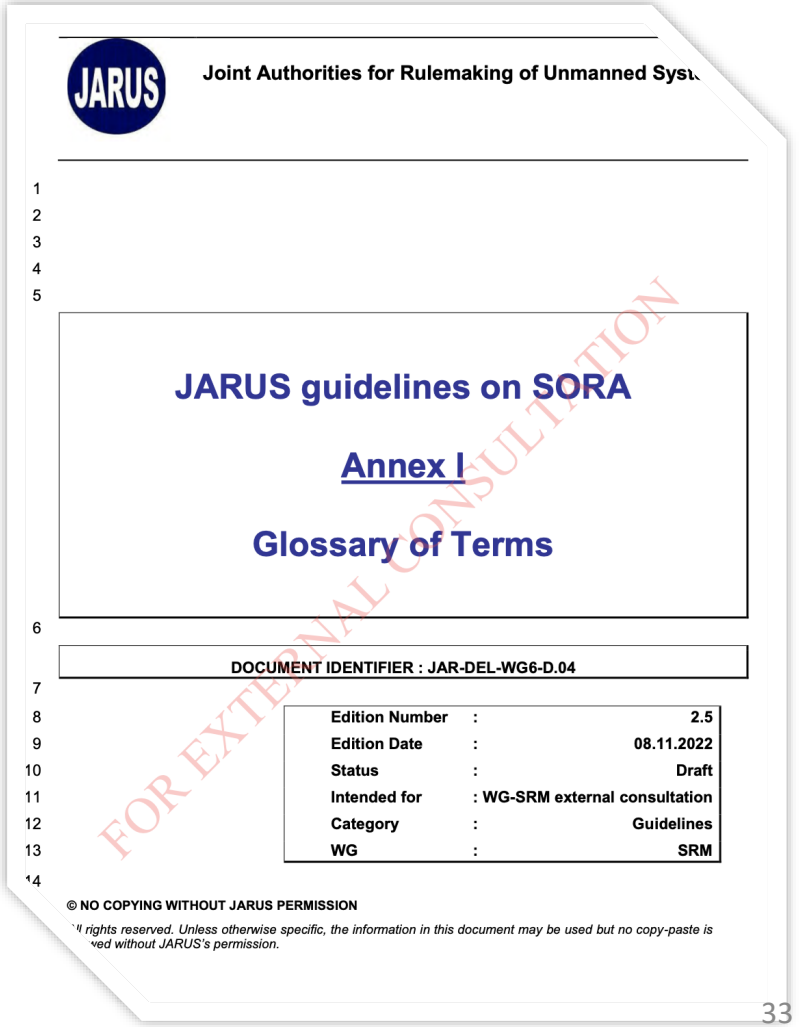
v2.5

- List of abbreviations added
- Terms and definitions updated, harmonised with the other documents



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Annex I

Glossary of Terms

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The package

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SORA v2.5

Under consultation until 6 March 2023

http://jarus-rpas.org/jarus-external-consultation-sora-version

Thank you for your attention and your comments!

The way forward – SORA 3.0

Joint Authorities for Rulemaking on Unmanned Systems

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- Focus on a more accurate air risk model, enabling better airspace integration
  - **updated** Annex C “Strategic Air Risk Mitigation”
  - **updated** Annex D “Tactical Mitigation Performance Requirements”
  - **new** Annex G “Air Risk Model”
- Further improvements on usability in all areas
  - based on field experience
  - add **guidance material** to allow for improved international harmonisation
- Addition of implementing recommendations for authorities
  - **new** Annex J “Notes to Aviation Authorities”
  - Tailored training material to support authorities in the process of adaptation

Notes on the Consultation

Joint Authorities for Rulemaking on Unmanned Systems

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SORA 2.5 external consultation is currently ongoing until March 6th 2023

Please participate and share your views! Feedback is highly welcomed!

Try to avoid comparisons to the Europe specific EASA SORA 2.0 (AMC1 to Article 11 2019/947) and references to European Rules